# PORT CONGESTION PROBLEM, CAUSES AND SOLUTIONS


**TARIG ALI EDDRGASH**

Cardiff University

Business school


This thesis is submitted to Cardiff University in partial fulfilment of the requirements for the degree of Doctor of Philosophy

September 2022

## Abstract

Port congestion has been the focus of numerous studies in the port operation and management field. Most have focused on two critical aspects of the problem and two strategies for solving and reducing or eliminating this problem: the supply and demand sides. Techniques from the supply side concentrate on increasing port capacity such as berths, cranes, storage areas, etc. From the demand side, the focus is on managing and controlling cargo traffic to ports to better match both sides' supply and demand on port resources. However, the factors behind the congestion at ports remain complex and multidimensional, and there is uncertainty in time and space. The variety of causes of congestion also creates diversity in defining port congestion phenomena. To understand this diversity and complexity, dividing and categorising the source types of port congestion problems is, in fact, needed from both academic and port industry perspectives. This research aims to reach a consensus definition for the problem and identify the common factors behind the congestion at ports. Therefore, two stages and two quantitative methodologies were employed: the systematic literature review and the online survey. The first stage aims to develop a deep understanding of the problem and establish a consensus definition for port congestion. In this stage, a systematic literature review was conducted, where evidence-based research was used to investigate the common theoretical classifications triggering port congestion and categorise the traits that can stimulate and cause the port congestion problem in most of the world ports, especially in developing countries. In the second stage, the online survey, exploratory factor analysis technique is used to model these causes and identify the most common reasons behind congestion situations at world ports, and also to reach a standard definition for the port congestion phenomena.

The research results identify a common definition that best defines the port congestion problem and accounts for all aspects of the phenomena. This provides a good foundation for future research on port congestion and helps port operators and decision-makers better identify the problem and overcome the causes. Also, the results identified nine common factors behind the congestion problem and the solutions for these causes have been categorised. Moreover, the results suggest that port congestion is highly related to management issues in parallel with weak infrastructures and shortages in facilities. Therefore, improving the infrastructure and investing in new facilities are needed. However, more concentration on enhancing and increasing the efficiency of port management, port policies and the government regulation system was highly suggested.

**Keywords**

Port, Congestion, Container terminal, Systematic literature review, Factor analysis.

## Acknowledgements

I express my complete gratitude and thank my Almighty Lord for assisting me to complete this thesis in a way that I am so proud of. I would also love to express my gratitude and thanks to all my supervisors, Dr Wessam Abouarghoub, Prof. Stephen Pettit, and Prof. Anthony Beresford, for their kind patience, constructive commentary, and helpful guidance.

I would also like to thank all these survey research respondents who agreed to participate, answered the questionnaire, and helped me gather the survey data and do this thesis.

Finally, I express my love, appreciation, and huge thanks to my beloved family, who encouraged, supported, and helped me achieve this goal.

*Tariq Eddrgash*

Table of Contents

# List of Tables

## List of Figures

## List of Abbreviations

| | |
|---|---|
| CIMO | Context, Interventions, Mechanisms, Outcomes model |
| EFA | Exploratory factor analysis |
| EBM | Evidence-Based Management |
| EBP | Evidence-Based Practices |
| EBR | Evidence-Based Research |
| ENTREQ | Enhancing the Transparency in Carrying systematic Reviews of Qualitative studies |
| IPA | Interpretative Phenomenological Analysis |
| LMA | Libyan Maritime Administration |
| LPC | Libyan Ports Company |
| MFZ | Misurata Free Zone Company |
| MMAT | Mixed Methods Appraisal Tool |
| NPC | National Planning Council |
| PCF | Prencipal Component Factor |
| PRISMA | Preferred Reporting Items for Systematic Reviews and Meta-Analyses |
| SPCO | Socialist Ports Company |
| SSRM | Social Sciences Research Method program at Cardiff business school |

# Chapter One:
## Introduction

## 1.1. Introduction

Ports are still considered the main gateways to the a country’s economy as transporting cargo by sea remains the most common way for international trading. More than ever before, they have become primers and major nodes in logistics chains. On the one hand, their fundamental activities, loading and discharging cargo, are crucial to maritime trade and transportation. On the other hand, ports are also very important as their services share contributes largely to the total chain cost. As a consequence of those two reasons, ports’ resources are more required to perfectly suit logistics chains' demands of which ports and container terminals are an integral component part. In reality, and by far, this is not always the case where one of the problematic issues that cause to prevent a match between the demand from logistics chains and the supply provided by ports’ services is the congestion phenomenon.

The congestion problem is one of the main issues facing and challenging the port and shipping industry worldwide. Ports that encounter these problems should act immediately, and within a specified period to solve them. Otherwise, these ports might lose their competitive role in competing with the neighbouring ports. This will negatively impact the country/region's economic growth.

Congestion as a concept speaks for itself that it will cause to impose a detrimental impact on both the overall cost of transport and the ports' productivity and performances. For goods transportation, congestion implies delays and extra time on shipping lines, which is eventually translated into a higher generalisation cost. It is also problematic for other port users where ships that were delayed berthing or serving because of congestion might become difficult to follow their loading and discharging schedule for the next ports’ calls. This may have consequences on capacity management and cause increased costs. This is also the same for other port actors such as cargo handling and hinterland intermodal and road accesses. Moreover, the effect of knock-on can be felt widely in logistics and supply chains such as factories, supermarkets, and others.

In the last two decades, the industrial organisations of port operations and logistic activities have changed significantly in both sectors, the port itself and its hinterland. For example, Slack and Frémont (2005) stated that the stevedoring industry and the ports are confronted with the increase in vessel size and alliance between shipping lines that have turned to increasingly demanding port services and put a high strain on its facilities. Consequently, many countries have expanded their port facilities to accommodate this increasing demand. This expansion has led to more interaction between port activities and hinterland congestion, where the latter has become more pronounced over time (Notteboom 2007).

From the economic theory point of view, any congestion situations can be efficiently reduced or eliminated by increasing the price of the system's services. This mechanism, unfortunately, cannot be employed for port services in the same way that is used in other services such as electricity, communications services etc. As stated by Agostini and Saavedra (2014), the reason behind this is that factors of seasonality do not drive much of the usage of port facilities as it is driven by the almost simultaneous arrival of so many vessels. This means that port resources necessarily must be rationed, and some vessels might need to wait (Komaromi et al. 2022).

The port congestion phenomenon has been the focus of numerous scholars in the literature on port operation and management. Most of these scholars have focused on two critical aspects of the problem and two strategies for solving and eliminating this problem: the supply and demand sides. The technique of the supply side is concentrated on increasing the port capacities, such as investing in new berths, increasing the capacity of port storage areas, increasing the number of port gates, etc. However, there are a few limitations to this strategy. First, extra land in ports might not always be available to build new berths, gates, or storage areas. Second, building new facilities might lead to the underutilization of these port resources in non-peak times.

On the other hand, the strategy of the demand side is focused on managing and controlling the cargo traffic in ports which can make a close match between both sides' supply and demand for port resources. However, the factors behind the cause of arising congestion situations at ports remain complex and multidimensional, and there is uncertainty in time and space. For example, there is strong randomness in cargo types’ where the goods' packaging, weight, and category are various, and the trucks' arrival times at port are random. Also, the vessels' arrival times at ports and the different types of these vessels are relatively unpredictable. In addition, meteorological factors might greatly affect the port operation and could lead to congestion situations in vessel berthing and cargo handling operation. Moreover, the complexity of the operation of the internal port agencies can also result in congestion cases at some port activities. The variety in causing congestion problems creates a kind of diversity in defining the phenomena of port congestion.

To understand this diversity and complexity, dividing and categorising the source types of port congestion problems is, in fact, needed for both academic and port industry fields. Therefore, the researcher in this thesis seeks to identify these main categories of the reasons that cause congestion problems and congestion situations at ports, especially in developing countries. The researcher based his research on a previous study (Eddrgash 2019), where he explored and understood the problem from a subjective view. Then the results from this stage have been adopted in this thesis to carry out two quantitative methodologies: the systematic literature review and an online survey to reach a more consensus definition for the problem and identify the common factors behind the arising of congestion situations at ports.

## 1.2. Motivation and research background

### 1.2.1. Motivation for this research study

Ports, in general, are known as essential logistics chain nodes in maritime transportation and seaborne trade. However, congestions are common problems that most ports worldwide have suffered from past and recently. The existence of the port congestion problem is global, and it not only hits larger seaports but also impacts smaller ports in the whole world. Congestion problems at ports are situations that arise when the quantities of sea freight exceed the capability of ports to deal with these increasing quantities (Bolat et al. 2020). This hampered traffic usually slows down port operation systems and causes vessels to queue for a berthing slot. Waiting time due to queuing vessels to berth at the port creates extra operation expenses for those vessels, and increases the cost for shippers.

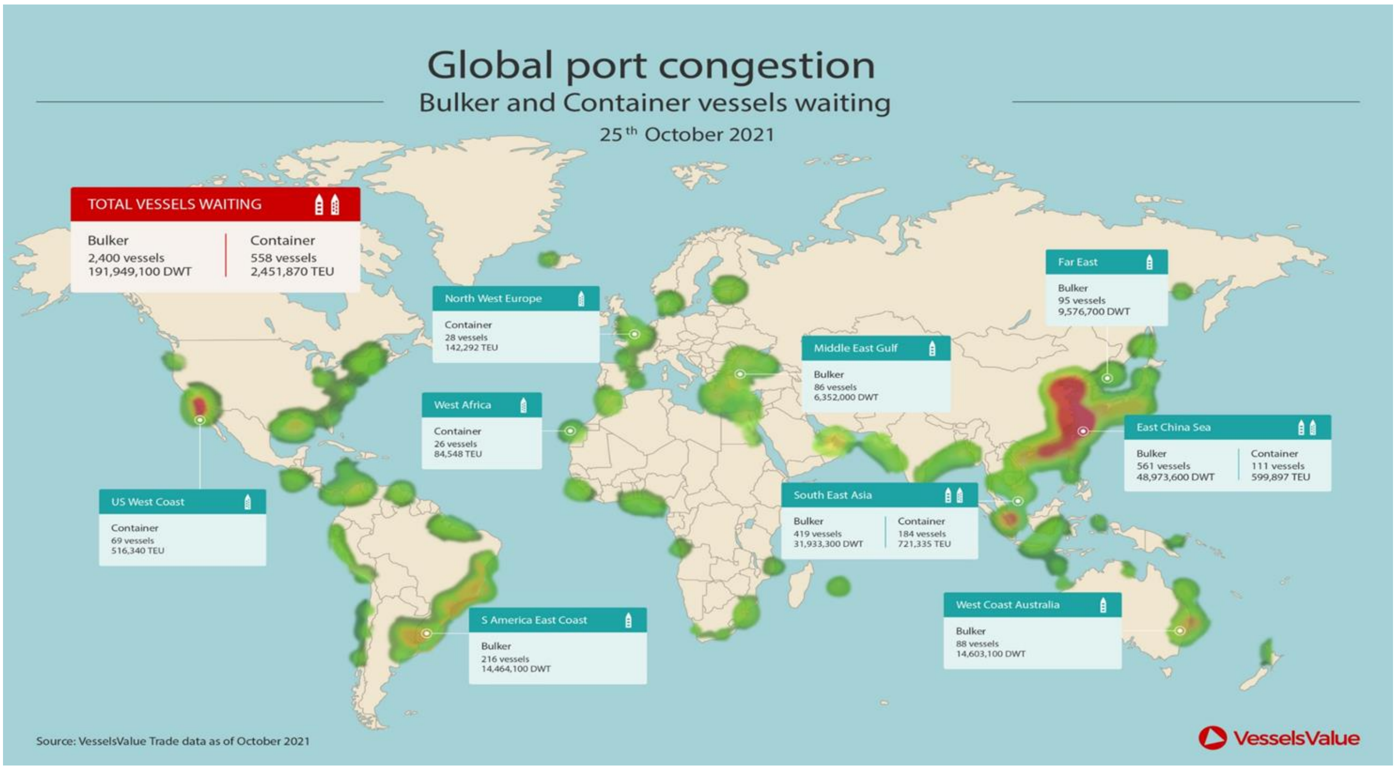
From the perspective of the port authority, problems of congestion at ports are entirely undesirable, especially if they increase and become out of control, thus seriously hindering port operations, slowing ports' developments, and it is burdening the country's national economy (Onwumere 2008). In the same way, he claimed that operators of shipping lines avoid congested ports because, from their point of view, any port's performance and productivity are measured by the average time that their vessels spend at the port for loading or discharging cargo.

Port congestion also impacts the freight market by putting pressure on transportation supply systems. This pressure leads to an increase in freight rates by aggravating the imbalance of the freight market, especially when the market is tight or booming (Bai et al. 2021). The causal effect of the port congestion problem on freight rates is usually exacerbation in severe congestion situations and also when a tight and booming market exists which certainly will increase costs for shippers and port operators.

Doll and Schade (2007) claimed that the port congestion landscape seemed to be varied and diversified from one port to another. They elaborated that while extreme port congestion situations rose at some ports and container terminals, others have not experienced congestion problems, and still a few others in between. They also claimed that, whereas some ports suffer from congestion problems on the landside, the situation problem is stated to be seaside congestion for a few other ports.

The Port congestion problem is not a phenomenon limited to a certain type of port or a specific country or region. It hits all types of model ports (public, landlord, tool, and private ports) and has been experienced in all cargo types such as container ports or terminals, bulk ports, oil ports, and passenger terminal ports. The Vessels value (2021) established a global map of world ports that reported congestion problems. In this map, the ports on the west coast of the USA, the Canadian ports, the East Asian ports, and some African ports were listed (see figure 1.1). This map suggests that the port congestion problem is neither bound to a specific part of the world nor solely connected to developing or developed market issues.

Historically, the most extraordinary heavy congestion situation ever registered was in the Nigerian ports during the 1970s. In that period the reflection of this congestion was not only felt by the ports sector, which suffered the most consequences but impacted even the industry of shipping at large as more than 10 million tons of ships capacity were stuck at congested ports creating a situation of the unbalanced shipping market and mainly known as the era of cement armada (Oyatoya et al. 2011; Onyema et al. 2015; Oruwari, A.M., 2021).



Source: Vessels value trade data as of October 2021

Figure1. 1. Ports worldwide with recently reported port congestion situations.

Also, following the last recession (2007 – 2009), the increase in international trade has caused many of the world's biggest ports (i.e., Los Angeles, Felixstowe, Long Beach, Rotterdam, etc.) to be congested due to the sudden growth in the demand for their services (Fan et al. 2012). As a result, many vessels were delayed for several days, though a lot of these ports' managers preferred to simply report that their ports were quite busy (ibid).

More recently and following the outbreak of the Covid-19 pandemic the restrictions that most governments have enforced to prevent the spread of the pandemic brought the issue of port congestion to the attention of the maritime trade community (see figure 1.1). In Europe, North America, and the Far East, ports are all experiencing some form of port congestion situations on either the seaside or landside or both levels (BPA, 2021). However, Chinese ports such as Shanghai and Tianjin reached the peak of port congestion during August 2021 when more than 370 ships have to wait for berth slots daily compared to only 70 ships in the queues in the same period in 2019 (Cook 2021).

Furthermore, according to Market Watch (2022), the war between Russia and Ukrainian, parallel with issues caused by Covid 19 restrictions, has caused more than one-fifth of the international container fleet to be tied in only a few main ports in China, the USA and Europe ports. For example, more than 344 ships in China reported having waited for berthing slots a front of the Port of Shanghai in March 2022, increasing 34% from the previous month (Ibid).

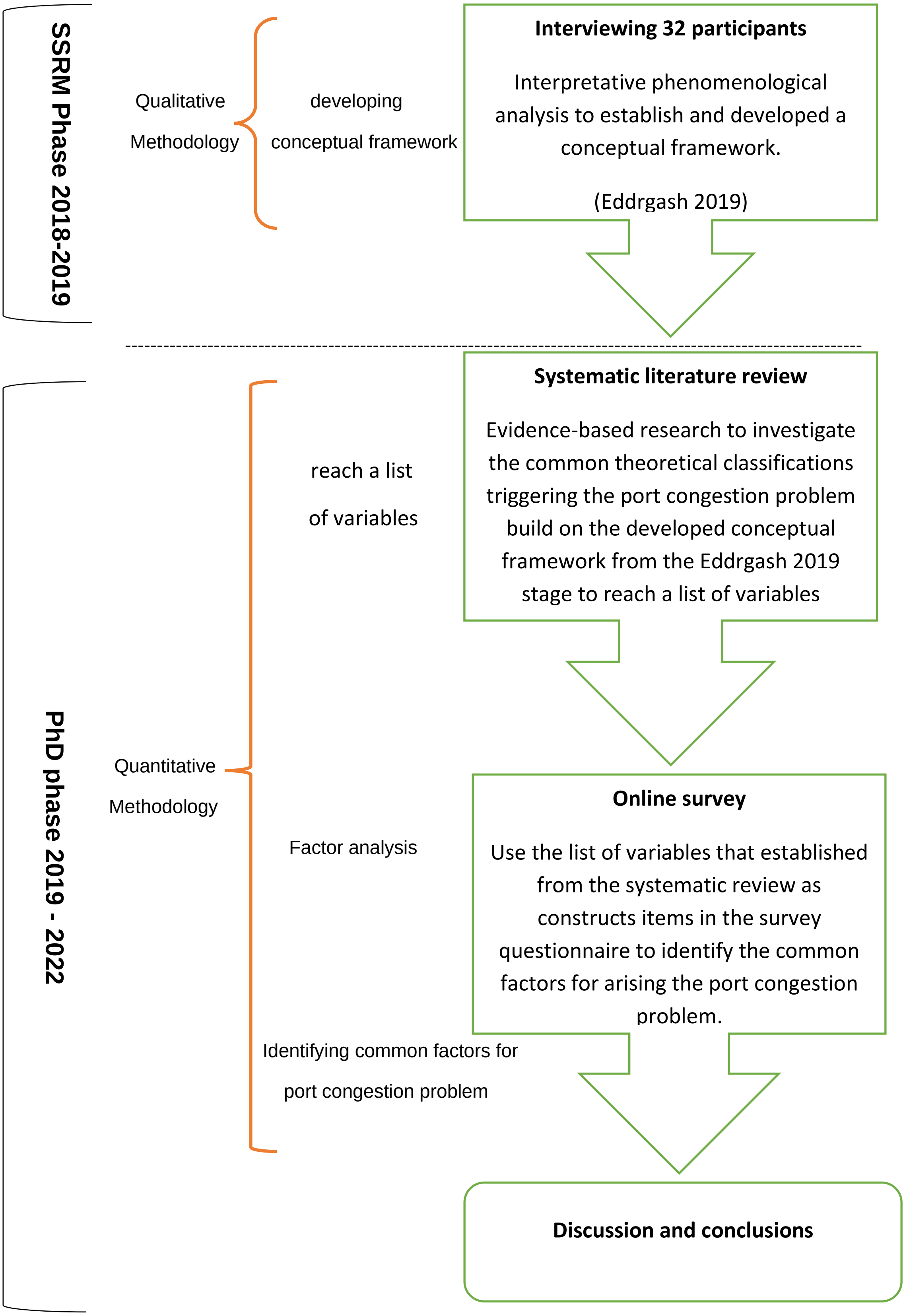
The port congestion phenomenon has been the focus of numerous scholars in the literature on port operation and management. However, one possible gap in this literature is that most of these studies have put a great focus only on port operators and shipping lines to tackle the congestion problem. In fact, maritime logistic chains imply more than simply port operators and shipping lines. They involve other important actors (players) such as Customs, Custom clearance agencies, shippers, truck companies, state authorities, logistic providers, governance mechanisms, policies, etc. The maritime logistic chain also is impacted by external uncertain (uncontrollable) factors. Some of these factors are behaviour uncertainty, such as the sudden increase in international trade (seasonality) and others are environmental uncertainty like weather conditions. Also, most scholars in previous literature have defined the port congestion problem based on the causes. They looked at the phenomena from different perspectives and generated definitions. This made a kind of diversity in defining the phenomena of port congestion. Successful, effective management of the congestion problem at ports should start with introducing an accurate and comprehensive definition of the problem. Thus, there is a need to produce a standard definition for port congestion problems that can be generalized to all congestion situations at ports and used as a baseline to identify the most common causes of the congestion problem at any seaport.

Moreover, to smoothly facilitate the maritime logistic chains and avoid congestion situations at ports, all controllable and relatively uncontrollable causes of congestion must be identified. This can be done only by considering the role of all players in any investigation that tries to explore and mitigate the congestion problems at ports. Thus, this thesis suggests overcoming this gap in the literature by extending the focus to include all players in the maritime logistic chains for tackling the port congestion problem.

#### 1.2.2. Research background

For tackling and solving the problem of port congestion the researcher in a previous study (Eddrgash 2019) explored and understood the problem from a subjective view, where 32 Libyan port stakeholders were interviewed to investigate the port congestion problem in-depth from the participants' perspectives and experiences. The findings from Eddrgash (2019) indicated that the causes of port congestion can be categorised into five common reasons that can trigger port congestion situations to arise at Libyan ports (technical, economic, social, political, and natural reasons). However, to generalise this conceptual framework (these triggering categories) to all seaports, the researcher found himself in a need of rebuts and strong positive and quantitative methodology to gain the generalisation of it which is the scope of the work of this PhD research study.

In this PhD research study, the result from (Eddrgash 2019) has been employed and tested by two quantitative methodologies: a systematic literature review and an online survey to reach a more consensus definition for the problem and identify the common factors behind the arising congestion situations at ports (see figure 1.2). Where firstly conducting a systematic literature review and based-evidence research study as a quantitative method to investigate and explore the previous publications on port congestion to identify the reasons behind the port congestion problem and their solutions and used as a list of variables for the second method. Then as a second, conducting factor analysis to analysis the data gathered from the online questionnaire to reduce those variables (the main reasons) to common factors behind the congestion situations at ports.




(Source the Author)

Figure1. 02. The research background and design for this PhD study.

## 1.3. Research statement, objectives, and research questions

Being able to accurately identify and predict the causes of congestion problem situations at ports can help the decision-makers and port operators to wisely allocate the existing port resources in the short term and evaluate the importance of infrastructure development in the long term when the problem persists (Peng et al. 2022). Thus, it is so important for academic scholars and maritime industry partitioners to deeply understand the port congestion phenomena and identify the reasons behind it accurately and make the most precise solutions to solve and eliminate the congestion situations at ports.

### 1.3.1. The statement of the research problem

Scholars in the port literature have defined the port congestion problem differently based on and in the lighting of different causes of the phenomena. This diversity in defining the problem of port congestion in the literature has emerged from the fact that the reasons behind the port congestion problem in ports are complicated and multi-dimensional (Gidado 2015). They also differ from one country to another and, in some cases, even from port to port. This was clearly seen when reviewing the literature on the port congestion problem (see chapter 2). Reviewing the literature shows many causes for congestion situations at ports. All those possible causes have been gathered from different situations and under various conditions. To understand this diversity and complexity, categorising these causes of port congestion problems into common factors behind arising the problem is, in fact, needed for both academic and port industry fields. Also, establishing a united definition can be used as a baseline for any future research about the port congestion problem to help for solving and mitigate these causes. Thus, this research study uses empirical data to tackle the problem statement, which is defined as: *It is difficult for academic researchers, port managers, and policymakers to identify common main causes and their solutions that cause congestion situations to arise at ports.* And employed the following research questions where the answer for them will help both academic researchers and practitioners in the maritime industry to solve the problems of congestion at any port:

### 1.3.2. Objectives of this study

The main purpose of this research study is to make a contribution to both fields: academia and the port operations and management industry. For the first one, this research will enrich the literature about the port congestion problem. The second one will help port operators overcome the congestion problems at their ports and provide guidelines for decision-makers and investors in port development, especially in less developed and developing countries. Thus, to consider the limitation in previous literature and the problem statement for this study, the researcher defines one main objective. This objective is to discover and distinguish the most common reasons that lead to arise port congestion nodes and how to solve these congestion nodes. Also, this main objective is divided into two associated sub-objectives to ensure a comprehensive and robust generalization of the research findings. These two sub-objectives are:

1- Conducting a systematic literature review and based-evidence research study as a quantitative method to investigate and explore the previous publications about port congestion to identify the reasons behind the port congestion problem and their solutions and used as a list of variables for the second objective. The reason for adopting this method is that the systematic review method can connect theory to practice and synthesizes evidence-based knowledge from academic studies. Thus this knowledge can be easily integrated into (policies) and effectively applied by the practitioners. Also, due to its advantage that decisions and policies can be established based on multiple forms of evidence rather than one single source of information. Moreover, The systematic review sets a boundary for the study and documents the steps. Therefore, ensuring the collection of replicable and high-quality content where the replicable process enhances the generalisability of the research findings, which is the goal of this thesis as it seeks to generalise the common factors causing port congestion in all ports around the world.

2- Building up a questionnaire and distributing online using the constructed and item variables (the main reasons behind arising port congestion problem) obtained from the systematic review stage (chapter 4). Then conducting factor analysis to reduce those variables (the main reasons) to common factors behind the congestion situations at ports. The employment of the questionnaire is popular due to its fast gathering of extensive data in a short time and low-cost way (Saunders et al., 2009). It also enables answering questions without the potential bias from the researcher (Bryman and Bell 2007). According to Bryman and Bell (2007), online questionnaires have become increasingly attractive to business researchers, especially management research studies. Online questionnaires have a lot of advantages and strengths that explain the increase in using them throughout the research. See table 5.1 in chapter 5 which summarises some of these strengths.

#### 1.3.3. Research questions

Three research questions and their sub-questions were stated to achieve solve the above research statement and problem:

**1.** What is the best definition for the port congestion problem that can comprehensively express port congestion situations?

1.1- What is the consensus among the port practitioners on a common or united definition of the port congestion problem?

**2.** What are the common reasons that lead for arising the congestion problems at ports?

2.1- What are the internal causes that impact the port systems and cause port congestion situations to arise at any port?

2.2- What are the external causes impacting the port systems and causing the port congestion situations to arise at any port?

**3.** What are the possible solutions to those common reasons for the port congestion problem?

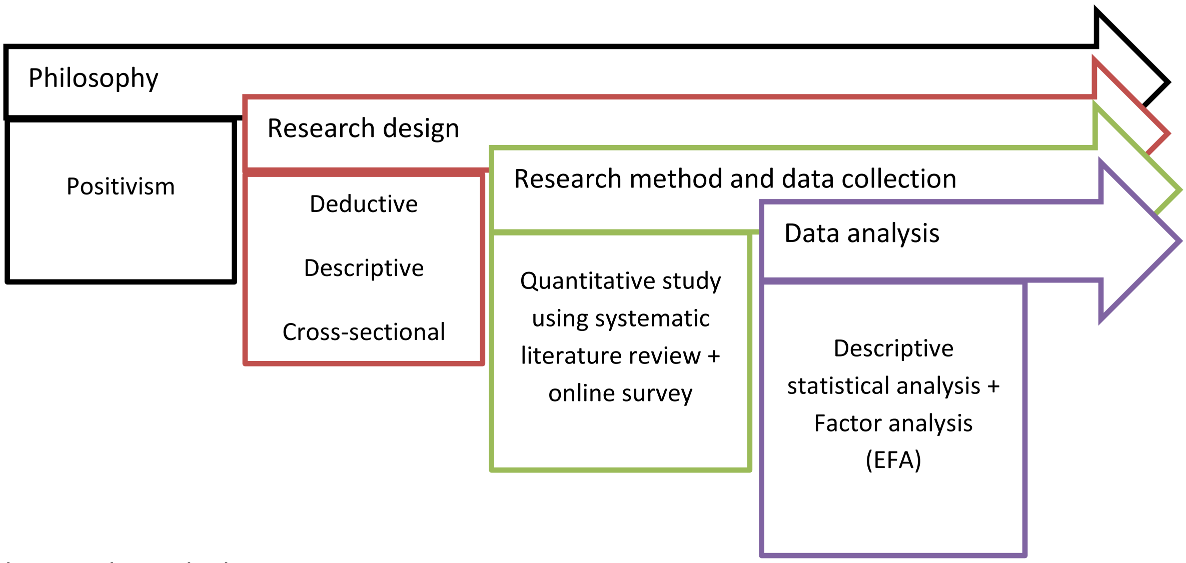
3.1- What is the role of the government in solving port congestion situations?

3.2- What is the role of the port operators in solving port congestion situations?

3.3- What is the role of the shipping lines or ship owners in solving the port congestion situations?

## 1.4. Research methodology

The researcher's target is to investigate the congestion problems at ports and identify the most common reasons behind these problems at global ports. For this target, the researcher has chosen the descriptive research design as the best fit for the study objective. Descriptive studies are usually used to describe the phenomena under study based on a prior understanding of the nature of the research problem (Collis and Hussey 2009). Furthermore, they are also used to vindicate whether the predicted relationships exist and are inherently objective, so they can be empirically tested and answered (Saunders et al., 2012). Thus, in order to achieve the research objectives, it is critical for the researcher to be under the positivism paradigm and use a quantitative research approach for collecting and analysing data. This research strategy can be used to understand human attitudes and behaviours via objective values and to gain a generalization of the research findings (Ibid). Therefore, the researcher adopted a positivist philosophical stance and used quantitative methodologies (systematic literature review and online survey) to collect and analyse the research data (see Figure 1.3). The full details of each methodology of those methods (systematic literature review and online survey) are fully discussed and explained in their chapters (chapter 4 for the systematic review and chapter 5 for the online survey). Then the results were discussed and confirmed, and recommendations were given to enrich the existing literature about the port congestion problem.




(Source the Author)

Figure1. 03. A brief summary of the research design for this PhD study.

## 1.5. Chapters summary

The structure of this PhD study is briefly explained in this section. This thesis has six chapters that come along with references and appendices, and here is the summary of these chapters:

**Introduction (Chapter one)**: It starts with a general view of the research topic and then explains the study's motivation. Next, the research background, research aims, and problem statement are discussed and followed by the research objectives. This chapter continues by formulating the research questions, and finally, it demonstrates and justifies the used methodology.

**Literature review (Chapter Two)**: The theoretical foundation of the existing literature about the port congestion problem is reviewed in this chapter. It starts with a background on the port congestion problem. The chapter extracts the definitions for the port congestion problem from the literature and elaborates on the lack of consensus among scholars on defining the phenomenon. This chapter also presents the type of port congestion levels discussed in the literature: Seaside congestion, Landside congestion, and Hinterland-side congestion. Finally, this chapter identifies, elaborates, and discusses all reasons behind the port congestion problem that emerged in the previous literature and theoretically classifies them into five categories: Natural reasons, Economic reasons, Technical reasons, Policy reasons, and Social reasons.

**Research methodology (Chapter Three)**: presents, outlines, and justifies the methodology selected to collect and analyse the data of this PhD research study. In this chapter, the methodology was employed to link the conceptual framework developed in the early study (Eddrgash 2019) with the empirical findings presented in the following two chapters. This chapter starts with the research paradigm and presents two different epistemological perspectives, positivism and constructionism and discusses how these two perspectives have influenced the research in the field of operations and management studies. Then it follows by explaining the research design. Finally, the applications of the used methods (systematic literature review and online survey) in this thesis are discussed.

**Systematic literature review research (Chapter Four)**: This chapter seeks to discover whether the eight Superordinate reasons and Subordinate reasons identified by Eddrgash (2019) cause and influence the problem of congestion at world ports. Also, it seeks to answer the question; What is the existing evidence in the previous literature that informs and exerts the most decisive influence? For this purpose, a systematic literature review method where the evidence-based research framework developed by Gough et al. (2012) is used to investigate the common theoretical classifications triggering the port congestion problem. Furthermore, it is used to categorize the traits that can stimulate and cause the port congestion problem in most world ports. These causes will be used as a list of variables in the chapter (5) to find the common factors behind port congestion problems at ports.

**Online survey research (Chapter Five)**: In this chapter and based on the theoretical, conceptual framework developed early by Eddrgash (2019), and the port congestion causes that have been identified and yielded from the systematic literature review method (chapter 4), an online survey is conducted to identify the common factors of port congestion causes in seaports. In this chapter, an online questionnaire is built, distributed, and analysed to obtain and model the common factors behind the problem. This chapter first provides a detailed account of the survey methodology that the researcher has employed in this study. Then it presents the research findings and discusses the results. Finally, it concluded with the study conclusion and remarks.

**Conclusions (Chapter Six)**: This chapter summarises the research process, and the findings from both studies (systematic review and online research) are represented. In addition, an explanation of how these findings have met the research aim and objectives was given. Furthermore, suggestions for port managers and policymakers have been given. Also, research limitation is pointed out with future recommendations for research. As a final point, this chapter ended with the contribution of this research to the knowledge base.

# Chapter Two: Literature Review (The port congestion problem)

## 2.1. Introduction

The literature about the port congestion problem is reviewed in this chapter to gain knowledge about the phenomena and understand the theoretical conception of the port congestion problem, especially the body of knowledge regarding the congestion definitions, common reasons behind the port congestion problem, and the potential solutions for it.

The researcher in this chapter remaps and elaborates on what has been discussed in the literature about the problem of port congestion by dividing the body of the literature into four sections. Following the first section (2.1) which is a brief introduction to this chapter, section (2.2) comes next with the potential definition for the port congestion problem. In this section, the researcher attempts to identify, explain and elaborate all definitions for the port congestion phenomena that have been included in the previous studies about port congestion. Then in the third section (2.3) (congestion source types), the researcher starts with identifying, explaining and elaborating the three areas of operation interface in any port (seaside, landside, and hinterland-side) as were distinguished in the previous studiers regarding port operations and management. Then the researcher tries to identify, explain and elaborate on congestion situations in these three areas as they were mentioned in the previous studies about the port congestion problem. The researcher called this section (2.3) congestion source types. Then, in the fourth section (2.4), the researcher tries to identify, elaborate, and critically evaluate all the causes of the port congestion problem and their potential solutions as they were mentioned in the previous studies. The researcher in this section also tries to classify these causes under the five categories that trigger the port congestion problem developed early by Eddrgash 2019. Also, the researcher tries to identify any difference (if there is one) regarding causing the problem and any suggested solution between developing and developed countries (see table 2.1). In section 2.5, the researcher discusses and explains the impact and the effect of the Covid 19 pandemic on the global port networks. Finally, in section 2.6, the researcher introduces and discusses the port stakeholders that are impacted and affected by the port congestion problem and should be targeted as population samples for any research study related to the causes and the solutions to port congestion problems.

| Section no: | The covering area from the literature |
|---|---|
| Section 2.1 | A brief introduction for this chapter |
| Section 2.2 | Identify, explain and elaborate all definitions for the port congestion phenomena that have been included in the previous studies about the port congestion |
| Section 2.3 | Identify, explain, and elaborate on congestion situations on the three areas of operation interface in any port (seaside, landside, and hinterland-side) |
| Section 2.4 | Identify, elaborate, and critically evaluate all the causes of the port congestion problem and their potential solutions according to the five categories that trigger the port congestion problem to arise at ports developed early by Eddrgash 2019. |
| Section 2.5 | Discuss and explain the impact and the effect of the Covid 19 pandemic on the global port networks. |
| Section 2.6 | Introducing and discussing the port stakeholders that are impacted and affected by the port congestion problem. Also, that should be targeted as population samples for any research study related to the causes and the solutions to port congestion problems. |

Table 2. 1 The structure of chapter two (the literature review)

## 2.2. Port Congestion: Potential Definitions

Broadly, the congestion concept can be defined as a situation when capacities cannot match throughput growth (Talley 2009). Congestion at seaports or congestion port problems has been differently defined by scholars in the literature. Some of them use a general picture to define the port congestion problem. Talley

(2006) defined the problem as a situation that arises when a port user impedes another in utilising port resources. Also, Meersman et al. (2012) used the same way to define the problem as a situation that arises when a transport user, for example, a ship, causes a delay to another user of the transport system. Other scholars were more specific in defining port congestion, so they concentrated their definition on a specific reason behind the port congestion problem. For example, Maduka (2004) based his definition on unclear cargoes as a reason for the port congestion. Therefore, he defined the problem as a situation where vessels have to wait for a long time before entering the port as all port capacities are occupied with clearing cargo backlogs.

In the same way, Alderton (2005) used the lack of port capacity to define port congestion as a situation that arises when port capacity cannot keep up with the increase of ship traffic to a port. Also, in the same direction but more broadly, Dragovic et al. (2006) defined the congestion problem, based on the change in the supply and demand for port capacity, as a situation where ports' capacities cannot cope with the increasing demand on them. Also and more recently, Bolat et al. (2020 p. 253) defined the problem as "a result of the quantities of sea freight surpassing the capability of the seaport to handle, store, and find space for moving the cargo". Onwumere (2008) went in another direction and used a different specific reason to define port congestion. He defined the problem based on port operation efficiency as a situation where ships have to stay and wait in a queue for an unusual time before getting a berth inside the port due to inefficient port operations. Another perspective to define the port congestion problem was taken by Chinedum (2018). He defined the congestion problem based on its effects on the supply chain as a situation that caused unpleasant consequences on logistics systems and the supply chain because of delays and extra time for vessels and cargoes at ports which usually impose extra charges on customers.

The diversity in defining the problem of port congestion in the literature has emerged from the fact that the reasons behind the port congestion problem in ports are complicated and multi-dimensional (Gidado 2015). They also differ from one country to another, and in some cases, even from port to port (Ibid). Thus, dividing and categorising the source types of port congestion problems are required to understand this diversity and complexity.

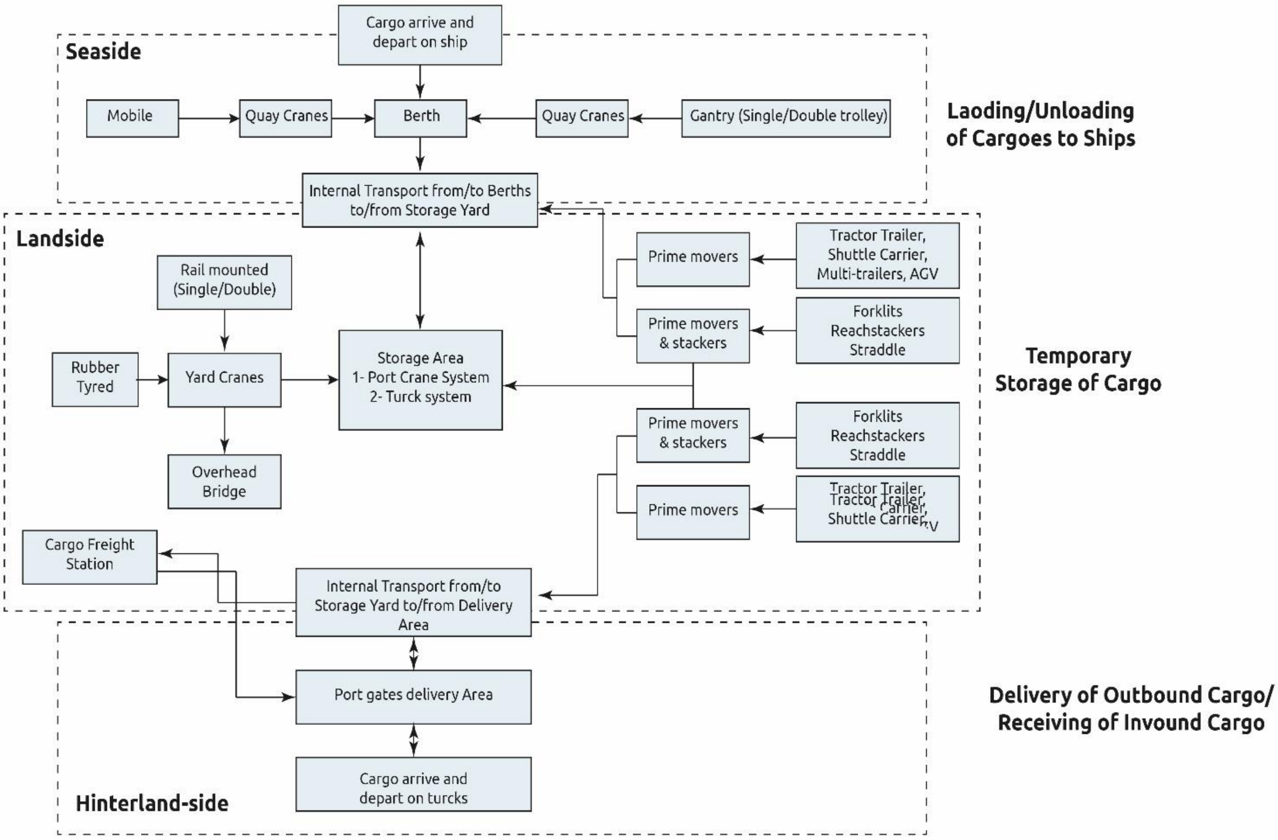
## 2.3. Congestion Source Types

Maritime ports in general* are open systems of cargo flow with two types of external interfaces. The first is the quayside, where cargoes arrive or leave by ships. The second type is the landside, where these cargoes leave or arrive at the ports through hinterland-side intermodal.

Thus, within any port, three areas can be distinguished: Sea quayside area where ships have to be berthed and served, port storage areas where cargoes have to be stacked and stored before being exported by sea or transferred outside through the port gate, and hinterland areas, where the cargoes have to be transported by one of the transportation models to the inland end-users. In the same way, operations at any port can be categorised into three types: Seaside operations, Landside operations, and hinterland-side operations, where the interaction among each other plays a crucial role in efficient management and operation (see figure 2.1).

Seaside operations represent guiding ships at the anchorage area, manoeuvring ships through port channels and berthing the ships at port berths. Landside operations consist of loading and discharging cargoes to/from ships via cranes and then moving these cargoes to the stacking or storing areas by internal port transport. The interaction between seaside and landside operations is through the port handling and internal transporters' equipment. Finally, the hinterland-side operations manage the cargoes transported from the landside to hinterland-side areas through port gates. The interaction between landside operations and hinterland-side operations includes the activities of receiving and delivering inbound and outbound cargoes, which deal with the operations of external transport of cargoes via trucks/rail from/to port storage areas to/from inland end-users.

* The word port in this research is represented for all types of ports in relation to cargo types such as dry cargo ports, container ports or terminals, passengers' terminals etc.., and the type of ports was specified only when there is a need for this such as special congestion issue related to the type of port.




(Adapted from Maguire et al., 2010.).

Figure 2. 1. Three categories of operations at any Seaport.

The consequence of the complexity of the above operations and interactions is that congestion problems at seaports can occur at one or more of these three different levels of port congestion (see table 2.2):

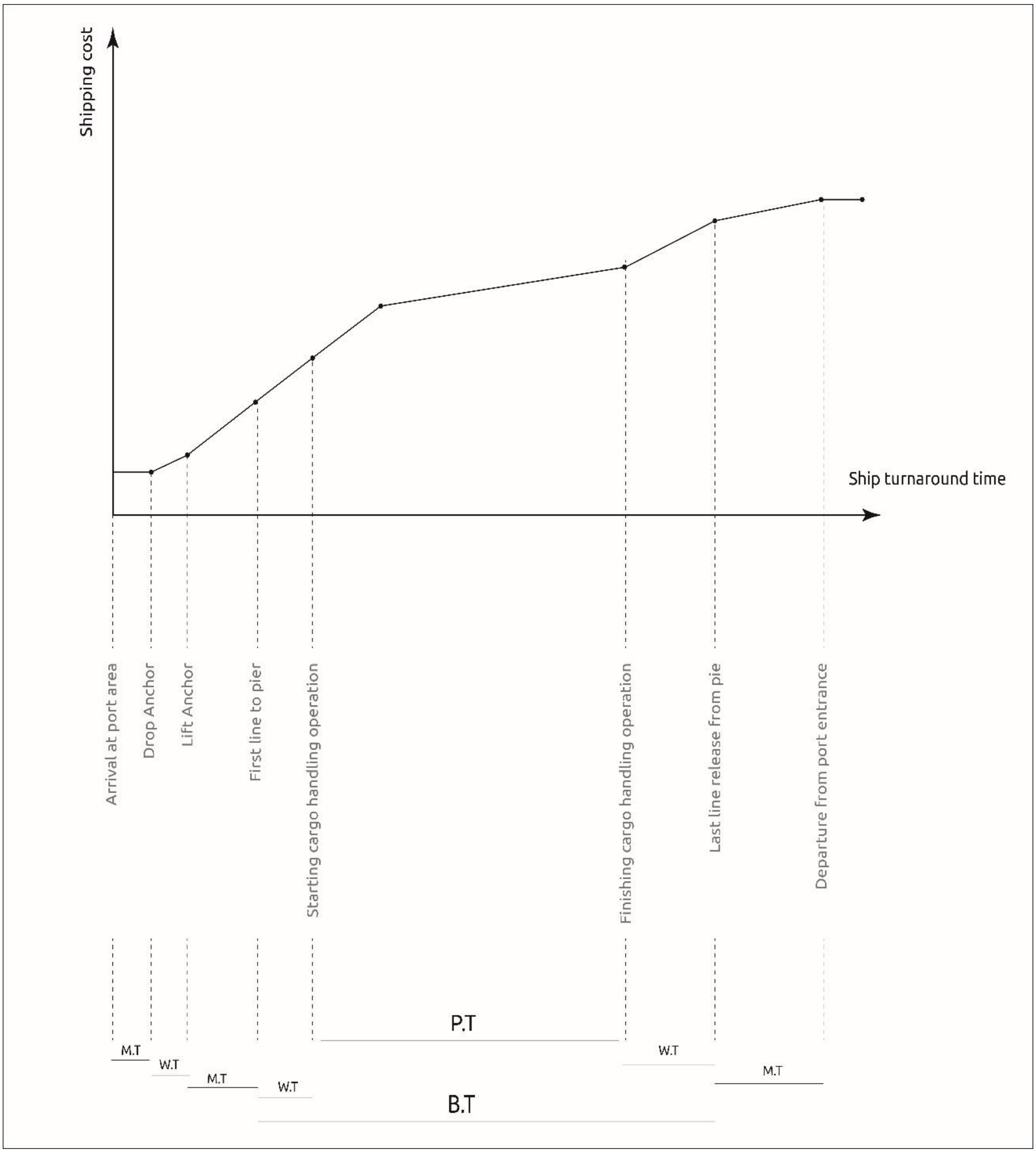
| Port operation congestion levels | Congestion source type |
|---|---|
| Seaside congestion level | **4.** Ship entry/exit rout congestion<br>**5.** Ship to berth congestion |
| Landside congestion level | **6.** Ship work congestion<br>**7.** Cargo storage and stack congestion<br>**8.** Vehicle work congestion |
| Hinterland-side congestion level | **9.** Vehicle gate congestion<br>**10.** Vehicle route congestion |

Table 2. 2 The congestion source types at any port

#### 2.3.1. Seaside Congestion Level

A vessel that is sailing from the open sea and calling at a port might experience congestion problems of two types of seaside congestion, depending on the geographical location of the destination port (Meersman et al., 2012). These types are Ship entry/exit route congestion and ship-to-berth congestion.

**Ship entry/exit route congestion** mainly arises due to external factors such as geographical blockages or circumstantial climate obstacles on the seaport access routes (Chinedum 2013). A ship at sea might face many uncertainties such as weather conditions, tides, and accidents that cause unreliability on its schedule (Zhang. et al. 2022). Also, ports in some areas of the world are connected to open seas or oceans by canals or in other areas by rivers where congestion problems might appear because of tide dependences (shallow water port entrance) or/and shortages in capacities. In all these situations, ships have to adjust their speed during the sea trip to match the expected vacancies on these routes. Also, some ports are located behind a lock system due to tide problems which might lead to congestion situations if the number of arrival ships is higher than the lock system capacity (Sheikholeslami and Llati 2018). Moreover, bad weather and flood conditions usually lead to blocking the port access for navigation movements, which could result in queuing of ships in the port anchorage area or ultimately the overstay of vessels at port berths (Li and Jia 2019).




W.T: waiting time M.T: Manoeuvring time P.T: Productive time B.T: berthing time

(Source: Author)

Figure 2. 2. The turnaround time for a ship at any port.

**Ship to berth congestion type.** This is a situation where ships have to queue waiting to enter the port due to internal factors such as shortages in tugboats' services and/or inefficient ship-to-berth plans (Chinedum 2013). In this situation, a lack of port facilities such as port tugboats or pilotage services can lead to congestion situations as ships have to queue and wait for their turn to be manoeuvred to the port berth. Moreover, inefficient ship-to-berth plans could lead to congestion problems, especially when the port is receiving different sizes and types of vessels and the port berths capacity was not used efficiently by port operators to accommodate these ships (Nze and Onyemechi 2018).

Also, this type of congestion might be a result because available berths allocated to the waiting traffic are still occupied by early-entering ships. According to Meersman et al. (2012) ship- to- berth congestion could arise when allocated berths to the traffic remain occupied by ships that are not ready to clear the berth even though the cargo handling operation was over. In such cases, they argue that the departing ship must be moored temporarily to another quay if there is one empty, otherwise, it must be moved to wait outside the port.

Thus, the seaside congestion type can be defined as situations that arise from external and internal factors related to the seaport accesses and entry routes and causing the delay of ships and increased turnaround time, and consequently, the increase of shipping costs (see figure 2.2). The external factors are related to factors that are not under the control of the country's port system, such as bad weather, tide, and floods. In contrast, internal factors are controlled or relatively controlled by the country's port system, such as port capacity and infrastructure.

### 2.3.2 Landside Congestion Level

Landside (or portside) congestion is a situation that arises from bottlenecks in cargo handling operations such as loading and unloading cargoes, stacking, and storing these cargoes, moving and transferring of cargoes from ships to stacking areas and the vice versa. In the literature, landside congestion is usually categorised into three types: ship work congestion, cargo staking congestion, and vehicle work congestion.

**Ship work congestion.** This occurs mainly due to delays assignable to breaks and time gaps in the operation works on charging and/or discharging the vessel, which might lead to unnecessary stoppages that could increase the service time for the vessel to complete the task of cargo operation (Chinedum 2013). Hence, most of the ports have a limited capacity of port berths. Usually, all of them are occupied by ships loading or unloading cargo; any shortages in handling equipment such as quayside cranes, straddle carriers, and port trucks can delay handling works on ships. Also, any bad management and poor maintenance of that equipment could consequently result in time delays and system failures.

**Cargo storage and stack congestion.** This type of congestion imposes additional waiting times for both shipping lines and cargo owners. It is mainly caused by insufficient storage capacity and a lack of stacking areas at the port (Meersman et al., 2012). It also might emerge from the sudden increase in international trade at the port or the lengthy stay of cargoes at the port stowage areas beyond the reasonable storing time, thus causing shortages in capacity at the port storage areas (Chinedum 2013). The latter could happen due to inefficient port policies and cheap storing tariffs or stringent customs regulations, and severe checking procedures at the port gates (Gidado 2015). Cargo storage and stacking congestion might also arise from ineffective port system configuration, resulting in inefficient plans for port trucks' movements between stacking areas (Roy et al. 2016).

**Vehicle work congestion.** This type of landside congestion mainly occurs at port storage areas and results from delays attributable to lapses in the operation of loading or discharging rail vehicles or trucks (Chinedum 2013). These delays could be either because of shortages in port handling facilities or inefficient operations due to a lack of information exchange opportunities between exporters and hauliers (Eddrgash 2019).

Therefore, the landside congestion type can be defined as situations that cause delays or extra costs for port operators, shipping lines, and shippers due to internal factors (such as the lack of storage areas capacity and inefficient handling and storing operations) or an external factor (such as increased traffic cargoes).

### 2.3.3. Hinterland-side Congestion Level

At seaports, the majority of cargoes, except transit containers at container terminal ports, are transported outside (for importing) or inside (for exporting) the port area by one of the hinterlands access road vehicles or rail lines to/from the inland shippers or end-users (Wan et al. 2013). Thus, any weakness in the hinterland intermodal infrastructures or inefficient operations for this system will undoubtedly cause to congest the port accesses and routs and will lead to influence its competitiveness and efficiency. There are two types of hinterland-side congestion prevalent in the literature: Vehicle gate congestion and vehicle route congestion.

**Vehicle gate congestion.** This type of congestion is attributed to delays and queuing of vehicles and trucks at the port gate (Chinedum 2013). It is usually caused by inefficient or poor programming of inland accesses to the port gate through vehicles' arriving schedules such as inappropriate cargo documents or misarrangement between the cargo owner and the transportation company (Maguire 2010).

**Vehicle route congestion.** This type of congestion results from the congestion problems on the rail lines system and urban roads that lead to or serve the port area (Motono et al. 2016). It is usually attributed to delays imposed on vehicles carrying cargoes or containers headed for ships waiting at the port berths or ships unloading cargoes or containers at ports to the final inland end-users. Wan et al. (2013) argued that the significant growth of seaborne trade parallel with the increase in vessels' size, especially the container ships, has imposed more pressure on the hinterland intermodal transportation system in most world countries. They also claimed that this increased pressure has translated to congestion situations in the transportation system. Consequently, it resulted in delay times, more fuel costs, and carbon emissions to the environment. This, of course, might decrease the overall reliability of the hinterland intermodal transportation, and as well it might be higher the probability of an unsynchronised trip schedule.

Therefore, the hinterland-side congestion type can be redefined: as situations arising from either the weakness in intermodal transportation infrastructures or inefficient management of these resources as internal factors, or the increase in international trade and ship size as external factors, which causes delay for shipping lines, port operators, vehicles' companies, and shippers.

## 2.4. Classification of Port Congestion Causes and Potential Solutions

There is evident diversity in the reasons behind the existing port congestion problem at most world ports in the literature. However, scholars in their studies used various theoretical ways to identify the reasons behind the port congestion problem and suggest the proper ways for solving it. Most of those scholars looked at the problem from a narrow-angle. They only concentrated their investigation and related the identification of the causes of port congestion to only four types from those previously discussed types of port congestion. These types are ship berth congestion, ship work congestion, cargo stack congestion and ship enter/exit route congestion. For example, Meisel and Bierwirth (2009) investigated the ship berth congestion type and identified the causes of the problem and suggested some solutions for it. They claimed that this type of port congestion arose due to inefficient ship-to-berth plans, especially if multi-size vessels call the port, and proposed some techniques to improve ship berthing plans to reduce congestion. Other scholars such as Kiani et al. (2006) and Kozan (1997) studied and investigated the ship work congestion type. They found that the number of port berths was insufficient as well as there were shortages in the quayside equipment parallel with insufficient working hours. As a solution, they advised the port operators to increase the period of working hours and invest in high-technology quayside equipment. Also, the cargo stack congestion type was investigated by other scholars such as Kabak (1970), Radmilovic et al. (1996) and Guan (2009). In their research studies, they studied the cargo storing plans and techniques and, investigated how these cargoes transferred from the vessel to the stacking areas and then from stacking areas to the outside of the port. They found that in order to prevent issues in these operations, the strategies for berthing the ship as close as possible to its cargo stacking, the cargo stacking type, and the way of transferring cargoes in/outbound ports were significantly important to prevent the port congestion problem. The fourth type of port congestion problem was investigated by many scholars. As an example, (Sheikholeslami et al. (2013); Mbonambi (2018); Rosario (2020); Potgieter et al. 2020)) studied the Ship's enter/exit route congestion and identified the weather conditions as one of the main reasons behind this port congestion problem. Also, Legato and Mazza (2001), Imai et al. (2007), Vacca et al. (2007), Lee and Chen (2009), Shahpanah et al. (2014), and Chou et al. (2021) studied the impact of some conditions on the seaside access routes and port berths procedure, such as shortages in tugging and pilotage services, depths and widths of port channels, the size and the radius of turning basin, and labour strikes. They claimed that those conditions were outstanding issues that might cause delays to the vessels from entering the port berths and leading to congest the port.

Relating congestion causes to only four types of congestion situations has limited these relativities causes and solutions to specific types of the problem. Also, there may be other causative reasons behind the port congestion problem that might not fall under or be related to any one of those four types of congestion problems at ports. So broadly, to understand the reasons behind the port congestion problem, this research study reclassifies the causes of the port congestion problem and their proposed solutions that were prevalent in the previous literature into five categories. These five categories describe the reasons according to the types of triggers for congestion at world ports, and they are discussed below:

#### 2.4.1. Natural Reasons behind Port Congestion Problems

Around the world and depending on the geographic locations and type of climate, port congestion situations are often caused by natural conditions such as bad weather, flooding, and tide conditions. The port operations stoppages and delays due to these circumstances create waiting times resulting in queuing of vessels before entering the port (Sheikholeslami et al., 2013; Misra 2021; Vu 2022). These types of port congestion causes, except for tides, are usually out of the hand of port operators and port users, and none of them can do anything other than wait for those uncontrolled conditions to pass. For example, during the high wind conditions, ports of Cape Town have to shut down their operations which causes an increase in the waiting times for the coming ships (Transnet 2019 and Potgieter et al. 2020). Mbonambi (2018) and Rosario (2020) described the weather conditions that port Durban in South Africa used to experience every summer as a season of heavy rain which sometimes accounts for 5 days of delay in cargo handling operations. Also, the typhoon that hit the east coast of China in July 2021 resulted in closing the ports in the region, such as Shanghai and Ningbo, from receiving ships, causing the ships to queue waiting afront on the neighbouring ports (Cook 2021).

Tide causes are a little different from the previous natural causes. Although it is considered random and uncertain conditions in nature, most ports around the world usually use harmonic tide tables that apply standard methods to model the tide level movement (Deo and Chaudhari 1998). However, the variation in the levels of the tide associated with the unexpected arrival of ships calling the port has a greater impact on the efficiency of the ship-to-berth plans (Sheikholeslami et al., 2014).

Recently, this subject has received increasing attention from researchers. Kelareva et al. (2012) and Kelareva et al. (2014) studied the impacts of tidal effects on navigation at port channels on berth location plans. They proposed a schedule for arriving and departing vessels, considering tide levels time-varying and the limitation on pilotage services.

Du et al. (2015) also investigated the congestion situations that rose from tidal effects on ships berthing schedules with the aim to enhance the vessels' departure times and minimize their fuel consumption. They proposed a set of arrival and departure policies that help reduce ships’ waiting times caused by tidal effects. Li and Jia (2019) also investigated the port congestion problem caused by tidal impacts on the ships’ navigation through port channels to reduce the ships queuing time. They suggested a model that is used to help port operators improve berthing plans and minimize the waiting time for vessels.

#### 2.4.2. Economic Reasons behind Port Congestion Problem

The last 50 years have witnessed the development of large-size and fast-speed cargo vessels and container ships together with investment in high technology of port handling equipment that facilitated the growth of the international maritime trade (Asteris et al. 2012; Mannaadiar 2020; Misra 2021; Smith et al. 2022). In such an era of rapidly increasing maritime trade, providing a low-cost shipping capacity and adequate port infrastructure with modern facilities was a real challenge. Hence, most world ports have been already developed to their maximum physical capacity. Any sudden increase in the seaborne trade or local market demand for goods in their country or region will consequently increase cargo flow. This most often results in congested ports and puts more strain on the international supply chain. Shipping routes from Asia to Europe and from Asia to North America have experienced major port congestion problems with respect to the latter (Komaromi et al. 2022), described the congestion situations due to the growing uncertainty in cargoes traffic on the USA West Coast ports between 2018 and 2022. They argued, "Ports up and down the US West Coast were totally unprepared for the massive wave of imports that engulfed them at end of 2020 and the following years, and congestion soon spread right along the supply chain as rail lines, freeways and warehouses found themselves equally overwhelmed by the unprecedented number of containers being off-loaded at the ports each day". Also, Smithy et al (2022) argued that the congestion situations that rose at the ports of Los Angeles and Long Beach in 2021 due to massive cargo traffic have caused delayed delivery of goods to most of the retailers of the USA for the Christmas season of that year.

Over the last recession (2007 to 2009), port congestion problems were barely noticed at most of the world ports as a result of the downturn of their nations' economies (Fan and Dahl 2012). However, as soon as the world economy and international trade started to recover, port congestion situations worldwide began to emerge again (Fan et al., 2012). This is because any refreshment in a country's economy will undoubtedly translate to an increase in the local market demand for international trade, resulting in an increase in the vessels' traffic at its ports, which in turn cause a congestion problem to them. Moreover, this can be worse when the flow of traffic is concentrated at the major ports, neglecting the other smaller ones (Aldcroft 1961). Saeed et al. (2018) investigated the port congestion problems that have risen lately at Manila port. They claimed that the recent increase in international trade in the Philippines has increased cargo traffic through its main port of Manila, which caused a rise in some congestion situations due to the port capacities' inability to keep up with the increase in demand. Also, Chassiakos et al. (2017) argue that the refreshment and the expansion in the American national economy during and after 2014 has led to increasing demand for international trade, especially with China, through its ports. They claimed that this increase has caused to congest most of the USA's west coast ports, and it resulted in diverting most of the ships destined for these ports to call the Canadian ports. Davies and Kieran (2015), Liu and Wang (2019), and Meng et al. (2022) indicated another reason for the rising port congestion situation in the USA ports. They claimed that the increased prevalence of ship-sharing alliances between shipping lines has also caused congestion situations at ports. They argued that this congestion was caused by the complexity of port terminal operations, which resulted from receiving containers from multiple shipping lines on the same ship.

To solve these congestion problems, the government needs to balance and equally distribute the increasing traffic from increasing trade flow to all its country ports. This can be done by investing in developing its smaller ports and establishing a type of policies and regulations that encourage shippers to use them. Gidado (2015), Okpomo (2021), and Oruwari (2021) have all agreed that to solve the problem of congestion at Lagos port, due to the increase in trade flow, the government of Nigeria needs to identify a better use of its undeveloped eastern ports to encourage shippers to ship their goods through them.

#### 2.4.3. Technical Reasons behind Port Congestion Problem

In the literature, most scholars look to the port congestion phenomena as issues caused by technical problems. These technical problems sometimes are clear, such as the breakdowns and the shortages of port equipment or, in other cases, related to technical issues such as inefficient operation and management of port resources or poor port infrastructures. Also, most of these scholars have used quantitative methods to identify these issues and obtain solutions for them.

##### 2.4.3.1 Shortages, Breakdowns, and Inefficient Operation for Port Equipment

According to many researchers, the type and the number of port equipment such as quay cranes, forklifts and tugboats are very important in determining the port operation efficiency and avoiding any congestion problems. Ports equipped with old or wrong types of machinery more often face congestion problems due to the continual stoppages in port operations because of the break down of these types of equipment. Moreover, to minimize these stoppages, most suggested that port operators carefully select the right type and number of equipment and continually maintain their old machinery and invest in new ones. For example, Khoshnevis and Asef-Vaziri (2000), Oruwari (2021), Misra (2021), and Vu (2022) argued that the type of handling equipment is a vital issue when it comes to determining the ports' operation efficiency and reducing congestion, especially in container terminals. All of these studies have identified several analysis variables to measure this performance where the port equipment utilization was the first one. Also, more specifically, Soriguera et al. (2006) have investigated the optimum number of handling equipment units assigned to a particular operation in a port to avoid any congestion problems at this port. They argued that this number depended on the number of quay cranes that could serve the vessel, the straddle carrier or the port trucks' type, and the type of cargo handling operation, whether it is loading or discharging.  In addition, Moghadam et al. (2011) have suggested a solution for solving the problem of selecting the best port equipment by using the multiple attribute decision-making technique to choose the best type of quay cranes, yard cranes, and straddle carriers.

Moreover, concentrating on the productivity and efficiency of the port equipment, Fereidoonian and Mirzazadeh (2012), and Vu (2022) argued that, in ports, quay cranes, yard cranes, port trucks, and tugboats are the most important types of machinery, and their productivity affects vessels turnaround times, especially at container terminals. Also, they stated that any inefficiency in managing the operation of this equipment might cause congestion issues in ports. They proposed an integrated yard crane, port trucks, and quay cranes scheduling problem that aims to solve congestion issues by minimizing the make-span of loading and discharging cargo operations on ports' handling and transportation facilities.

Also, in the literature, scholars placed considerable attention on tugboat services, especially in developing countries where these services are usually compulsory in manoeuvring vessels from and to port berths. Llati et al. (2014) claimed that tugboat services are an important task when it comes to reducing port congestion issues. They argued that shortages in tugboat services directly and significantly impact the ship waiting time at both the anchorage area and port berths. In this context, scholars went in the same direction to solve the utilization of tugboat services. For example, Liu and Wang (2004) developed a discrete event simulation model to analyse and suggest the best operation for tugboats at a port.

Also, Wenhui (2011) built a heuristic simulation and optimization model to best allocate tugboat services in a port. Also, Xu and Jin (2012) formulated scheduling for tugboat service problems to minimise the total times for all tugboats and reduce congestion at the port. Moreover, Chou et al. (2021) analyse the towing operation problem and the shortage of tugboat services in a Taiwanese port and proposed feasible alternatives for reducing the congestion problem and enhancing the effective operations of tugboat services.

#### 2.4.3.2 Poor and Insufficient Infrastructure for the Port or in the country as a whole

Many studies in the literature investigated the port congestion problem based on technical issues related to insufficient infrastructure and capacities, whether at the port itself or its country. Souf-Ajen et al. (2016), Wang and Wang (2019); Cong et al. (2020), Guo et al. 2021, and Komaromi et al. (2022) argued that most of the time, improving and developing the port infrastructures are required to enhance the port capacities throughput in order to cope with the increased demand on its resources and minimize congestion situations. However, where and how to develop the existing port infrastructure for rising port service demands is the most important dynamic dilemma that decision-makers have to face (Islam and Olsen 2011). El-Naggar (2010) argued that it is possible to upgrade the port infrastructure so that its capacities at all times are fully utilized. However, any increase in the demand for its services would force the vessels to wait and queue at the anchor area. This can last until those who occupied its berths were served (Ibid). El-Naggar argued this solution would be uneconomic and inefficient as it imposes delay costs on ships while upgrading the infrastructure of the port to prevent vessels from waiting and sometimes make uneconomic use of port facilities. The ideal situation where all port berths are engaged all the time, and no vessels waiting is hard to reach in reality due to the random ships' arrival with different vessels' sizes. Thus, to solve this problem and reduce the congestion situations at ports, El-Naggar suggested a queuing model for trading off the cost of developing the port infrastructure and the cost of delay and ship waiting time. Other scholars (Noritaka 1978, Kozan 1994, Van Asperen et al. 2003, Jagerman and Altiok 2003, and Jagerman et al. 2004) have also used the queuing theory to investigate the port congestion problems at ports and determine the adequate number of port berths. Moreover, maintaining and repairing the port infrastructure and facilities is very important for reducing port congestion problems. Kabir and Helal (2021) studied this issue and suggested a proper maintenance schedule for keeping port resources up to date and eliminating port congestion situations.

Another solution to the problem of short capacities of port berths discussed in the literature is to transfer cargoes (or containers) from ship to ship in the open sea to avoid keeping ships waiting for a berth slot at the port (Jordan et al. 2007, Ismail et al. 2015, and Ngo et al. 2017). Ismail et al. (2015) argued that this type of solution had become an alternative way to reduce port congestion problems and subsequently increase port efficiency. Also, according to them, a floating crane barge can be moored to a container ship in the open sea and then containers can be transferred from it to a deck barge or feeder ship. They also argued that this solution could be used both with transit and local shipments when the available berth slot is small and does not fit the ship's length, however, this type of solution is highly dependent on the sea condition (whether it is rough or smooth).

Ports are still considered significant interface hubs in the logistic chain transportation sector, where they work as collection and distribution networks. As a result, they can be affected by both port cargo traffic transportation and urban traffic (Peng et al., 2018). Any increase in ports cargoes traffic might lead to congesting the port collecting and distributing network (the hinterland access). In the literature, many researchers such as ( Humphreys et al. 2019; Hancock 2020; Muchunu 2021) pointed out this fact and related the port congestion problems to poor hinterland access and infrastructure as a whole, especially in developing countries.

As efficient port cargo transportation is significantly dependent on smooth traffic on land transportation (Regan and Golob 2000), developing and investing in hinterland infrastructure is a very important key for successful intermodal operation and minimizing congestion situations in both ports' urban ways. De-Borger et al. (2008), Zhang (2008) and Martineze and Feo (2017) argued that investment in developing port infrastructure would lead to minimizing congestion situations in the port but might increase the hinterland congestion in the country or the whole region where the port was subjected to investment. This is due to the investment will lead to improving the port operation efficiency, which might encourage and increase the cargo traffic and could cause to congest the roadways or the rail lines of its hinterland. This also might lead to shippers switching their cargoes to rival ports. Wan et al. (2017) studied and analyzed the US container ports in relation to their urban road congestion. They found that the increase in road congestion delays at the port hinterland accesses is correlated with a decline in the throughput of the container terminal but also an increase in rival container terminal's throughput. Also, they stated that adding road and rail capacities and distributing some of the port traffic to be transported by waterways are the most common and important port congestion mitigation plans. Moreover, the lack of development of the hinterland transport infrastructure (Teye et al. 2016) parallel with the increase in vessels' size (Manaadiar 2020) and the growth of shipping lines alliances (Liu and Wang 2019 and Zheng and Luo 2021) had raised the congestion situations and environmental issues in ports and inland accesses. Therefore, developing the port hinterland infrastructure, especially the road, rail and water channel networks, is an optimum solution to these congestion issues.

In developing countries, the contribution of hinterland accesses (roads and rail lines) and the infrastructures of the country at all (bank systems, telecommunication, and power supplies) are very important to the magnitude of ship and truck turnaround times, port productivity and general economic growth of the country (Stephens and Ukpere 2010; Humphreys et al. 2019; Hancock 2020; Muchunu 2021). This is, in fact, true and essential for most developing countries where the economies are highly oriented, but country infrastructures and systems are poorly integrated and sparsely developed. Gidado (2015) argued that underdevelopment infrastructures occupied by poor country systems in most sub-Saharan African countries have heavily affected their ports' productivity and resulted in congestion problems. He pointed out that, in many African countries, the relationship between the ports' activities and traffic congestion on inland transportation has become more evident over time. Gidado (2015) claimed that the flows of urban traffic around port cities such as Mombasa, Dar es Salaam, and Lagos have become deeply congested, partially because of the increased cargo traffic on their ports which eventually resulted in congesting these ports as well. Moreover, he claimed that frequent electricity power failures in Nigeria had caused stopping cargo handling operations in Mombasa port, leading to delays and increased vessel waiting time.  Gidado (2015) also argued that one of the reasons for delaying clearing cargo from ports is that exporters need a fast bank system to transmit their documents and payments while most Nigerian banks’ systems are still under development for fast transactions.

In addition, developing countries in East Asia since the late 1990s have actively developed and upgraded their ports to cope with the increasing demand for international trade in their region and accommodate the increase in ship size. However, most of these ports have experienced congestion problems at their hinterland accesses, especially with the increasing demand for international trade post the Covid-19 period (Komaromi 2022). However, In Africa and Nigeria for example, the failure of its rail system has caused more pressure on road transportation in moving cargoes from and to ports which lead eventually to congesting the port gates and port accesses (Okpomo 2021). Also, Humphreys et al. (2019) and Muchunu (2021) agreed with the above scholars and argued that although the port of Durban in South Africa has increased its port capacities, it has, however, a shift from rail transportation to roads which already in bad conditions and that led to congest the roadways and all the accesses around the port.

Another idea was widely established in the literature as a solution for congestion situations that rose due to poor infrastructure where insufficient port storing capacities and congested hinterland access are the main issues. This idea is to build a dry port that is directly connected to and served by the seaport (Facchini and Mossa 2020) to accommodate the increased cargo traffic on seaports. The new concept of the dry port as an optional tool to mitigate the congestion situations at seaports rather than in ordinary places connected to container terminals was first introduced in 2009 (Roso et al., 2009). The development and use of this choice (dry port) as a solution for minimising the congestion at seaports has seen a potential reduction in both port and urban congestion ruts (Roso et al. 2009, Hanaoka and Regmi 2011, Tsao and Linh 2018). Jeevan and Roso (2019) also argued that dry port has become an optimum solution for better seaport inland accesses and minimising air pollution.

In developing countries, a lot of congestion problems due to the recent growth in cargo traffic can be solved by employing the concept of dry ports. Kwateng et al. (2017) argued that the congestion around the area of the main ports in Ghana had put more constraints on these ports' supply chains. They also claimed that the establishment of Bonkra dry port has served as a greater efficient solution to the congestion situations at Ghana ports than building new port capacities in seaports. Also, in Malaysia, a study by Jeevan and Roso (2019) has suggested an urgent requirement for the assimilation of inland ports into the seaports system to adopt the increase in cargo traffic from larger ships calling Malaysian seaports and avoid any congestion situations.

#### 2.4.3.3 Inefficient Operation and Management of Port Resource

The Port congestion problem cannot be solved by imposing extra charges, even though some ship owners transfer their ship extra costs at congested ports to shippers and impose them as demurrage costs. According to economic theory, the congestion problem can be efficiently reduced or eliminated by increasing prices. Agostoni and Saavedra (2014) argued that in ports, this mechanism could not be applied in the same way that it can be for other services such as electricity or drinking water. It is because the usage of the port resources is not so much seasonal driven, but it is the simultaneous arrival of too many vessels (Ibid). In fact, this means that port resources without fail have to be rationed and, therefore, some vessels need to wait. Moreover, the only way for rationing the port resources in the absence of the choice of increasing capacity is by maximizing the efficiency of managing operations for these port resources.

In the literature, a significant number of studies indicate that the main reasons behind the port congestion problem are neither the shortages in port equipment nor the poor infrastructures, but rather the poor management and the inefficient operation of these resources. These studies emphasized that ports have to enhance their operational productivity and manage their facilities more efficiently to mitigate the congestion problem and increase the competitive share. Efficient port operation and management involve numerous interrelated management decisions to obtain a range of aims; reducing berth waiting time for ships, minimising and maintaining the equipment needed for handling the cargo operation, the efficient use of limited storage area capacities, and mitigating the congestion at port gates and hinterland accesses. The four cases of inefficient management and operation of port resources, which cause port congestion, will be represented in the following sections as discussed in the previous literature.

#### 2.4.3.4 Inefficient Management of Ship-to-Berth Operation

The Port berths allocation system is very complex considering the various inter-arrival times of vessels, different sizes of vessels, different quays’ lengths, and various capabilities of quay cranes productivities. Since both the vessel and the port facilities are of high cost, it is very important for port managers to reduce congestion problems at their ports by optimizing the balance between the cost of ships' waiting time and the economical use of their allocated resources (Dragovic et al. 2006). In other words, any port expansion or development must be considered in the light of port objectives according to the national or regional point of view for economical transport. As stated by Fararoui and black (1992), this objective is related to the fact that the port resources should aim to supply their services at minimum cost to the national economy.

Hence, port managers should manage their resources (port berths and equipment) at the least service cost, where they must consider the cost of ships' waiting time, the cost of delayed cargoes and the cost of investment in new facilities. Thus, improving the strategies of port berths allocation and equipment assignment plans are the most important target in managing ports and reducing congestion problems. Port managers' effective berths allocation strategies can help reduce the vessels waiting time at congested ports or container terminals (Meng et al., 2009; Xchange 2020).

In the literature, most research studies have agreed that the policy rule of “first-come, first-served” for assigning ships to port berths is inefficient and can cause an increase in the waiting time for ships. Alvarez et al. (2014) argued that the “first-come, first-served” rule is nearly impossible unless all arriving vessels and cargoes are identical. To solve this dilemma, the literature has taken different ways to consider priority in the port managers' account for allocating ships to port berths (berths allocation strategies). Svendsen (1967), Imai et al. 1997, and Imai et al. 2004) suggested the ship size or the cargo volume as a priority rule policy. Some other scholars like Alvarez et al. (2010) studied and compared three types of berths allocation strategies to find the best strategies for allocating ships to port berths. These strategies are first come, first served “FCFS”, standardized estimated arrival time “SETA”, and global optimization of speed berth and equipment allocations “GOSBEA”. They found that the global optimization of speed berth and equipment allocations priority policy “GOSBEA” is superior to both policies of first-come, first-serve “FCFS” and standardized estimated arrival time “SETA”. Also, they found that the standardized estimated arrival time “SETA” policy is superior to the first-come, first-serve “FCFS” policy. They also claimed that the global optimization of speed berth and equipment allocations priority policy “GOSBEA” has reduced port congestion issues and minimized ships’ costs, cancellations, and contractual penalties. Fararoui and Black (1992) took a different direction in investigating the best allocation port berths plans. They argued that to reduce the effect of congestion situations, the four main sources of congestion, and cost should be considered when port managers assigned ships to their port berths. They proposed a system of berthing priority that considered these sources; cost of delay to ships, cost of delay to cargoes on board ships, cost of late completion of national development projects due to delay cargoes, and pollution cost. Recently and after introducing the Automatic Identification System (AIS), some scholars try to use this technology to measure and predict the port congestion problem to help port operators wisely allocate the current port resources in the short term and assess the necessity of investing in new infrastructure for the long time term. Pruyn et al. (2020) applied the Markov technique to model and predict waiting time at major bulk ports using the AIS data. Also, Bai et al. (2021) based on AIS data, constructed a port congestion index and investigated the impacts of congestion on LPG shipping freight.

#### 2.4.3.5 Inefficient Management of Cargo Handling Operation

In the literature, one of the main causes for delaying ships at ports and increasing congestion situations is that ship service time (loading or unloading) is much more than it should be. It has been responsible for delaying ships in ports, especially at container terminals, due to improper or inefficient utilization of cargo handling facilities. If quicker services are supplied by optimum utilization of cargo handling facilities, the length of the consonant queue and waiting time will shorten further

(Hoque and Biswas 2007; Bolat et al. 2020; Neagoe et al. 2021). Moreover, a significant berth-side factor that directly impacts the ship make-span is how quay cranes and port trucks are scheduled and planned to load and unload cargo from ships (Choo et al. 2010), which is an essential step for ship-served planning.

The cargo handling problem was highlighted and investigated by many researchers. Daganzo (1989) and Taleb-Brahimi et al. (1993) have argued that improving cargo handling schedules and plans rather than investing in new cargo handling machinery can minimize the congestion issues in cargo operations. They proposed some programming formulations for helping port operators with planning for loading and unloading vessels. Quayside cranes management at ports, in particular, is also addressed by Kim and Kim (1999), Cheung et al. (2002), and Zhang et al. (2002), who proposed microeconomics modelling for crane movements and the number of containers transfer carnes that can reduce the congestion in cargo operations. Manaadiar (2020) have suggested investing in new and innovative technologies regarding port handling equipment to boom port operations productivity.

Lee et al. (2006) and Jiang et al. (2012) went in another direction. They studied the interferences and conflicts that happen between handling equipment in container terminals and cause congestion situations to arise. They suggested that to reduce yard crane shifting and avoid yard congestion, the port managers have to consider using yard templates that consider vessel berthing time.

Another way to reduce congestion in cargo handling operations that were presented in the literature is the double cycling technique for loading and unloading of ships. This technique was first mentioned by (Bendall and Stent 1996). Their study illustrated the impact of this technique not only on the cargo handling operation efficiency but also on vessel design. Goodchid and Daganzo (2006) examined the double cycling technique deeply. They first defined this technique as a way to improve the operation efficiency of the quay cranes by minimizing the empty crane movements. In other words, instead of unloading all inbound cargoes from the ship before starting to load the outbound cargoes, this operation can be done together to eliminate the empty crane shifts. They also claimed that although double cycling might not eliminate the port congestion, it can ease the congestion that arises in container handling operations before a long-term investment in port equipment comes online. However, the drawback that they mentioned of this kind of technique is that it can be used only with container cargo.

In the literature, some other scholars addressed the congestion situations that arise at cargo handling operations as a problem of insufficient and sometimes unproductive port labour working hours (Shabayek and Yeung (2001); Xchange (2020); Misra (2021); Oruwari (2021)). Shabayek and Yeung (2001) applied the queuing theory to investigate the congestion problems at Hong Kong's Kwai Chung port. They found that port managers should ensure the maximum productivity of working hours to avoid congestion issues. Xchange (2020) argued that increasing the number of port labours might solve the problem, while Misra (2021) and Oruwari (2021) suggested increasing these hours as much as possible to absorb any increasing seasonal demand on port resources.

#### 2.4.3.6 Inefficient Management of Cargo Stacking and Storing Operation

In the port's management field, the management of stack and storage areas in practice is a complex process that needs to address some challenging decision issues at different levels of planning. In fact, there are two particular interrelated decision issues involved in this complex process. First is the storage area allocation problem, concerned with where and how to store the incoming cargo (in the best place and way) (Jin et al., 2016). The second dilemma is the deployment of yard cranes and trucks, which determines how many cranes and trucks should be used in each area and the way of their movements between blocks (Misra 2021). Any inefficient management of those operation problems will lead to rising congestion at port storage yards, especially at container terminal ports. Also, the optimal cargo allocation dispersion and the efficient deployment of yard equipment are found to be good management solutions for reducing the congestion situations raised because of time window conflicts and shortages in yard equipment (Yu et al., 2018).

Previous literature has widely discussed the inefficient management of port storage areas as the main source of congestion. One common inefficient operation management practice issue is the multi-level container staking at port yards, especially when the port has intensive transhipment activities but no more land capacity to expand. Stacking containers on top of each other is less costly as nothing needs to be built or bought. However, this can result in a high concentration of cargo handling movement within a tiny space that might lead to congesting the traffic at port yards (Lee et al. 2007). Congestion from dense traffic at port yards and passages is the most critical issue that constrains the operation of port landside processes efficiency where it causes to prevent port handling equipment from moving freely at the port yard (Lee et al. 2006, Zhen et al. 2013, Zhang et al. 2009, Han et al. 2008, Wang and Wang 2019, Hancock 2020, and Manaadiar 2020). The typical situations that were noticed in this type of congestion problem are that many port handling equipment may be crowded and stuck around a specific storing place or moving in the same passing lane, which might cause them to slow down and create extra delay times. Another problem of multi-level stacking is the unproductivity of the container reshuffle operation. Taleb-Ibrahimi et al. (1993) suggested a kind of strategy for handling and stacking of export containers where their performance was quantified according to the storing area capacity and the number of movements of handling equipment required. Also, Chen (1999) argued that the reshuffle movement could reduce resource productivity such as yard cranes and straddles and increase yard traffic congestion. He also argued that stacking efficiency depends significantly on plans of allocating storing areas to arriving ships. Moreover, based on a multi-level stacking strategy, Kun (2015) compared two multi-level styles for stacking containers (parallel style and vertical style) that generate less congestion and delay times at container terminals. He claimed that when it comes to loading and discharging vessels operation, a stacking vertical style has a shorter queue length but slower truck flows and a smaller number of node delays but it is more congested than the parallel one. This suggested, as he claimed, that the parallel stacking strategy compared to the vertical one has higher efficiency at loading but relatively higher chances of traffic jams.

Another type of stacking, called consignment stacking, was studied, and analyzed by Chen et al. (1995), Scheithauer (1999), and Davies and Bischoff (1999). This strategy, as described, is to store and stack the same destination, contents and loading time containers together at the same dedicated storing place. In this way, a conflict between handling equipment that works on different arriving ships is eliminated. This storage strategy is called yard template planning. Its objective is to minimize congestion problems by reducing the cost and the time for transferring containers from berths to stacking areas and vice versa (Zhen et al., 2016).

The increase in vessel size, especially with the recent introduction of mega container ships coupled with the increase in shipping alliances between two or more shipping line companies to combine their ocean shipments (containers), has put more constraints on ports' storage capacities worldwide. Despite the huge advantages that these implications (increased ship size and the alliances between shipping lines) have provided to international trade due to economies of scale and environment, they created the need for efficient management of port storing capacities, especially with the scarcity of portland spaces (Jiang et al. 2012). Many related papers have been published in the literature suggesting solutions for accommodating the increase in cargo traffic at ports, especially container terminals (Hu et al. 2008; Zheng et al. 2017; Liu and Wang 2019; Zheng and Luo 2021). One of these suggested solutions was presented by Hu et al. (2008). They proposed an automated storage/retrieval system (AS/RS) to accommodate the increased demand for storage areas in container terminals, especially with transit shipments. This system aims to disperse the containers evenly into many rectangular blocks at the terminal yard to eliminate vehicle congestion. Furthermore, before berthing the ship, a suitable (AS/RS) cell is decided for each container of the shipment and where it has to be put in these rectangular blocks (Manaadiar 2020).

The increased traffic due to the increase in vessel size and shipping lines alliances has also caused the problem of managing empty containers at container terminals. Choong et al. (2002) argued that empty containers have greatly contributed to the rise of congestion situations at and around container terminals. They have studied the impact of the length of the planning horizon on managing empty containers. They proposed an integer program that could minimise congestion and reduce the cost of empty container movements. Another direction was taken by Jula et al. (2006) and Manaadiar (2020) to avoid the congestion situation raised by empty containers. They suggested reusing them to reduce the congestion costs significantly. Two methodologies can do this reuse as they claimed. The first one is the depot-direct, where the empty containers can be kept at a dry port for potential reuse, a drop or pick-up movements. The second one is the street turn. In this methodology, the congestion situation can be reduced by directly moving the empty container from the local end-user to the new local shipper without returning to the terminal. Finally, they claimed that empty reused containers are moved to depot-direct at a critical time since this operation takes less time and congestion situations and travelling cost is critical.

Another way to increase the efficiency of managing port storing areas, especially with increasing incoming cargo traffic, is the direct port delivery program that allows importers to clear their cargo directly from the ship to their storage facilities or factories. Rajasekar and Rengamani (2017) stated that more than 19% of the import cargoes at Chennai (India) ports are cleared based on this program. They also claimed that the congestion situations at the Chennai port have notably reduced using this procedure.

Storing containers directly on Chassis within the terminal is another way to increase port storage managing efficiency. In the California container terminal which was designed to transport the containers over trucks, containers are directly stored on chassis at the terminal yard (Davies and Kieran 2015). They argued that this type of storing reduced congestion situations at the storage yard by enabling fast container movement and reducing the number of shifting containers. They also elaborated that the yard provided those Chassis to be used by the truck industry free of charge. However, this type of storing system needed a relatively large terminal storage yard which in most times does not exist.

#### 2.4.3.7 Inefficient Management of Port Gate Operation and Accesses

With the continuing growth of international trade coupled with the increase of container traffic and the enlargement of ships’ sizes, many world ports experienced congestion problems at their port accesses and gates due to the vast number of trucks’ arrivals. These congestion issues have caused most ports worldwide an efficiency decline and severe air pollution (Pruyn et al. 2020). Chen et al. (2013) argued that port gate congestion is becoming a common issue for the major world ports, where long truck queues reduce the port system efficiency, increase traffic accidents and worsen environmental issues. Even though nearly most of the worldwide ports provide a 24 hour/seven days a week service, large numbers of trucks are still kept waiting at port gates and roads around ports (Xu et al. 2021). In literature, almost all studies have related these long truck queues at and around seaport gates to three reasons. The first is the lack of sufficient handling capacities offered by most of the seaports' gates, especially with the increase in cargoes traffic at these seaports (due to the increase in vessels size, shipping lines alliances, and the growth in international trade) (Guan and Liu 2009; Chen et al. 2013; Phan and Kim 2015; Motono et al. 2016; Chen Jiang 2016; Manaadiar 2020; and Zheng and Luo 2021). The second reason, as was argued by studies such as Islam et al. 2013, Motono et al. 2014, Keceli 2016, Gracia et al. 2017 and Misra 2021, is that some trucks and trailers drivers come to port gates with incomplete documents or incorrect ones but still entered the gate queue to maintain their turn. Thus, they cause an increase in traffic flow and waste more gate time. Islam et al. 2013, Lubulwa et al. 2011, Gracia et al. 2017, Oruwari 2021 and Misra 2021 discussed the third reason. They claimed that congestion situations at ports' accesses and gates might happen due to the inefficient operation of port gates that was caused by the lack of coordination and information exchange between port operators, shippers, truck companies, and the other integrators of the port community.

In the maritime industry, one of the measures for the seaports' landside efficiency is the truck turnaround time, which counts the time when the truck arrives at the port gate till it loads the cargo and exits the port yard (Lubulwa et al. 2011 and Xu et al. 2021). According to the demand and supply theory, there are two critical approaches for mitigating congestion at port accesses and gates: supply-side and demand-side. Since it is not easy to increase both capacities of port gates and road accesses around ports (supply side) (Chen and Yang 2010). Thus, port managers, port operators, and the government have the same interest in reducing congestion situations at port accesses and gates by improving the operation management of these resources (demand side). Guan and Liu (2009) argued that the supply approach is focused on improving productivity by increasing port gate capacities, which can be only by increasing the number of gates or/and increasing the gate working hours. This approach has some limitations. Guan and Liu (2009) have mentioned five of them. Firstly, the scarcity of port lands might constrain any increase in port gates. Secondly, if the capacities of handling cargo equipment are not sufficient, allowing an excessive number of trucks to enter the port might arise congestion situations at the port yard. Thirdly, increasing port gate capacities may result in the underutilization of the seaport gate system at non-peak times. Fourthly, the flexibility of managing levels of port gates needs to be maintained due to the rate variation in the trucks' arrival at the gate. Fifthly, increasing port gate capacities, either by increasing their number or increasing the working hours, might not be feasible due to the current terms in the port labour contracts. On the other side, Guan and Liu (2009) argued that as the approach of demand is focused on managing the trucks' arrivals by controlling available time slots at the port gate, the demand and supply for gate services in this situation are closely matched. They stated that this approach is more feasible as it provides a mechanism for greater and efficient use of the capacities of seaport gates and reduces congestion and truck waiting times at the gates.

In the light of the above discussion, most published studies in the previous literature have focused on improving the efficiency of operation and managing the port gates' capacity to solve the problem of congestion situations at port accesses and gates. These publication studies have identified different port gate and access management services. The following paragraphs include their achieved findings on this subject.

Employing software systems that offer information about port accesses services web pages and browsers (Baumgrass et al. 2015) wherein those web pages port managers can advance information from their terminal to shippers and truck companies. For example, information via webcams can be provided to road hauliers (Huynh et al. 2011) or used information technology systems (IT) and webpages that include traffic information about traffic jams, accidents, and updated timetables for the moveable bridge's closure (Heilig and Vob 2017). Both papers argued that using these information-sharing facilities, the arrival of trucks and trailers at ports' gates can be utilized as hauliers can benefit from this information for sending their trucks to ports during off-peak periods, resulting in minimising port gate congestion.

Another port gate management services system used to reduce unnecessary stoppages for trucks at the terminal gate is the gate automation technology services. This technology allowed the automatic inspections of the inbound and outbouund containers (Dekker et al., 2013). Also, with this management system, information sharing via the port community (port managers, port operators, customs, shippers, and truck companies) is used to help importers and hauliers to inform the terminal and customs about the cargoes' details, which will result in accelerating the cargo clearing process at gates (Heilig and Vob 2017; Maneno 2019; Oruwari 2021; Misra 2021).

A platform service for real-time exchange of information (a single window project) is another successful management system for port accesses and gate services. In this solution, a single platform employs a decision support system in real-time and transaction processing systems, allowing all port community actors to exchange information and make money transactions in less time and effort (Garlan et al. 2016; Huynh et al. 2016). By applying this platform, both terminals and hauliers could plan their resources better, and all access services reliability can be improved due to minimising the old-fashioned bureaucratic paperwork.

Another prevalent port gate management service that was widely discussed in the previous literature is the pre-notification and appointment services. In this type of service, different control techniques have been employed in practice: truck arrival management (TAM), vessel-dependent time windows (VDTWs), and terminal appointment system (TAS). In (TAM) technique, the arrival rate of trucks is controlled in an operational, economic way that ensures the congestion at port gates at a very low level or unlikely to happen (Chen et al., 2013). TAM technique tries to make a balance between the demand and the supply of external trucks within the capacity of the port gate (Yang et al. 2013, Islam and Olsen 2013, and Islam and Olsen 2014). The second technique (VDTWs) was first introduced and employed at some terminals in China, where the terminal storing capacities are insufficient to cope with the increase in cargo traffic (Chen and Jiang 2016). In this method, the outbound trucks for the same ship are assigned to a specific time window of arrivals decided and appointed by the port operators. The advantage of this method is that trucks’ arrivals can be avoided when the terminal storing areas are fully occupied, which eliminates the congestion situations at port yards and gates (Jacobsson et al. 2018). The third approach (TAS) is a well-known solution in the previous literature. In the TAS management system, port operators usually announce gate time slots within each hours of the day through the terminal web page-based information system where trucks drivers can choose between available entry time slots (Maguire 2010, Chen et al. 2013, Phan and Kim 2016, Yi et al. 2019, Misra 2021 and Xu et al. 2021). As was stated by Phan and Kim (2016), the advantage of this solution is that a significant number of trucks can be assimilated without congestion problems by spreading out the demand on port accesses and gates throughout the whole day. In the meantime, the only disadvantage of this technique, as was argued by (Jacobsson et al. 2018), is that sometimes there were some slots cancellations without prior notificaton to the port, which reduces the system efficiency (Xu et al. 2021).

#### 2.4.3.8 Inefficient Operation Management of Port Resources in Developing Countries

Most studies on the problem of port congestion in developing countries have reached the same above results where efficient operation management in these countries is hard to reach. For example, studies like El-Naggar (2010) used queuing theory to investigate and analyze the congestion problems at Alexandria port (Egypt). Monem (2015) also used queuing methodology to tackle the congestion issues at Emkaser port (Indonesia). Saeed et al. (2016) have applied the same queuing technique to solve the port congestion situation at the Manila international container terminal. Scholars such as Maneno (2019), Misra (2021), and Oruwari (2021) have studied the factors behind the congestion problem at developing countries' ports and suggested improving the productivity and the efficiency of port operations management. Using machines to maximum capacities need to train and develop the skills of the port workforce, as poor training and development usually lead to a decline in the productivity and efficiency of operations. Kabir and Helal (2021) have studied the congestion at Chittagong seaport (Malaysia) causes and its consequences and they suggested investing in skilled personnel and establishing training plans to upgrade the port labour qualification to adapt to the innovation in port equipment. In addition, introducing incentive schemes that linked the high performance of labour to monetary incentives as it was applied in most developed countries’ ports is very important for increasing the productivity of the port labour. Rosario (2020) argued that the port management in Durban port (South Africa) needs to pay an additional premium fee to the terminal workers if they succeed to reach a high rate of productivity to ensure the handling operation efficiency.

Moreover, Misra (2021) has introduced and explained the idea of smart ports which is based on the automation of all port resources and interconnection of all port chain players via mobile data transfer in real-time. Smart ports and smart ships are a single window for the “just in time” principle which makes it possible to integrate all operations (loading, shipping, discharging, and clearing processes) in real-time data available on mobile apps or internet web pages.

All the above studies agreed and approved that those ports have sufficient infrastructures and good functional equipment to cope with the demand on their resources. However, they claimed that the congestion situations are mainly raised due to unproductive port operations paralleled with inefficient management of their port facilities.

#### 2.4.4. Policy Reasons behind Port Congestion Problems

Governance structures are a legal environment where they can be used to mitigate conflicts between partners in transaction processes and subsequently to achieve mutual gains among these parties. Brook and Cullinane (2007) argued that the government rules, policies, and regulations that apply to businesses and their shareholders should be suitable to manage the relationship among all parties. In the literature about the port congestion problem, there were some questions that many studies tried to answer: What are the impacts of some government rules and policies on cargo traffic flows and port operation efficiencies? Could the port congestion problems be relieved by changing or developing these policies and regulations instead of investing in new facilities? Moreover, If governments have not implemented the correct and proper governance regulations, congestion might spread to other ports and even the areas surrounding these ports as time goes by. Grubisic et al. (2020) and Xu et al. (2021) stated that the congestion situation that occurred in Shanghai port in April 2017 spread all over the eastern region of China including both ports of Ningbo and Zhoushan.

As an example of government regulation, imposing the custom regulation of 100% cargoes inspection that leaves or enters the seaports can result in waiting for the containers' trucks in queues for screening which will consequently increase the traffic congestion in front of and around the port accesses and gates (Jizba et al. 2015; Ruiz-Aquilar et al. 2016; Xu et al. 2021). Oyatoye et al. (2011) and Onyemejor (2015) also pointed out this reason for port congestion. They claimed that the policy of 100% physical inspection of all import containers through Nigerian ports imposed by the federal government had caused a backlog of uncleared cargoes, which led to congestion of all ports around the country. Also, Alhameedi et al. (2018) claimed that the increase in security level at the gate of port Khalifa Bin Salman, which was established by the Bahrain government, has resulted in queuing the containers' trucks at the port gate waiting for inspection causing more delays and reducing the port operation efficiency.

As a solution to this problem Bakshi et al. (2011), Jizba et al. 2015, and Ruiz-Aquilar et al. 2016 suggested that government should ease this inspection policy by alternative inspection legislation that includes fast primary scans for all containers followed by physical secondary inspection for only failed containers in the first inspection.

Another cause for the port congestion problem that arises due to ineffective policies or regulations is the pricing policies for storing cargo at port yards. Sauri et al. (2011) argued the scarcity of terminal storing spaces makes the need for increasing the storage pricing policies to maintain high port productivity and performance. By increasing the storage pricing policies, port managers enforce shippers and customers to declare their cargo from port yards as soon as possible to generate more yard spaces. In the same issue, Gidado (2015) and Vu (2022) argued that the government, through its governance institutions (customs and ports' authorities), should pressure the port users from the private sector to comply and minimise their cargo dwell times at ports.

In developing countries, as ineffective governing rules and policies are fundamental causes for existing port congestion situations (Ojadi and Walters 2015; Baba and Abubakar 2022), governments in these countries should enhance their legislation mechanisms before investing in any new port capacities (Gidado

2015). In fact, in many developing countries, rules are usually issued to serve a particular group of people or a specific government political direction where these regulations, most of the time, encourage both the monopoly and centralism of the public sector for the interest of a few VIP government's people. The regulation structure in this type of political regime has enormously contributed to reducing the productivity and the efficiency of its country's ports and hindering them from convoying other world ports in the fast and rapid development. Lane et al. (2009) argued that the monopoly by the South African public sector in managing ports, at that time, has deterred private investment in developing these ports and resulted in increasing congestion situations. Furthermore, they suggested that due to the lack of government financial resources that allowed the public sector to develop the country's ports, the government should change its regulations to guarantee and strengthen fair competition among port sectors. This eventually will lead to involving the private sector in developing and managing those ports and maximising the national benefit from them. Oruwari (2021) has gone far in this subject, he argued that in Nigeria, the government face a lot of challenges to develop and update the policies on decongestion ports. He argued that these challenges are an inadequate definition for the policies and a lack of clear definition in responsibility coordination which usually causes no transparency and stall in the work processes.

Another face of de-effective government regulation is the bureaucracy widely practised in developing countries, especially in governed organizations where ports are not an exemption. The complicated cargo clearance documentation process has also exerted a lot of attention in the literature about the port congestion problem since it is one of the ugly faces of bureaucratic and multi-agent roles. In this documentation processing, bureaucracy usually causes an increase in the filled forms and the official signatures needed to process ships and clear cargoes. Consequently, these over-complicated procedures will undoubtedly impose extra time and lead to congestion and jam the seaport. Perssonm (2008), Gidado (2015), Carballo et al. (2016), Elentably (2017), Oruwari (2021), and Baba and Abubakar (2022) argued that delays and congestion situations from the process of vessel and cargo clearance at the African ports had caused de-efficient and unproductive port operations and management. To prevent bureaucracy and reduce any accounted congestion problems, the government should establish a regulation that reduces bureaucracy and involves information technologies (IT) in managing ports. This can be ensured by introducing a data exchange platform (single-window projects) where all port stockholders are incorporated in this single-window platform for the documentation and clearance process (Alhameedi et al. 2018; Maneno 2019; Misra 2021 )

#### 2.4.5. Social Reasons behind Port Congestion Problems

Before and still to our present day, ports are considered the main source for creating employment chances for most urban people. This might come as a result of most ports being at the heart of big cities and greatly integrated into their population's social life. However, the recent developments and the high technology contribution in upgrading the port equipment parallel with the increasing power of labour unionisation have left most ports suffering from excessive workforce numbers, which generate more strike issues and a decline in ports' efficiency (Oruwari 2021). The excessive workforce numbers (with no correlation to production improvement) are the main cause of decreasing operation efficiency and increasing capital costs. In fact, the more excessive number of labours in a port, the less productive that port becomes (Simoes and Marques 2010).

Also, most of the traditional public ports around the world are controlled by solid labour syndicates (Mainly stevedoring workers), which usually promote the increase of port workers' numbers without considering the qualification of staffing (Simoes and Marques 2010). Trujillo and Nombela (1999) argued that labours, as being civil workers, at traditional public ports are usually enjoying great social benefits that they want to maintain; nevertheless, these benefits sometimes contrast with port managers' plans for improving productivity. In these conflict situations, they might commit strikes to force the port management to accept their demands. Maloni and Jackson (2005) stated that in 2004, a two-week labour strike at the USA's west coast ports resulted in congestion in these ports and leaving 200 ships waiting in front of them. In another example, the over-bloated labour force at the Nigerian seaports has a strong contribution to the increased levels of port labour strikes, cargo theft, unproductive port operation, and delays upon ships (Oghojafor et al. 2012; Oruwari 2021).

Also, another common reason for entailing delays and congestion issues at ports, especially in developing countries, is the numerous public holidays in certain seasons of the year.  They cause to decrease in the working days and attribute to disruptions in port operations and lead to an increase in the ship turnaround time (Aldcroft 1961, Simoes and Marques 2010, Chinedum 2013, and Misra 2021).

Solving the problems mentioned above, most of the studies in the literature agreed on two solutions. First, a labour deregulation process should be established by governments to reduce the excessive control power of port unions and then secondly to allow the private sector to invest in developing and operating these ports (Kent and Hochstein 1998, Trujillo and Nombela 1999, Oghojafor et al. 2012, Oruwari 2021, and Misra 2021).

Another social cause contributing to rising congestion at most world ports is the corruption in the seaport managing systems and government institutions related to the port sector, especially at traditional public ports. Although many published papers consider corruption a great problem for the underdevelopment of port infrastructures and inefficient port operation management, none of them directly related it to the port congestion phenomena. As an example, for these studies, Ojadi and Walters (2015) and Odukwe and Ikeh (2017) claimed that at the Nigerian ports, the corruption that exists in all port activities, especially in custom systems, is responsible for the inefficient ports' operations and the Nigerian supply chain. Oruwari (2022) stated that port users in Nigeria have to deal with corruption (especially bribery, and red tape) where the attitude of port officials who deliberately delayed ships and cargo to their own benefit cause to decline in port operation efficiencies and results in delay times. This was agreed upon by Comins (2020) who was cited in Misra (2021) who argued that the main challenges faced by the port operators of Durban port in South Africa in applying the truck booking system were the mess caused by people who haven't booked but keep coming as they bribed and cheated the system.

Hancock (2020) explains another face of corruption in government institutions where the inadequate governmental sensitives in South African ports have led to a stall in checking and clearing cargo processes at ports and corrupt practices, and misappropriation of government funds and foreign investment for developing the South African port sector.

Another study by Wagner (2017) has indicated that the effect of corruption in Poland's seaports has badly impacted all seaport users.

Corruption usually comes as a result of severe bureaucracy and results in more constraints on systems' processes. Collier et al. (2008) pointed out that the severe bureaucracy at most Nigerian customs institutions has caused corruption in most of their customs processes at ports and contributed to the degradation of ports' efficiencies. Also, some other studies in the literature argued that in ports, corruption is usually a posted bureaucracy. Most times, it is a significant cause for hindering the smooth operation of international trading (Clark et al. 2004, and Yang 2008). Moreover, it can be an obstruction to the development of the port infrastructures that might be underway (Sequeira and Djankov 2010).

To prevent corruption within ports and in government institutions in general, most studies in the literature suggested the involvement of electronic document management platforms. This platform is a single-window project for all port communities that allows all port actors to submit their documents, make money transactions, and issue clearance permissions with less or no in-person contact between public servant agents and port users (Collier et al. 2008, Ojadi and Walters 2015, Wagner 2017, and Odukwe and Ikeh 2017, Hancock 2020; Misra 2021; Oruwari 2022).

As it can be seen from the above literature, these scholars already have acknowledged that corruption has existed in seaports and customs and this corruption is directly responsible for lowering port efficiency and also for port infrastructure under-development. However, these scholars have not directly related corruption to the port congestion problem, which might need further research to indicate and prove this relationship. Finally, as most studies in the previous literature have not declared a direct relation between corruption and port congestion issues, future research might be feasible to study and may prove this relationship.

### 2.5. Covid 19 and its impact on the port congestion problem

The Covid-19 pandemic started to spread globally in early 2020 and its bad effect influenced the economic development of many countries to variable degrees. Moreover, it led to a change in the pattern of global economic structure that has been formed through many years of development and forced many industries to adapt to its consequences (Hisaka et al. 2020). The shipping and port industries are not exceptional where they were heavily impacted by the pandemic as many countries have introduced strict measures for ports to control and prevent the covid-19 from spreading all over. These measures forced most ships to remain waiting inside or sometimes outside ports for a long time (Meng et al. 2022). For example, in 2020 and the beginning of 2021, vessels were kept waiting outside ports even though the port berths were idle in ports such as Yantian in China and Los Angels in the USA (Ibid). In addition, these measures affected badly the port operation efficiency causing a slow berthing of ships and cargo handling operations which led to an increase in the port congestion situations in most world ports. This came as a result of the reason that most ports' authorities have to comply with regional and international rules relating to the Covid-19 such as Covid tests and restrictions. Although, these regulations might vary among ports, however, most of them have led to minimising the number of port labour that are allowed to be at work at the same time. This put more pressure on the efficiency of cargo handling operations and led to congestion situations as no adequate number of workers to accomplish services such as loading/discharging of goods, customs clearing, and checking at port gates.

As the Covid-19 pandemic continued to spread, more pressure was imposed on ports all around the world and causing delays for incoming and outgoing vessels preventing them from transporting cargo to their destinations on time (Ma and Zhu 2021). The delay and the increase in ships' waiting times have resulted in a huge waste of fuel, environmental pollution, and increased the cost of operations. That was for ships' owners. However, for port operators, the delay in loading, discharging, and clearing cargo operations has caused systematic problems in port storage and management. And this sequentially caused a decline in port operation efficiency and resulted in arising congestion situations at most world ports. Komaromi et al. (2022) stated in their study that with the outbreak of the

Covid-19 pandemic, shipping times around the world have jumped upwards and time delays from the end of 2020 till the end of 2021 exceeded 1.5 days on average which represents about 25% increase in international trade transporting time. They explain that the cost of delayed shipments in that period can be compared to a value of 0.9 – 3.1% of an ad-valorem tariff.

The pandemic outbreak has unveiled the insufficiency of a successful response for controlling the epidemic in some developed nations such as in the USA and in some European countries which resulted in arising congestion situations at ports and interruptions for the whole supply chain (Meng et al. 2022). However, the response and the control of the epidemic have improved since the beginning of 2021. This improvement has led to an increase in product purchase orders, especially from China after the shortages in supplying goods during the early period of the outbreak of Covid-19. Container ports in the USA have experienced severe congestion situations since mid of 2020 and these congestion situations are generally attributed to import surges triggered by heavy spending on consumer goods during the pandemic period (Smith et al. 2022). Also, Meng et al. (2022) stated that China's exports have increased to 29% in 2021 especially to the USA compared to the previous two years and this increase has led to higher pressure on the transportation supply, and caused congestion to the most of Chinese and the USA ports and the west coast ports. In Europe, and Germany as an example, the delay time for vessels before the outbreaks of Covid-19 was around 45 – 55 hours, however, the pandemic caused the vessels' delay times to jump upwards and to be around 2 weeks (Kaufman 2021).

In developing countries, the consequences of outbreaking the Covid-19 pandemic had a severe impact on their maritime transportation and ports. For example in West African ports such as Nigerian ports, vessels in the pre-Covid period had 2 weeks delay time, however, the inability to adapt covid regulations during the pandemic worsened the congestion even more and the ship waiting time went up by the end of 2020 to reach 25 days delay time (Anagor 2020 and Munshi 2020). Moreover, by the end of 2021, the ships' delay times jumped to 50 days and the cargo clearing times take around 80 days (Hellenic Shipping News 2021).

The covid-19 pandemic itself did not cause directly the problem of port congestion but its impacts that did so (Vu 2022). Ports which experienced the pandemic were forced to be shut down by the local authority and remain under quarantine for 2 weeks. And ships calling those affected ports were re-directed to neighbouring ports causing the traffic to be concentrated on some ports and lead to congest them. For example, the port of Ningbo in East China in August 2021 was closed by the China government due to the outbreak of Covid-19 among its workers, and several coming ships to this port were re-directed to Shanghai port putting more pressure on it (Meng et al 2022). In addition, most of the world's governments have forced ports' authorities to comply with regional and international rules relating to the Covid-19 such as Covid tests and social distance restrictions which eventually led to minimising the number of port labour that are allowed to be at work at the same time. This caused a lack of workforce at ports and put more pressure on port management and leading to declining the efficiency of cargo handling operations and resulting in congestion situations at ports.

### 2.6. Seaport stakeholders

Stakeholders, in general, have characterized as those: an individual, group of individuals, system or organization who was/were affected, impacted, or influenced by actions of organizations or policy (Freeman 2001). Moreover, the stakeholders' satisfactions are a significant measure in organization performance evaluation (Brooks 2006).

According to the above definitions the seaports' stakeholders that are affected or/and impacted by port congestion and also their responsibility to play a vital role in reducing and mitigating the problem of port congestion can be identified as Port actors or port users such as Port operators' companies, Port authorities' entities, ships' owners' companies, shippers (traders), shipping lines' agencies, customs government institutions, cargo clearance agencies, government maritime administration (such as port states and ministries) (Ghashat 2013 and Elferjani 2015).

Seaport operators play a focal role in enhancing the efficiency and productivity of a seaport as they are the main provider of port services such as Stevedoring activities, pilotage services, and storing cargo activities to the port users. Most port operators attend to increase their productivity level by attracting new vessels without putting more investment in increasing port facilities' capacities, which might eventually lead to congesting their ports and increasing ships' turnaround times (Besleovnik 2008; Imai et al. 2008). Thus, they can be considered one of the important populations that should be included in any study about the causes of port congestion problems.

Companies of shipping lines and vessel owners and their port representatives (shipping agencies) generally measure the performance of ports and container terminals based on various important key parameters. One of these important key parameters is the turnaround time for their vessels at ports as they always look to minimise the time that their ships spent to be served at ports and usually try to avoid congested ports (Chang et al., 2008). Moreover, they play an important part when it comes to the process of sharing information between port management and their ships for scheduling the arrival of their vessels to minimise and avoid the congestion situations at their calling ports. This makes those individuals working at the management level at these three organisations (shipping lines, ships' owners, and shipping agencies) important stakeholders to be considered in any research about the port congestion problem.

Additionally, the Port Authority and port state should be considered as one of those important port stakeholders due to their regulatory role over seaports and container terminals. Depending on the port control model (public port, tool port, landlord port, or private port), they are the authorized entity for implementing local government rules and international conventions. Thus, including various managerial levels from, both entities as port stakeholders are very important in any research about port congestion problem as they seek to eliminate port congestion situations at their ports. Similarly, the representatives from the government ministry that controls ports and have the role of decision-makers in the ports sector are very important port stakeholders to be included in studying, investigating and solving port congestion problems. This is because they should be interested in developing such solutions and policies that help them regarding the congestion problems at their countries' ports (Perssonm 2008; Gidado 2015: Carballo et al. 2016).

Customs entities and private customs clearance agencies are also very important to be considered among the port stakeholders. This results from their role and their responsibility for ensuring smooth port cargo flow processes in/out of port gates. Their efficiency and performance in checking cargoes entering or leaving ports influence and impact the port operation productivity and, in most situations, are the direct cause of port congestion problems (Onyemejor 2015; Alhameedi et al. 2018).

Finally, shippers, traders, and cargo owners, by which the shipping process is started, or ended, are very important port stakeholders. Their role in sharing the cargo information process with all other port actors such as (port operators, customs, and truck companies) plays a very important part in minimising and reducing congestion situations at ports. This can enhance the process of scheduling the arrival of ships and/or trucks at port gates (Baumgrass et al. 2015). Moreover, as they usually seek and are interested in having their cargo flow through ports efficiently and quickly, they attempt to avoid importing or exporting via congested ports as much as they can.

All the above port stakeholders should be targeted as population samples for any research study investigating the causes and the solutions to port congestion problems.

### 2.7. Summary

This chapter started with a background on the port congestion problem, where the port congestion landscape seemed to be varied and diversified from one port to another. Also, where extreme port congestion situations rose at some ports and container terminals, others have not experienced congestion problems at all, and still a few others in between.

Then the chapter extracted the definitions for the port congestion problem from the literature and elaborated on the consensus among scholars on defining the phenomenon. The diversity in defining the problem of port congestion in the literature has emerged from the fact that the reasons behind the port congestion problem in ports are complicated and multi-dimensional. They also differ from one country to another and, in some cases, even from port to port.

This chapter also presented the type of port congestion levels discussed in the literature. Congestion problems at seaports can raise at one or more of these three different levels of port congestion:

**Seaside congestion level** where the first type is the ship entry/exit route congestion, and the second type of seaside congestion is the ship to berth congestion.

**Landside congestion** where the first type of landside congestion is ship work congestion, the second type of landside congestion is cargo storage and stack congestion, and the third type of land congestion type is vehicle work congestion.

**Hinterland-side congestion** where the first type of hinterland-side congestion is vehicle gate congestion, and the second type of hinterland-side congestion is vehicle route congestion.

Then, this chapter has identified, elaborated, and discussed all the reasons behind the port congestion problem in the previous literature. To provide a broad picture of the reasons behind the port congestion problem, this research study has theoretically classified the causes of the port congestion problem and their proposed solutions prevalent in the previous literature in five categories. These five categories were built according to the type of classification that triggers and raises the situations of congestion at world ports:

**Natural Reasons:** The port operations stoppages and delays due to bad weather, flooding, and tide conditions create waiting times and queue vessels before entering the port. These types of port congestion causes, except tide, are usually out of the hand of port operators and port users, and none of them can do anything other than just wait for those uncontrolled conditions to pass.

**Economic Reasons:** any sudden increase in the seaborne trade or local market demand for goods in a country or region will consequently increase cargo flow at its ports. This is because most of the world's ports have been already developed to their maximum physical capacity. This situation often results in congested ports and puts more strain on the international supply chain. To solve these congestion problems, the government needs to balance and equally distribute this increased traffic in trade flow to all its country ports. This can be done by investing in developing its smaller ports and establishing a type of policies and regulations that encourage shippers to use them.

**Technical Reasons:** In the literature, most scholars looked to the port congestion phenomena as issues caused by technical problems. These technical problems sometimes are clear, such as the breakdowns and the shortages of port equipment or, in other cases, related to technical issues such as inefficient operation and management of port resources or poor port infrastructures. Most published studies in the previous literature have focused on improving port operation efficiency and managing the port gates' capacity to solve the problem of congestion situations at seaports.

**Policies Reasons:** where congestion problems arise due to inefficient government or port policies and regulations, such as imposing the custom regulation of 100% cargo inspection. The pricing policies for storing cargoes at port yards where the scarcity of terminal storing spaces make the need for increasing the storage pricing policies to maintain the high port productivity and performance. Also, in developing countries, ineffective governing rules and policies that encourage the monopoly, and bureaucracy in their public sectors, are essential causes for existing port congestion situations. The government should ease the severe inspection cargo policies and establish new rules that prevent monopoly and bureaucracy in their institutions to solve policy issues.

**Social Reasons:** the excessive number of port workers in the traditional public ports with no correlation to production improvement as well as the increasing power of port labour unions has contributed to increasing the port strikes and, as a consequence, declining the port operation efficiencies and generating more congestion problems. Solving the problems mentioned above, most of the studies in the literature agreed on two solutions, establishing a labour deregulation process in ports and allowing the private sector to invest in developing and operating these ports.

This chapter also discusses and explains the impact and effect of the Covid 19 pandemic on global port networks.

Finally, this chapter has identified, elaborated, and discussed the role of the seaport stakeholders. How they were affected and impacted by the port congestion problem and also their role in minimising and reducing the congestion phenomena at seaports.

# Chapter Three: Research Methodology

## 3.1. Introduction

This chapter aims to present, outline and justify the methodology selected to collect and analyse the data of this PhD research study. This methodology was employed to link the conceptual framework developed in the study (Eddrgash 2019) with the empirical findings presented in the following two chapters. This chapter starts with the research paradigm and presents two different epistemological perspectives, positivism, and constructionism. This chapter also discusses how these two perspectives have influenced operations and management studies research. Then it follows by explaining the research design. Finally, since they were the main methods in this thesis, systematic literature review and online survey applications are briefly discussed in this chapter, however, the full details on these methodologies can be found in their own chapters (chapter 4 for the systematic review and chapter 5 for the online survey).

## 3.2. Research Paradigm

It indicates a set of beliefs and practices related to a particular research style. It also presents the idea that a research study is fundamentally performed according to specific philosophy and worldview, and all those functions share this view within the research paradigm (Sunders et al., 2009).

The main components of a research paradigm are ontology, epistemology, and methodology (Grix 2002). According to him, ontology is the starting point for all social science research studies, which should be followed by the researcher's epistemological and methodological assumptions. Blaikie (2003, p. 8) defines the ontology as "science or study of being" which indicates explicitly the "claims or assumptions that are made about the nature of social reality, claims about what exists, what it looks like, what units make it up and how these units interact with each other". Therefore, ontological assumptions are related to how the researcher looks at the nature of reality (Cooke-Davies et al., 2009).

Epistemology can be defined as "the theory or science of the method or grounds of knowledge" (Blaikie 2003, p. 8). It represents the claims that were made about the potential means of obtaining social reality knowledge or whatever it is assumed to be (Richards and Morse 2007). In other words, it illustrates how the researcher acquires his knowledge about social reality.

Finally, the methodology demonstrates the techniques that the researcher used to determine the knowledge of reality (Blaikie 2007). It emphasises the approaches that he/she took to collect, analyse, and justify the acquiring knowledge (Guba 1990). Thus, the philosophical stand that a researcher should adopt needs to reflect how the researcher looks at the reality and links between the acquiring knowledge and the method developed to obtain this knowledge.

## 3.3. Philosophical stance of a research study

The main issue of orientation in ontology is about how the researcher looks at a social entity, whether it should be treated as an objective entity, or a social construction built up from the social actors' perceptions, actions, and experiences. While the first situation, refers to the philosophical stance of objectivism, the latter is considered constructionism (Bryman and Bell 2007). The philosophical stance of this research study is objectivism. In the objectivism paradigm, the researcher claims that the existence of the social phenomenon and its meanings is independent of social actors. In other words, objectivism suggests that the knowledge about any social phenomenon exists independently and separately from the perception of the involved people in this phenomenon (Bryman 2008).

In social sciences, and regarding epistemology as the second component of the research paradigm, there are two main prevalent epistemological orientations: Positivism and constructionism (Thomas 2004). Constructionism is sometimes called interpretivism or phenomenology. The positivistic philosophic school is the oldest and most prevalent scientific methodology and is quantitative in nature. While the constructionism school of thought is an approach keen on understanding human behaviour and actions, it is qualitative in nature. Both philosophical stances might have different impacts (positively or negatively) on different research contexts; however, the main concerns remain the same (Saunders et al. 2009). The differences between the philosophical stance of both epistemologies are given in table 3.1.

| Philosophical stance / the way to gain knowledge | Positivism | Constructionism (Interpretivism) |
|---|---|---|
| *Preferred conceptions of:* | | |
| The real world | Set of natural objects | Set of human meanings |
| The type of analysis | Variable analysis | Cultural analysis |
| Theory of human behaviour/action | Behaviourism | Symbolic interactionism |
| Relation between structure and action | Explain actions in terms of structures | Explain structures in terms of actions |
| Knowledge | General, nomothetic, universal | Particular, Ideographic, contextual |
| Data | Given, found | Constructed |
| Method of securing data | Data collection via observation | Data construction via interpretation |
| Description | Quantitative measurements | Qualitative descriptions |
| Explanation | Statistical relations | Narrative accounts |
| Causal emphasis | External to internal | Internal to external |
| Prediction | Based on statistical forecasts | Based on understanding of typical behaviour in typical situations |
| *Preferred research approach* | | |
| Research strategies | Experiment, quasi-experiment, survey | Case study, ethnography, action research |
| Research methods | Self-completion questionnaire, structured interview, structured observation, psychological tests | Unstructured interview, participant observation, personal documents (diaries, letters, etc.), |
| Analytical method | Multivariate statistical analysis | Hermeneutics |
| *Methodological problems* | Internal validity, contextualization | Generalization, replication |
| *Symbol/image* | Hard, science, physics, variable net | Soft, humanities, anthropology, cultures |

Source: Thomas (2004, p. 127)

Table 3.1. The differences between the philosophical stances for both epistemologies positivism and constructionism.

In order to choose a suitable philosophical stance and rational methodology to produce this study, it is essential to define both stances and methodologies.

### 3.3.1. Positivistic philosophical stance

Over the years, positivism has been associated with social science studies that typically involve empirical tests. In this way, numerical data is collected to understand human behaviours and actions or other information about people over objective measures and values. According to Collis and Hussey (2009), a positivist researcher seeks to investigate the causes or the facts about the social dilemma by applying the language of theories, variables and/or hypotheses without any individual subjective states. This philosophic stance is more suitable than others when the study object is to collect data concerning the frequency of the existing problem. The positivism approach depends on a great number of scientific methods that provide numerical and alphanumerical data (Easterby-Smith et al., 2008). In social sciences, positivist researchers deal with reality as an objective entity, and they believe that it is not related to human perceptions (Carson et al. 2001). Also, they identify their research topic by detecting an external object rather than creating the research by building up the actual study object (Ibid). Positivist researchers also claimed that their stance promotes the logic of experiment and test methods for proving or disproving the research hypotheses to increase the understanding of a specific problem or phenomenon. This might lead eventually to establishing new theories by exploiting the facts to produce new laws or principles (Myers 1997; Greener 2008).

The essence of the positivist stance emphasises the employment of research methods such as experiments and surveys (Saunders et al., 2009). It also justifies using a set of formalised methods to investigate and measure the assumed existing or driven by natural laws or mechanisms independent facts about an individual reality (Carson et al. 2001). Also, the positivist's tendency for considering that everything, in the end, can be known and proved is a significant characteristic that helps the researcher to secure empirical data in large quantities (Fisher 2007). It also can assist the researcher in statistically analysing these extensive data to discover any underlying symmetric (Easterby-Smith et al., 2008). Moreover, it is worth remarking that only objective statements are deemed acceptable in the positivist stance, the data gathering is quantitative in nature, and the results can be generalised and replications (Fisher 2007, Saunders et al. 2009, and Easterby-Smith et al. 2012).

### 3.3.2. Interpretivist philosophical stance

In contrast to positivism, the interpretive, in the social sciences and under the constructivism paradigm, focuses on human perceptions and experiences to understand the problem or the phenomena (Welman et al. 2005). Interpretivism, thus, believes that “the world is constructed by series of multiple, unique and holistic realities” (Saunders et al. 2009, p. 116), and they focus on individuals as they consider that human behaviours and actions are the key elements of sense-making (Collis and Hussey 2003, and Saunders et al. 2009). Researchers in the interpretive stance aim to look at the real world through the eyes of individuals being studied, which allows them to gain various participants' perspectives, the involvement of the researcher him/herself and considering the context under study (Kura and Sulaiman 2012).

Saunders et al. (2009) argue that the philosophy of interpretivism is about perceptions, intuitions, explanations, descriptions, experiences, and arguments. They explain that researchers of this school of thought usually look to the world as a complex entity that needs to be rationalized. This rationalising might lead to the development of general principles and theories. As Saunders et al. (2012) argued, this thought is challenging our complete understanding of the knowledge around the real world. Also, according to interpretivism philosophy, the reality is socially constructed rather than objectively determined (Hussey and Hussey 1997). The philosophy itself is highly contextual rather than generalizable (Collis and Hussey 2009). Thus, the key assumption of interpretivism philosophy is that it develops a greater approach to comprehending individuals' perceptions and actions by putting them in the proper social context (Saunders et al., 2012). In addition to the above discussion, the greater need for using qualitative data to develop knowledge is promoted by the very nature of this philosophy, wherein in social sciences, the researcher, based on the evidence extrapolated from this qualitative data, could gather, analyze, and develop new rules or theories (Smith 2015).

### 3.3.3. Philosophical stance of this research study

After reviewing the two main philosophic school thoughts in most operations and management studies, the researcher of this PhD study is aware that there is no approach or methodology without weaknesses or critics for their reliability and validity in social sciences.

On **an ontological and epistemological level,** the researcher of this study accepts the assumptions of the positivist positions. The researcher also believes that positivism is an appropriate approach to carry out this research since it is linked with variables analysis and quantification and is suitable and widely used in the area of studying operations and management problems (Thomas 2004).

Several strengths can be gained from being a positivist researcher (Kim 2003). First, since the positivist seeks to examine the causal relationship between variables, where the change in the independent variable will cause to change in the dependent variable, the very nature of positivism facilitates the effort for obtaining more output for the researcher's input. Secondly, basing the research study on empirically grounded positivistic methodology decreases the values that might corrupt the study process and help to overcome the researcher's biases. This is due to the tool offered by positivism methodologies. This self-corrective tool can allow the researcher to check the credibility of the data and minimise the personal subjectivity that might cause a distorting influence on the knowledge production process. Thirdly, adopting the positivist philosophical stance assists the researcher in producing externally valid knowledge and, in a situation where the research results can be generalized and applied to other cases beyond the case under investigation by the original study. Finally, employing the positivistic approach might result in capturing the discrepancy between the research-developed hypotheses and the existing theories, which might lead to challenging the previously accepted concepts to resolve these conflicts. Therefore, the positivistic approach helps improve existing theories by investigating them and asking for more refined applications instead of accounting for previous and past studies.

This research attempts to identify the most common reasons behind the congestion problems at seaports and their proper solutions by quantitatively using a systematic literature review to investigate the phenomena and extract evidence-based reasons and solutions. Then these reasons will be quantitively tested to simplify the problem to its simplest elements (Bryman and Bell 2011). Thus, this PhD study argues for the positivist philosophical stance with the employment of quantitative methodology.

## 3.4. Methodology for this research study

The methodology for research was defined by Richard and Morse (2007, p.10) as "a consistent way of making, interpreting, analysing, and judging the results' theoretical outcomes." The decision for choosing the appropriate research methodology depends on the ontological and epistemological researcher's perspective, the problem that the researcher tries to tackle, the study's aims, the type of available data, and the available time for answering the study questions (Creswell 2003).

**At the Methodological level**, researchers usually distinguish between two types of methodologies, quantitative and qualitative. The differences between those approaches are summarised in table 3.2. (Marvasti 2004; Bryman and Bell 2007).

| Type of methodologies | Quantitative | Qualitative |
|---|---|---|
| Ontological level | Objectivism | Constructionism |
| Epistemological level | Natural science model, in particular positivism | Interpretivism |
| Gathering Data | Experiments, Pre-code surveys or other formulation techniques | Direct, fluid, observational techniques |
| Analysing Data | Statistical analysis aimed at highlighting universal cause and effect relationships. | Analysis focused on context-specific meanings and social practices |
| The conceptual framework role | Separates theory from methods | Views' theory and methods as inseparable |

(Source: Summarized by Marvasti (2004); Bryman and Bell (2007)).

Table 3. 2. The differences between the quantitative and the qualitative methodologies

This research, the quantitative methodology has become the focus of this study. Bryman (2008) argues that quantitative methods emphasised quantification in both data gathering and data analysis. It is also a common methodology for most empirical research studies within the sciences of operations and management fields (Baruch and Holton 2008). Quantitative methodologies enable the positivistic researcher to assess and validate the existing and previously constructed theories that explain the happen of phenomena. Moreover, the time consumption for collecting and analysing quantitative data is relatively less than in qualitative methodologies (Johnson and Onwuegbuzie 2004). It also has samples with a much larger size than the qualitative methods studies have, allowing the generalization of the study results when its data is based on random samples with sufficient size (Sale et al. 2002).

## 3.5. Research design

Research design is a general plane about how the researcher links the conceptual research problem to relevant and workable empirical research. It is simply a research framework that guides the researcher in gathering and analysing data in a way that enables him/her to answer the research questions (Churchill and Lacobucci 2002; Saunders et al. 2012). In the research design, the researcher set the study boundaries and logic, such as the type of employment methodology, the industry under investigation, time and budget limits and other issues related to the study (Ghauri and Gronhaug 2002; Yin 2009).

Two important factors should be considered when deciding on the research design: The selection between theory building and theory testing and the types of study questions (De Vaus 2001). The first factor is related to the relationship between theory and the type of research. In this context, two types of research approaches, induction, and deduction, have been established in social sciences (Ibid). Positivistic researchers attend to use the deduction approach to validate their research, while interpretivistic researchers go for the induction approach to establish the legitimacy of their research (Bryman and Bell 2011). The other differences between these two types of research approaches are summarized in table 3.3 (according to Saunders (2009, p. 127)

**The deductive approach** is a process for forming reasoning where conclusions are validly drawn or derived from some structures and must be correct if those structures are correct (Malhorta and Birks 2007). In the deduction approach, the researcher starts with a theoretical or conceptual framework, establishing the research hypotheses, and then the conclusions are logically deducted from the study findings (Baker and Foy 2008). The theory of the conceptual framework through the analysis of the research data can be accepted, amended, or refused with the objective of explaining the enquiry of the study (Bryman 2008; Saunders et al. 2012). **On the other hand, the inductive approach** contrasts the deductive, where it performs the common-sense view of a phenomenon or problem under observation, obtaining conclusions and then creating a theory (Ghauri and

Gronhaug 2002). Thus, the approach of induction in research studies enables the social actors' interaction to be used to understand reality in a flexible structure (Saunders et al., 2009).

This PhD research study will use the deductive research approach to tackle and answer the research questions. This is due to two reasons: firstly, the researcher has developed a conceptual framework in an early stage (the Eddrgash 2019 research study) about the port congestion phenomena. This conceptual framework needs to be tested accordingly. Secondly, the existence of significant rich literature about the port congestion phenomena that can assist the researcher to develop a research model for the research problem (see chapter two of this thesis).

| Deductive emphasises | Inductive emphasises |
|---|---|
| - Scientific principles | - Gaining an understanding of the meanings' humans attach to events. |
| - Moving from theory to data | - A close understanding of the research context. |
| - The need to explain causal relationships between variables. | - The collection of qualitative data. |
| - The collection of quantitative data. | - A more flexible structure to permit changes of research emphasis as the research progresses. |
| - The application of controls to ensure validity of data | - A realisation that the researcher is part of the research process. |
| - The operationalization of concepts to ensure clarity of definition. | - Less concern with need to generalise. |
| - A highly structured approach. | |
| - Research independence of what is being research. | |
| - The necessity to select samples of sufficient size in order to generalise conclusions | |

(Source: summarized by Saunders et al. (2009, p. 127).)

Table 3. 3. The differences between the Inductive and the deductive research approach

The second factor in designing research is what type of research needs to be implemented. In social sciences and based on the problem tackled by the research, there are three distinguished types of research in the literature: exploratory, descriptive, and Exploratory (Cooper and Schindler 2001).

***An exploratory study*** is specifically valuable for clarifying the researchers' understanding of the problem under investigation (Saunders et al., 2012). It mainly seeks to identify new insights and ideas about a problem that might be unstructured or poorly understood (Robson 2002). ***The descriptive study*** is a valuable means of providing an accurate profile of individuals, events, or situations (Robson 2002). It is objective to identify the frequency of occurring for certain characteristics or the relationship between the variable of interest in a given situation where the phenomenon under investigation is structured and well understood (Churchill and Lacobucci 2002). ***The Exploratory study,*** also called causal research, is applied when researchers face causal and effect problems (Ghauri and Gronhaug 2002). The Exploratory study is helpful in the same as in descriptive study when the problem under investigation is structured correctly (Ibid).

Based on the objectives of this PhD study, this research can be considered a descriptive study. This can be related to the nature of the research question "What" and, due to these reasons. Firstly, descriptive studies target to describe the problem under the research investigation before starting to gather the data, based on the conceptual framework and some antecedent understanding of the nature of this problem (Collis and Hussey 2003; Saunders et al. 2012). This study aims to describe the problem of port congestion before starting to collect the data, based on the conceptual framework developed in the research (Eddrgash 2019) and some understanding from the previous literature about this problem. Secondly, descriptive research also aims to validate if the relationship between variables, which was assumed, is existing and inherently objective to be examined by empirical tests (Hair et al., 2003). In fact, this PhD research aims to empirically examine the relationship between some causes of port congestion problems to identify the common reasons behind the problem's existence.

There are two types of descriptive research studies cross-sectional and longitudinal research (Churchill and Iacobucci 2002). in longitudinal studies, panel data of a fixed sample of population elements is measured frequently during a period of time, while cross-section research studies involve gathering data from a particular sample of population elements just for one-time measurement (Ibid). In social sciences, cross-sectional studies are the most prevalent type in the descriptive research design. Some scholars also see them as the most important classification type of descriptive studies (Churchill and Iacobucci 2002; Malhorta and Birks 2007). This is because the data collected from cross-sectional measurements better represent the general population and is relatively less costly and less time-consuming than in longitudinal data measurements (Levin 2006; Malhorta and Birks 2007). Thus, this PhD research can be classified as a cross-sectional research study where the data (whether in a systematic review method or online survey) is gathered at the same time from samples to investigate the relationships among the variables and determine the common factors for the port congestion problem.

## 3.6. Data collection process

One of the fundamental issues of research design is the selection of the data collection methods. The researcher's way to gather the data has to ensure the collection of valuable and workable information from the resources when answering the study questions. Also, the researcher can either employ one or multi-methods for collecting the research data (Saunders et al., 2009). As was described in chapter two of this thesis that the port congestion problem (the research problem of this PhD study) is complex and multi-dimensional. Hence, a large amount and different types of data need to be collected to answer the research questions.

Consequently, using a single method for collecting data was not an option; thus, there was a need to use both the systematic literature review and online survey methods. This first one is to help the researcher build up the theoretical conceptual framework about the problem with the one that developed early in the (Eddrgash 2019). The second method for collecting data is to test and find the common factors among the variables that cause the port congestion problem to occur.

When a researcher wants to choose his/her research method, three significant factors need to be considered (Yin 2009):

I. **Types of study questions that need to be asked.** Yin (2009) argues that the type of questions that the researcher needs to ask is the most important factor for differentiating between various study methods. Questions' terminologies such as "to what extent", "how many/much", "who", and "what" are suitable for survey research and/or systematic review studies. In this PhD research, "what" and "to what extent" question terminologies are appropriate for both data collection methods used in this research (systematic review and online survey).

II. **To what extent the researcher has control over the behavioural events in the study?** As in this PhD study, the researcher has no control over behavioural events, so both data collection methods (systematic review and online survey) are preferred to carry out this study.

III. **The extent to which the researcher focuses on contemporary against historical events.** The questionnaire survey is a proper method for collecting data for investigating a problem when a researcher's focus is on contemporary events. As the researcher focuses on this PhD study on the ongoing contemporary causes of the port congestion problems, the online survey is a suitable method for collecting data for this research study.

**This PhD research's first data collection method** is a systematic literature review. The systematic review is a technique that employs a replicable methodology that allows potentially the researcher to generate new information based on synthesizing the results from previous studies (the previous literature). It differs from the traditional narrative literature review as it adopts a replicable scientific and transparent process where it can (Petticrew and Roberts 2006). Also, by providing explicit inclusion and exclusion criteria, set the study boundaries and allow other researchers, if necessary, to review articles with the highest quality to duplicate the search process (Ibid). To create a management study that can be theoretically sound and methodologically rigorous, "It is important that the scholarly and practitioner communities develop processes and methodologies for bringing research evidence together systematically and applying it to practice"

(Denyer and Tranfield 2006, p. 213). The systematic review connects theory to practice and synthesizes evidence-based knowledge from academic studies where this knowledge can be easily integrated into (policies) and effectively applied by practitioners. The systematic review sets a boundary for the study and documents the steps. Therefore, ensuring the collection of replicable and high-quality content where the replicable process enhances the generalizability of the research findings. Also, clear, and transparent documentation for the protocol can help other scholars on the same subject repeat the research and reach the same results. The evidentiary validity offered by EBR adds high credibility to the study.

To achieve a comprehensive and reliable literature analysis, the researcher employed evidence-based research (EBR) using a systematic review. The problem presented in this thesis was the difficulties that the decision-makers faced with identifying the causes of port congestion problems in their ports and finding a proper solution for these causes. These difficulties emerged because these causes are complex, multi-dimensional, and might differ from one country to another and sometimes even from port to port. EBR, through a systematic literature review, gave validity by producing a replicable means of grouping and classifying the different components reported from reliable studies that tackled the research problem. As the researcher seeks to discover whether the eight Superordinate reasons and Subordinate reasons (the conceptual framework identified by Eddrgash (2019)) cause and influence the problem of congestion at world ports. Thus, If so, what is the existing evidence in the previous literature that informs and exerts the most decisive influence? For this purpose, this study seeks to use a methodology that can implement a theoretical lens that emerged from the definition of port congestion, where the reasons behind this phenomenon are complex and multi-dimensional. This can be done through a systematic literature review method where evidence-based research is used to collect and investigate the common theoretical classifications triggering the port congestion problem and categorize the traits that can stimulate and cause the port congestion problem in most world ports.

The seven typical stages of the systematic review framework developed by (Gough et al. 2012) were used. Those seven stages are: (1) Review initiation, (2) Review question and methodology, (3) search strategy and locate the studies, (4) description of study characteristics, (5) study selection and quality evaluation, (6) analysis and synthesis, and (7) reporting findings and using results. For the literature search database, the electronic database which is identified as relevant to business, economics, and transport information resources, includes EBSCO, Emerald Insight, Google Scholar, Scopus, ProQuest, and Web of Science (Petticrew and Roberts 2008) were searched for this review study. First, an initial online search using google scholar was conducted as an iterative search to enhance the review process sensitivity and minimize the risk of missing articles (Barnett-Page and Thomas 2009). Then, exhaustive searches for each of these databases (EBSCO, Emerald Insight, Google Scholar, Scopus, ProQuest, and Web of Science) were conducted to provide a comprehensive and diverse database for this systematic review study. The review period for this review research was continued for September 2019 till the end of October 2020. **See chapter four of this thesis section 4.3 for complete details on this method's samples, method's process, validity, and reliability.**

**The second method** to be used is the online survey based on a close-structured questionnaire type. An online survey was carried out to identify the common factors of port congestion problems at seaports. This identification was based on the theoretical, conceptual framework developed early in the (Eddrgash 2019), and on the port, congestion causes identified and yielded from the systematic literature review method (chapter 4). An online questionnaire was built, distributed, and analysed to obtain and model the common factors behind the problem. The questionnaire is one of the most widely used study tools in operations and management research fields. Each participant must answer the same group of questions correctly before a quantitative analysis can be conducted (Saunders et al., 2012). In other words, it is a list of tested and then chosen structured questions that are used to seek reliable answers from a selected population sample to investigate a phenomenon through their perception and experiences (Collis and Hussy 2009). The employment of the questionnaire is popular due to its fast gathering of extensive data in a short time and low-cost way (Saunders et al., 2009). It also enables answering questions without the potential bias from the researcher (Bryman and Bell 2007).

Recently, there was a significant development in how the questionnaire is utilised, designed, distributed, and analysed. One of these questionnaire development techniques is the online questionnaire or the online survey (Evan and Mathur 2005). According to Bryman and Bell (2007), online questionnaires have become increasingly attractive to business researchers, especially management research studies. Online questionnaires have a lot of advantages and strengths that explain the increase in using them in research (see table 5.1 in chapter five which summarises some of these strengths). The online questionnaire method is widely used within the managerial and behavioural sciences due to its low cost and its capability to describe a large population's characteristics with limited subjective observation (Palmquist 2012). This method has been used in this PhD study to collect data to examine the relationships between port congestion variables (causes that make the problem happen) and attempt to reach a consensus on defining the port congestion phenomena and also identify the common factors among these variables and model the port congestion problem.

The questionnaire of this survey research was built and distributed based on the main five steps developed and introduced by (Churchill and Lacobucci 2002; Malhorta and Birks 2007; Saunders 2012) for building the questionnaire. It included two parts. The first part covers the respondents' demographic information, such as gender, age, level of education, organization type that they work at, managerial level, working area, and years of experience. The second part was divided into two sections. In the first one, the respondents were asked to select a proper definition for the port congestion problem to measure and reach a consensus amongst the industry experts on defining it. In the second section, the respondents had to respond to a list of statements describing the reasons behind port congestion problems at ports with a Likert scale of seven points.

The questions and the categories in this survey have been designed to motivate the participants to respond and complete all the questionnaire questions. Moreover, the researcher made a great effort to keep the survey questions straightforward and easy to read to ensure comprehension of the questions and avoid any misunderstanding, which gives a greater chance of completing the survey. See Appendix (F) for more details about the survey questionnaire.

The link to the survey questionnaire was distributed by email to obtain the useful maximum quality and quantity in the population sample by this method. These emails were sent to the target population of managerial levels of individuals, groups, companies, and government organisations. The target network was based on respective organisation webpages advised by the researcher supervisors and based on personal visits to maritime companies or the researcher's personal connections**. See chapter five of this thesis sections 5.2 till 5.7 for complete details on this method (samples, method process, ethical consideration, validity, and reliability).**

# Chapter Four:

## Systematic Literature review of the port congestion problem

## 4.1. Introduction

This chapter seeks to discover whether the eight Superordinate reasons and Subordinate reasons identified by Eddrgash (2019) cause and influence the problem of congestion at world ports and, if so, what is the existing evidence in the previous literature that informs and exerts the most substantial influence. For this purpose, this stage seeks to use a methodology that can implement a theoretical lens that emerged from the definition of port congestion, where the reasons behind this phenomenon are complex and multi-dimensional. This can be done through a systematic literature review method where evidence-based research is used to investigate the common theoretical classifications triggering the port congestion problem and categorize the traits that can stimulate and cause the port congestion problem in most world ports.

To achieve a comprehensive and reliable literature analysis, the researcher employed evidence-based research (EBR) using a systematic review. The problem presented in this thesis was the difficulties that the decision-makers faced with identifying the causes of port congestion problems in their ports and finding a proper solution for these causes. These difficulties emerged because these causes are complex, multi-dimensional, and might differ from one country to another and sometimes even from port to port. EBR, through a systematic literature review, gave validity by producing a replicable means of grouping and classifying the different components reported from reliable studies that tackled the research problem.

This chapter begins with a brief introduction to what constitutes a systematic literature review and the rationale for using it to review empirical research studies in management and operations studies. Following this general overview, complete details about the methodology used are presented. The seven typical stages of the systematic review framework developed by Gough et al. (2012) were used. Those seven stages are: (1) Review initiation, (2) Review question and methodology, (3) search strategy and locate the studies, (4) description of study characteristics, (5) study selection and quality evaluation, (6) analysis and synthesis, and (7) reporting findings and using results. Finally, the chapter is completed with the results and the discussion.

## 4.2. Systematic review

A systematic literature review is defined as a scientific method for investigating and classifying a massive amount of information contributing to exploring the research boundary and expanding the knowledge background (Gu and Lago 2009). It gives a structured review of previous studies obtained through an evidence-informed approach that emphasizes relevant studies and research questions (Denyer and Tranfield 2009) and is employed through a clearly documented and fixed plan (Gough et al. 2012). Also, it synthesizes various studies and uses “the systematic accumulation, analysis and reflective interpretation of the full body of relevant empirical evidence related to a question” (Rousseau et al. 2008, p. 475). Briner and Walshe (2014) argued that using a systematic review methodology in social science studies can give much value to answering the research questions. The transparency in the procurement of the data and applying the method that supports the research conclusion allow the researcher to see the whole picture and avoid any bias. For example, articles with agree or conflict findings might be both shown in the systematic review.

The systematic review is a technique that employs a replicable methodology that allows potentially the researcher to generate new information based on synthesizing the results from previous studies. It differs from the traditional narrative literature review as it adopts a replicable scientific and transparent process where it can (Petticrew and Roberts 2006). Also, by providing explicit inclusion and exclusion criteria, set the study boundaries and allow other researchers, if necessary, to review articles with the highest quality to duplicate the search process (Ibid).

### 4.2.1 Rationale for using a systematic review

Over the last two decades, there has been a broad argument and discussion around the nature of management and operations research. The ontological position of this discipline was the concern for most of these debates; specifically, it is both fragmented and divergent characteristics (Tranfield et al., 2003). This means “that the significance of problems and preferred ways of formulating them is unstable, subjected to disputes and are assessed by diffused and diverse standards" (Whitley 1984, p. 343). Also, further clarification on this ontological position by Whitley (2000) suggested that the continued fragmentation of the management and operations discipline might displace academic researchers as primary stakeholders in the study process. By comparing the management and operations field with other social science fields, there has been a deep dissension between academic researchers and practitioners, where "this divergence is likely to proliferate irrelevant theory and untheorized and invalid practice further" (Hodgkinson 2001, p. 45).

On the other hand, practitioners such as organization managers and decision-makers usually rely on their experience to solve operations and management problems rather than scientific research (Vandenbosch et al., 2006). Thus, a disconnection between practice and academic findings might be the result, as Aken (2004) argued that management and operations research needs to be developed with a view that is based on the design science, instead of formal or explanatory science. He explained (p. 225) that "conceptualizing management research in this way needs a field of study to deliver the output of high academic quality and a practitioner and context-sensitive.". Meeting the double hurdle of embeddedness in the management and operations field and the worlds of both practices and policies requires a design based on valid, valuable, and reliable knowledge. This valuable and reliable knowledge has to be developed in one form of "field-tested and grounded technological rules" to be employed to solve specific management and organization problems (Aken 2004, p. 225).

To create a management study that can be theoretically sound and methodologically rigorous, "It is important that the scholarly and practitioner communities develop processes and methodologies for bringing research evidence together systematically and applying it to practice" (Denyer and Tranfield 2006, p. 213). The systematic review connects theory to practice and synthesizes evidence-based knowledge from academic studies where this knowledge can be easily integrated into (policies) and effectively applied by practitioners.

### 4.2.2. Evidence-based management

The background for the systematic review concept in academia has begun with the "evidence-based" movement. The management field incorporates evidence-based management (EBM), evidence-based research (EBR), and evidence-based practices (EBP). Evidence-based management "derives principles from research evidence and translates them into practices that solve organizational problems" (Rousseau 2006, p. 256). It also clearly and transparently explains the connection between academia and practices (Tranfied et al., 2003). The incorporation between practitioners and academic scholars in the evidence mix, which EBM made, allows the availability of a broad range of evidence to managers and decision-makers along with its context in academia and practices.

Supporting a claim using evidence might seem logical. However, Rousseau (2006) argues that EBM has increased the connection between practice and policies by incorporating evidence into management decision-making by concentrating on facts based on the evidence. Gathering information for research and then systematically synthesizing this information is a unique process. This gathering is not only for helping managers make a decision but also for implementing evidence to support the research. EBM research studies over the century have witnessed a growth in depth and value by employing concepts used in natural sciences research studies to manage and develop a body of shared knowledge based on scientific evidence. Rousseau (2006, p. 262) argues, "Given managers' diverse backgrounds and education, there is limited understanding of the scientific method. With no formally mandated education or credentials, practising managers have no body of shared knowledge. Also, due to the lack of scientific knowledge to add weight to an evidence-based decision, managers commonly rely on other bases such as experience, formal power, incentives, and threats when making decisions". The advantage of EBM is that decisions and policies can be established based on multiple forms of evidence rather than one single source of information. Also, EBM can shift the focus of the managers and decision-makers to understand the cause-and-effect connections that are illuminated by evidence-based research.

#### 4.2.3. Evidence-based research

Evidence-based research (EBR) has been widely accepted and used in policy-based fields. This is because presenting the value of the evidence gives more weight to the structure of a systematic review study (Petticrew and Roberts 2006). When conducting systematic review research, the methodology of systematic review employs the highest review of evidence and provides a scientific and transparent protocol via thorough searches of previous literature (Harden and Thomas 2005; Petticrew and Roberts 2006; Macpherson and Holt 2007; Kepes et al. 2014; Briner and Walshe 2014). “In other words, a detailed technology aims to minimize bias” (Tranfield et al. 2003, p. 209). The systematic review sets a boundary for the study and documents the steps. Therefore, ensuring the collection of replicable and high-quality content where the replicable process enhances the generalizability of the research findings. Also, clear, and transparent documentation for the protocol can help other scholars on the same subject repeat the research and reach the same results. The evidentiary validity offered by EBR adds high credibility to the study.

On the other hand, “any threat to the integrity of the research process is a cause of concern, another reason for cumulating studies, and comparing their patterns of results before concluding” (Rousseau et al. 2008, p. 480). There are six criteria steps created by Rousseau et al. (2008) to help defend the evidentiary validity and make an excellent contribution to the greater use of systematic review. These six steps are:

- **Validity:** To prove that a phenomenon is likely to be real and meaningful in the first place essentially means that the regularity that scientists use to determine it can be constantly demonstrated.
- **Internal validity** is the possibility of the study effectively demonstrating the causal relationship between a presumed cause and the expected effect.

- **The significance of effect size** is the measurement of the relationship strength observed between variables. In a meta-analysis, the significance of effect size is considered essential information; however, this depends on the research purpose. Also, combining cost-benefit information to effect sizes can generate a crucial evidentiary value of studies, mainly where great benefit can be achieved with less effort and minimum cost.
- **Generalisability** or in other words, external validity is the extent to which study findings hold across the study populations, study methodology, and their consistency over time. Only research studies (quantitative or qualitative) that provide information concerning phenomenon conditions are considered to have evidentiary value and can be generalised. Considering results from published research studies only threatens generalisability. The primary purpose of reviewing the traditional literature is to investigate whether the results are stable among scholars and toward methods, measures, and times to establish a solid ground for advancing knowledge (Salipante et al. 1982). However, to identify the stability of the results, it is required to review both relevant published and unpublished studies to overcome the bias that many traditional journals have versus publishing non-significant findings.
- **Intervention compliance:** is the extent to which all conditions are needed to produce a specific cause or employ a particular treatment. Compliance is an essential issue in management and operations studies due to the diversity in operational and management practices. One of the most critical questions that the awareness of compliance might raise is whether all practices specified in the study protocol were followed. A study provides information related to the differences in actual implementation, and the sensitivity of results has considerable evidentiary value.
- **Contextualisation:** empirical evidence refers to how the context influences the investigated phenomenon. It identifies the limitation of a cause-effect relationship or a phenomenon and gives the reason for

this limitation, which goes beyond generalisability. To distinguish contextual supports, one of the vital pieces of evidence is that the co-occurring conditions that influence or make the phenomenon occur or the phenomenon consequences are not part of the phenomenon itself. On the other hand, the unaccommodating organisational setting for new management practices or any other intervention indicates contextual support absence. Also, constructive management practice might be failed due to prior events or previously failed to change, and the investigation of the conditions which led to this failure (or success) can contextualise the given practice/intervention occurrence and operation.

#### 4.2.4. ENTREQ model.

The systematic literature review design has three essential elements: planning for the review, conducting the review, and reporting and disseminating the results (Tranfield et al., 2003). Tong et al. (2012) by collecting and reviewing 40 syntheses published research studies, establish a model for Enhancing Transparency in carrying out systematic Reviews of Qualitative studies (ENTREQ). This model establishes a framework for the 21 steps listed in the table (4.1). Those 21 steps are applied to clarify and demonstrate the transparency traits and rigour (Perrar et al. 2015; Hughes-Morley et al. 2015; Glujovsky et al. 2015). While transparency clarifies reporting synthesis, the rigour shows the study's thoroughness. As this systematic review research seeks to use both kinds of literature (quantitative and qualitative), the ENTREQ model was helpful in the framework of this thesis as it gives an excellent and brief approach regarding the steps of the systematic literature review.

| no | Item | Guide and Description |
|---|---|---|
| 1 | **Aim** | State the research question the synthesis addresses. |
| 2 | **Synthesis methodology** | Identify the synthesis methodology or theoretical framework that underpins the synthesis and describe the rationale for the choice of methodology *(e.g. meta-ethnography, thematic synthesis, critical interpretive synthesis, grounded theory synthesis, realist synthesis, meta-aggregation, meta-study, framework synthesis)* |
| 3 | **Approach to searching** | Indicate whether the search was pre-planned *(comprehensive search strategies to seek all available studies)* or iterative *(to seek all available concepts until [the] theoretical saturation is achieved).* |
| 4 | **Inclusion criteria** | Specify the inclusion/exclusion criteria *(e.g. in terms of population, language, year limits, type of publication, and study type).* |
| 5 | **Data sources** | Describe the information sources used (e.g. *electronic databases (Scopus, EBSCO, Emerald Insight, ProQuest, Web of Science), grey literature databases (digital thesis, policy reports, trade articles), relevant organizational websites, experts, information specialists, generic web searches (Google Scholar) hand searching, reference lists)* and when the searches [are] conducted; provide the rationale for using the data sources. |
| 6 | **Electronic Search strategy** | Describe the literature search *(e.g. provide electronic search strategies with population terms, clinical or health topic terms, experiential or social phenomena-related terms, filters for qualitative research, and search limits)*. |
| 7 | **Study screening methods** | Describe the process of study screening and sifting *(e.g. title, abstract and full-text review, number of independent reviewers who screened studies).* |
| 8 | **Study characteristics** | Present the characteristics of the included studies *(e.g. year of publication, country, population, number of participants, data collection, methodology, analysis, and research questions).* |
| 9 | **Study selection results** | Identify the number of studies screened and provide reasons for study exclusion *(e.g., for comprehensive searching, provide numbers of studies screened and reasons for exclusion indicated in a figure/flowchart; for iterative searching describe reasons for study exclusion and inclusion based on modifications of the research question and/or contribution to theory development).* |
| 10 | **Rationale for appraisal** | Describe the rationale and approach used to appraise the included studies or selected findings *(e.g. assessment of conduct (validity and robustness), assessment of reporting (transparency), assessment of content and utility of the findings).* |

Source: Tong, (2012).

Table 4.1. The 21 ENTREQ steps

| no | Item | Guide and Description |
|---|---|---|
| 11 | **Appraisal items** | State the tools, frameworks and criteria used to appraise the studies or selected findings *(e.g. Existing tools: CASP, QARI, COREQ, Mays and Pope; reviewer developed tools; describe the domains assessed: research team, study design, data analysis and interpretations, reporting).* |
| 12 | **Appraisal process** | Indicate whether the appraisal was conducted independently by more than one reviewer and whether consensus was required. |
| 13 | **Appraisal results** | Present results of the quality assessment and indicate which articles, if any, were weighted/excluded based on the assessment and give the rationale. |
| 14 | **Data extraction** | Indicate which sections of the primary studies were analysed and how were the data extracted from the primary studies. *(e.g., all text under the headings "results/conclusions" were extracted electronically and entered into computer software).* |
| 15 | **Software** | State the computer software used if any. |
| 16 | **Reviewers number** | Identify who was involved in coding and analysis. |
| 17 | **Coding** | Describe the process for coding data *(e.g. line by line coding to search for concepts).* |
| 18 | **Study comparison** | Describe how were comparisons made within and across studies *(e.g. subsequent studies were coded into pre-existing concepts, and new concepts were created when deemed necessary).* |
| 19 | **Derivation of themes** | Explain whether the process of deriving the themes or constructs was inductive or deductive. |
| 20 | **Quotations** | Provide quotations from the primary studies to illustrate themes/constructs and Identify whether the quotations were participant quotations of the author's interpretation. |
| 21 | **Synthesis output** | Present rich, compelling and useful results that go beyond a summary of the primary studies (e.g. *new interpretation, models of evidence, conceptual models, analytical framework, and development of a new theory or construct).* |

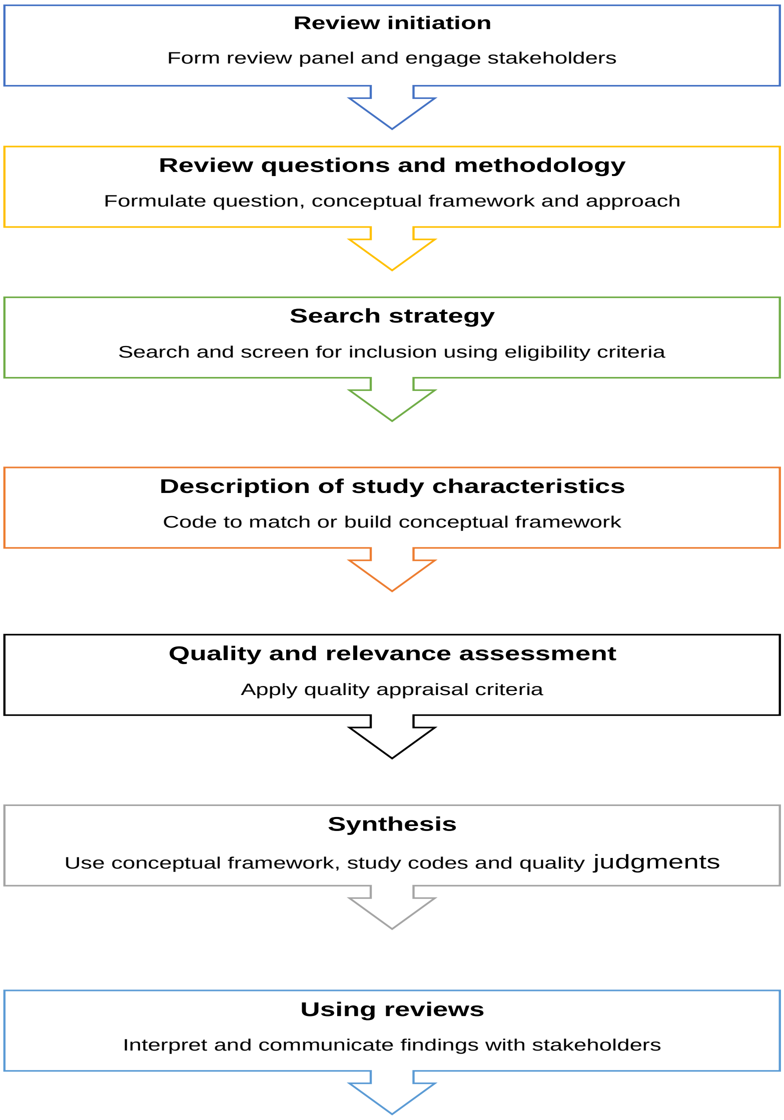
Source: Tong, (2012).

Table 4.1. Cont. The 21 ENTREQ steps

## 4.3. Methodology (Systematic review framework)

Using a framework based on the seven common steps of the systematic review developed by Gough et al. (2012) and elements comparable to the ENTREQ model by Tong et al. (2012), this thesis provides a systematic review of the port congestion problem. The first step provided by this list was to establish a review panel by gathering a team and engaging experienced stakeholders to support the researcher in creating an environmental research scan of potential advocates, which will increase the value of the "evidence-informed" decision-making. This step is followed by the formulation and review of the study questions.

Then, a defined search strategy with a clear eligibility criterion, step three, followed by step four, which described the research characteristics that implicate the codes used in the study protocols. The criteria for quality appraisal and the relevancy are explained in step five. Step six employed the developing conceptual framework in step four to synthesise the literature and explain the used methodology. Finally, step seven recorded the interpretation strategy used to interpret the systematic review results and communicate findings with stakeholders (see figure 4.1).




Source: Gough et al. (2012).

Figure 4.1. The seven common steps of the systematic review.

### 4.3.1. Step one: Review initiation

**Stakeholders**. In this step, researchers start to initiate their systematic review by collaborating with stakeholders to establish an expert review panel to maintain a group discussion that provides potential perspectives and alternate views for the subject of the study (Gough et al., 2012). Reviewers can beneficially use other experts' knowledge who have not necessarily carried out formal research. This knowledge might be gained from the familiarity with various jobs, that are, nevertheless, relevant to the systematic review subject, or from experience gained from using a service or a product that is under the focus of the study. A reiterated consultation provided by stakeholders is precious because the input to the professional practices' decisions and policymaking matches the evidence-informed decision-making review (Gough et al., 2012). They also argued that the involvement of stakeholders could be at any stage in the review. This involvement can contribute to good governance and accountability and can help produce a more relevant review in accessible ways and languages. Thus, the systematic review can be widely spread through stakeholders' networks. However, Miles and Huberman (1994) highly emphasize the early involvement of stakeholders in the systematic review, where the earlier discussion with stakeholders can help to 'pause and ponder' the research frame regarding the main concepts, themes, issues, and questions.

This research study used and involved the outcome from Eddrgash (2019), which interviewed non-academic practitioners involved in port management and operations in Libya (Libyan port stakeholders). The reason behind this is to explore the study topic (port congestion problem in developing countries), develop a profound understanding of the problem and use the findings from that stage to build up this systematic review. The base criteria applied in that stage of this research study for selecting review stakeholders (the Libyan port stakeholders) were that all should be involved in Seaport activities, whether they work for the public or private sector. Appendix A details all selected stakeholders, their experiences in port activities and multiple levels of involvement. The discussion with the stakeholders was about introducing a proper definition of the port congestion problem as it was a different perception of defining port congestion among scholars and practitioners. Also, the discussion targeted the impact of the problem on economic, political, managerial, and social aspects of developing countries to identify the causes of the port congestion problem in developing countries and their proper solutions.

The question, what are the leading causes of port congestion in developing countries and their potential solutions, was found to be too broad and too large a question to address. A period of thorough collaboration with these stakeholders has resulted in narrowing the focus to eight leading causes under five standard theoretical classifications triggering the port congestion problem. Through the discussion in the interviewing process (stage one of this PhD research study), most of the stakeholders provided examples and cases from their work experience (evidence) regarding the causes of the problem of port congestion. These conversations bring more literature reviews regarding this research topic (port congestion problem), such as corruption, centralism, monopolism, and bureaucracy in ports and government institutions.

**External review panel.** As the Evidence for Policy and Practice Information and Coordinating Centre (EPPI-centre 2010) suggested forming an external review panel to advise the review researcher and help support the systematic review research. The researcher for this thesis relied on his PhD supervisors' team as an external review panel member who is knowledgeable about the topic and methodology of the study to provide lengthy consultation and advice throughout the whole systematic review study process. The external review panel conducted several follow-on meetings and discussions to clarify the study's research questions and to value the worth of the subject topic. Moreover, the external panel reviewed the search strategy with the researcher to find if it is clear and rigorous enough to set the boundary of research to address the research questions.

**The review Protocol**. Identifying the review question in systematic review studies is critical because the whole review process is based on and flows from it (Tranfield et al., 2003). The outcome decisions in the systematic review are obtained via a formal review protocol, which is a plan that helps to maintain the study objectives by describing the steps explicitly for the whole review process (Ibid). The review protocol should contain clear and transparent information about the addressed study questions, the study focus sample, the search strategy used to identify the relevant research studies and the inclusion and exclusion criteria for reviewing the studies (Davies and Crombie 1998). The review protocol for this study research is presented and explained in the next steps of the systematic review process (steps 2 and 3).

### 4.3.2. Step two: Review questions and methodology

The second step in the systematic review process is the question formulation and choosing an appropriate methodology for synthesising the findings. Primary studies ask various questions from many different standpoints, and this abundance of questions is reflected in the systematic review studies (Gough et al., 2012). It is also essential that the argument structure of a systematic review study should allow the reviewer to report information clearly and concisely (Rousseau et al., 2008). Thus, a clear explanation of the systematic review study questions can allow the reviewer to understand the background picture and its relevance. Briner et al. (2009) argued that a question must be structured to be rigorously addressed in a systematic review study. They based their argument on the statement of Counsell (1997, p. 381), who said “the questions guide the review by defining which studies will be included, what the search strategy, to identify the relevant primary studies, should be, and which data need to be extracted from each study. Ask a poor question, and you will get a poor review”. To achieve this in medical field studies, researchers employ the Population, Intervention, Comparison, and Outcomes (PICO) Model to help to formulate a well-defined research question at an early stage of the study and prevent inefficient effort for repeating them during the review process (Briner et al. 2009). However, in social field studies, Denyer et al. (2008) reformulated the PICO model into the Context, Interventions, Mechanisms, Outcomes (CIMO) model to suit the domain of operations management and organization in the field of business research. The CIMO model was used to identify the main aspects of this research study and presented as follows:

**Context.** The internal and external environment is considered to be the surrounding factors for the phenomenon under study and the context of the research question, such as individuals, organisational settings, relationships, or related systems understudying (Briner et al. 2009). Other examples provided by

Denyer et al. (2008) for context include features like experience, age, competency, power and policies, organisational stability, and the technical system nature (system uncertainty and interdependencies). This means that the situation or the atmosphere around the phenomenon or the project problem is considered to be the context of the research question. Therefore, the context for this systematic review (in this thesis) is the congestion problem in seaports and container terminals.

**Intervention.** Revels to the study actions or activities such as events, behaviours, effects (causes), or procedures used to obtain the outcomes or caused them to happen (Denyer et al. 2008). The effects (components) reviewed by this research are the causes or the reasons behind the existence of the port congestion phenomenon, as these components might alter the outcome of the problem of port congestion. In other words, each of these components can be an intervention as each of these causes could generate or increase the congestion problem in ports. Its absences could reduce or eliminate the congestion in ports.

**Mechanism.** It explains how the intervention generates the outcome, and this explanation might be through an existing theory or a proposed theoretical perspective (Denyer et al., 2008). Scholars in the previous literature have adopted a different theoretical approach to identify the causes (interventions) of the port congestion problem. Most of them have used the four types of port congestion (Ship berth congestion, Ship work congestion, Cargo stacks congestion and Ship enter/exit route congestion) as an identical theoretical approach to identify and explain the reasons behind the problem of port congestion and suggest a proper solution for solving the problem (Eddrgash 2019). He argued that this theoretical approach has only explained the technical side of the port congestion problem (reasons and solutions). At the same time, it might be some other aspects that could trigger the problem to occur in ports. Based on the type of classification triggering the congestion problem in ports, he theoretically classified these reasons and solutions into five economic, technical, natural, political, and social categories. This thesis chose this theoretical approach to be the mechanism that explains the generating of the interventions (causes) for the port congestion phenomena.

**Outcome**. It addressed the outcome of the intervention in its different aspects (Denyer et al. 2008) and represented the findings or the results as a conclusion of the research. As mentioned by (Denyer et al. 2008), the usual outcome in social scientific research addressed: what the intervention effects are? What is the relevant outcome? Furthermore, how can the outcome be measured? In this thesis and as explained in the literature review (chapter two), there are various causes of the port congestion problem. This variety came from the fact that the reasons behind this phenomenon are complex and multi-dimensional. When this variety can be classified and recognised, decision-making and policymakers can use this outcome to establish based-evidence policies. Using the theoretical classification for triggering the port congestion problem will enhance the better identification of the causes of the port congestion problem and improve the suggested solutions.

Based on the CIMO elements of this thesis research (see table 4.2), the research questions for this study are introduced as follows:

RQ1: What is the relevant definition that best defines the congestion problem in ports?

RQ2: What are the common reasons that cause port congestion to happen in ports?

RQ3: What are the research methods and techniques used to investigate and identify the causes of the port congestion problem?

RQ4: What are the potential solutions that have been suggested to solve the problem of congestion in ports?

| | **Brief definition** | **This study selection** |
|---|---|---|
| **Context** | Phenomenon or system under study. | Port congestion problem |
| **Intervention** | Activities, behaviour, or effects. | Causes or reasons behind the port congestion problem. |
| **Mechanism** | Circumstances or triggers of the problem. | Five triggering classifications |
| **Outcome** | Effects of interventions. | Suggest proper solutions. |

Source: The Author

Table 4.2. The CIMO elements for this study questions.

#### 4.3.3. Step three: Search strategy and locate the studies

Search strategies aim to identify and locate unbiased sufficient aggregation studies, and this is sometimes considered to be aiming to locate and identify every single relevant study (Gough et al., 2012). The reason behind this, as they argued, is that the aggregation target is to obtain high confidence and reliability via the investigation of the same problem in various contexts, and this could be counteracted if the research studies being reviewed have a systematic bias. The strategy for searching studies should be detailed and reported sufficiently so the exact search can be replicated (Tranfield et al., 2003). They also argued that the search should focus not only on published journals and peer-review articles but also on unpublished studies such as conference papers, dissertations, trade journals, and other grey literature. The information search output should comprise a complete list of literature that contributes to the topic study of the review.

**Reasons for using grey literature.** In general, grey literature can be defined as any composed of knowledge artefacts that are not part of or produced by peer-review published journals (Lawrence et al., 2014). They also argued that the size and the influence of this type of literature have dramatically increased recently through digitization. The need for involving it in review studies became more evident than it was. To identify this involvement in management operations studies (MOS), Adams et al. (2017) investigated to what extent the grey literature has been used in 243 MOS, which employed systematic review and published between 2003 and 2014. They found that around 23% of them incorporated it, while about 48% acknowledge the grey literature as a potential information source, and the rest excluded it.

By allowing the diverse and heterogeneous available knowledge that is not part of the traditional peer-review academic procedure, the incorporation of grey literature can provide a positive contribution to the study review process. Tuner et al. (2013, p. 3) argue the reason for using it by many major articles; “they intended the study to be as inclusive as possible and tried to avoid eliminating potentially valuable contributions.” They claimed this as evidence that all grey literature levels can define and contextualize the phenomenon, which is occasionally not considered or reported sufficiently in white literature (academic articles). Another reason given by Adams et al. (2017) for incorporating the grey materials in MOS systematic review is to provide a helpful guide and inform practice better.

Another benefit of incorporating grey literature in other disciplines is that it can help to identify publication bias, the “file drawer” problem (Hopewell et al., 2007). This reveals a situation where the published literature used in research is systematically unrepresentative of the study population. This happens when journals attend to publish poorly positive results rather than neutral or weakly significant results (Rothstein et al., 2005). In MOS, publication bias remains vague, though one indication of its existence could be promoting the practice depending on potentially faulty findings (Kepes et al., 2012). In this context, some MOS scholars have claimed that incorporating grey literature in systematic review can help to counterbalance this bias (Briner et al., 2009; Homberg and Bui 2013; Adams et al. 2017).

Some MOS scholars consider the systematic review only a first stage in MOS and practice projects; however, others argue that it contributes significantly to accomplishing these projects. This made from involving grey literature in some MOS systematic reviews is significant where practices can be seen in the head position of academic research at investigating the phenomenon (Smart et al. 2007). This is in the same line with the argument provided by Pawson et al. (2005), who stated that systematic reviews that only rely on the white literature could fail to sufficiently understand complex interventions in a rich, detailed, and practical way. Broader engagement of grey literature is conducive to innovation in the MOS systematic review because it intensifies the variety of interactions with evidence generated from previous experiences. In other words, involving grey literature in MOS systematic reviews makes “scientific evidence can be juxtaposed with other sources of evidence to provide a more pluralist stance for academic projects” (Adams et al. 2017 p. 447).

Based on the above discussion, the grey literature can provide the reviewers in the MOS systematic reviews with broader access to multiple and various data and knowledge than can be found in white literature alone. It also gives the reviewer a unique perspective to contextualise, critique, and reflect on published literature. It also provides both practitioners and scholars with information and experiences to give them a more comprehensive and contextual view of their study topic. Thus, this thesis incorporated and involved the grey literature such as conference papers, trade journals, books, reviews, and dissertations, along with peer-reviewed articles (Academic articles).

To locate as many possible unbiased aggregation research studies, the researcher needs to involve three research strategies: search terms, the literature database that needs to be searched, and screening for inclusion and exclusion eligibility criteria.

**Search terms**. A systematic search starts by identifying the keywords and the terms for searching based on the information provided by the study scope, the previous literature, and the review panel discussion (Tranfield et al., 2003). Then the researcher should choose the most appropriate search strings for the study. As the protocol for this research focuses on the topic of congestion problems in ports and container terminals, the initial search strings contain these key terms: "port," "container terminal, "congestion", "bottlenecks", "causes", and "solutions". To cover studies as much as possible, the researcher needs to use an asterisk at the end of the keyword to consider various derivatives of the same word (Denyer and Tranfield 2009). Also, by using the advanced search, the researcher needs to employ the Boolean logic "OR" to allow synonyms and "And" to relate two keywords (Ibid). Then, according to the four steps iterative procedures developed by Davarzani et al. (2016) for establishing effective search keywords (see table 4.3), the keywords "causes", "bottleneck", and "solutions" do not seem to add any benefit to the search. Thus, the study keywords were structured as: "port congestion" OR "container terminal congestion". All the study searches were run using this combination of those two types of keywords.

| Step no | Step description | The state of this study |
|---|---|---|
| 1 | - Defining initial set of keywords and search structure | port, container terminal, congestion, bottlenecks, causes, solutions |
| 2 | - Checking the results articles and journals<br>- Ensuring whether key articles and major journals are included in research results.<br>- Updating the keywords accordingly. | Combining words (causes) and (solutions) to other keywords did not add any beneficial to the search. |
| 3 | - looking for irrelevant articles and research area<br>- Identifying the exclusion keywords.<br>- Updating the keyword structure accordingly. | Excluded the keywords: causes, solutions |
| 4 | - Looking for irrelevant subjected area.<br>- Narrowing down the search space.<br>- Updating the keyword structure accordingly | updated keywords; port congestion, container terminal congestion |

Adapted from (Davarzani et al. 2016)

Table 4.3. The iterative procedure to establish keywords for this study

**Literature search database**. The electronic database which is identified as relevant to business, economics, and transport information resources, includes EBSCO, Emerald Insight, Google Scholar, Scopus, ProQuest, and Web of Science (Petticrew and Roberts 2008) were searched for this review study. First, an initial online search using google scholar was conducted as an iterative search to enhance the review process sensitivity and minimize the risk of missing articles (Barnett-Page and Thomas 2009). Then, exhaustive searches for each of these databases (EBSCO, Emerald Insight, Google Scholar, Scopus, ProQuest, and Web of Science) were conducted to provide a comprehensive and diverse database for this systematic review study. The Boolean search string “port congestion*” OR “container terminal congestion*” was used to search each one of the database sources. Table (4.4) shows the database used against the type of the default search scope. Also, it shows how many articles have been generated by each database for each type of default search scope. The default search scope “ALL” in some databases established thousands of non-relevant studies, making them difficult to manage and use, so the alternative default search scope Title, Abstract and Keywords “Til+ABS+KW” was used.

| Database | Scope "ALL" | No generating articles | Alternative Scope | No generating articles |
|---|---|---|---|---|
| Google Scholar | All text | 4810 | TL | 119 |
| **Scopus** | All fields | 247 | TL+ABS+KW | 117 |
| **EBSCO** | All text | 2615 | TL+ABS+KW | 415 |
| **Emerald Insight** | All fields | 146 | TL+ABS | 12 |
| **ProQuest** | Anywhere | 2146 | TL+ABS | 73 |
| **Web of Science** | All fields | 51 | Topic(TL+ABS+KW) | 49 |
| **Total** | | 14825 | | 785 |

Source: The Author

Table 4.4. Boolean string search protocol.

**Search protocol for Google Scholar database**. Google scholar's advanced search has a limited search default scope, and it can be only searched either in all text or based on the title. So, as "ALL" produce thousands of non-relevant and unmanageable articles, the choice was to use the search default scope "Title" only, which generated 119 articles.

**Search protocol for the Scopus database**. The Scopus database advance search uses multiple search defaults scope in one search step. This allows the chosen search default scope "Title, Abstract, and Keywords" to generate 117 articles.

**Search protocol for the EBSCO database**. The advanced search in this database has a split choice for the search default scope. Therefore, the search started with the "Title" default and then added two rows to include "abstract" and "Keywords" and connected these rows with "OR" Boolean. This search generated 415 articles.

**Search protocol for the Emerald Insight database**. The advanced search in this database has a split choice for the search default scope, and it only allows the "Abstract" and "Title" search default scope in two rows connected by the "OR" Boolean. This search produced 12 articles.

**Search protocol for ProQuest database**. The ProQuest Advanced search is similar to the Emerald Insight, where the database has a split choice for the search default scope, and it only allows the “Abstract” and “Title” search default scope in two rows connected by “OR” Boolean. Also, this database source allows the exclusion of some sources. So, the Newspaper source was excluded, and this search generated 73 articles.

**Search protocol for Web of Science database**. The advanced search in this database has a split choice for the search default scope. However, it should be noticed that the “Title”, “Abstract”, and “Keywords” search default scope are under one default search term, which is “Topic”. This search gave 49 articles as a result.

The total number of articles generated from the six database sources was 785 (see table 4.5).

**Screening for inclusion and exclusion eligibility criteria.** The third step in the searching strategy is to establish inclusion and exclusion eligibility criteria that are used to screen and filter searched articles to improve the reliability of the selected articles. Thus, this systematic review included all articles generated from the six database sources which have full access to full text and covered the congestion problem in Seaports and container terminals. Also, this systematic review included academic journals (peer-reviewed articles) and books, dissertations, trade journals, reviews, and conference papers (as grey literature). The exclusion criteria for this systematic review were to exclude all non-English research studies. Since this review is concerned with topics (port congestion definition, causes of the problem and solutions for the problem), articles that have not covered these topics were excluded. The newspaper articles were also excluded, as most of them have anonymous authors. See table (4.5).

| | |
|---|---|
| **Inclusion criteria** | ✓ Full access to full-text articles<br>✓ Articles covered the congestion problem in Seaports and container terminals<br>✓ Academic journals (peer-reviewed articles), books, dissertations, trade journals, reviews, and conference papers. |
| **Exclusion criteria** | × Non-English research studies<br>× Articles not covering topics of (port congestion definition, causes of the problem, and solutions for the problem).<br>× Newspaper articles |

Source: The Author

Table 4.5. The inclusion and the exclusion criteria for reviewing the systematic literature

Following the search process, which gathered 785 articles, a verification for duplicated articles was carried out. This process excluded a large number of duplicated articles and reduced the total number to 559 articles. The second step was to read the title and the abstract for each of the selected articles to ensure whether the article was falling within the purpose and the topic of this review. This step minimizes the number of selected articles to 223 articles as irrelevant articles such as articles that target congestion problems in Airports, computers, and communication networks were excluded. The third and final step was to read the whole text for each article separately and apply the inclusion and exclusion criteria to exclude any articles not covering one of these congestion topics ((port congestion definition, causes of the problem and solutions for the problem). Only 150 articles consisted of the scope of this review of research artefacts, and the rest are extraneous to the central study and the research questions specified earlier.

The selected articles were reduced through the iterative filtering process from 785 to the final sample size of 150 articles, which accounted for around 81% of the original sample size. This is consistent with other studies on ports and maritime logistics, such as Davarzani et al. (2016) research, which had an 84% reduction sample. The review period for this review research was continued for September 2019 till the end of October 2020.

**Use of PRISMA diagram**. The reliability and accuracy of the evidence reported from the systematic review have been under scrutiny (Rousseau et al., 2008). So, to increase those features for systematic reviews, Liberati et al. (2009) established the diagram for the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). This diagram was developed by a group of 29 people that contained (review authors, methodologists, clinicians, medical editors and consumers) to record the use process and strategy for systematic reviews (Liberati et al. (2009).

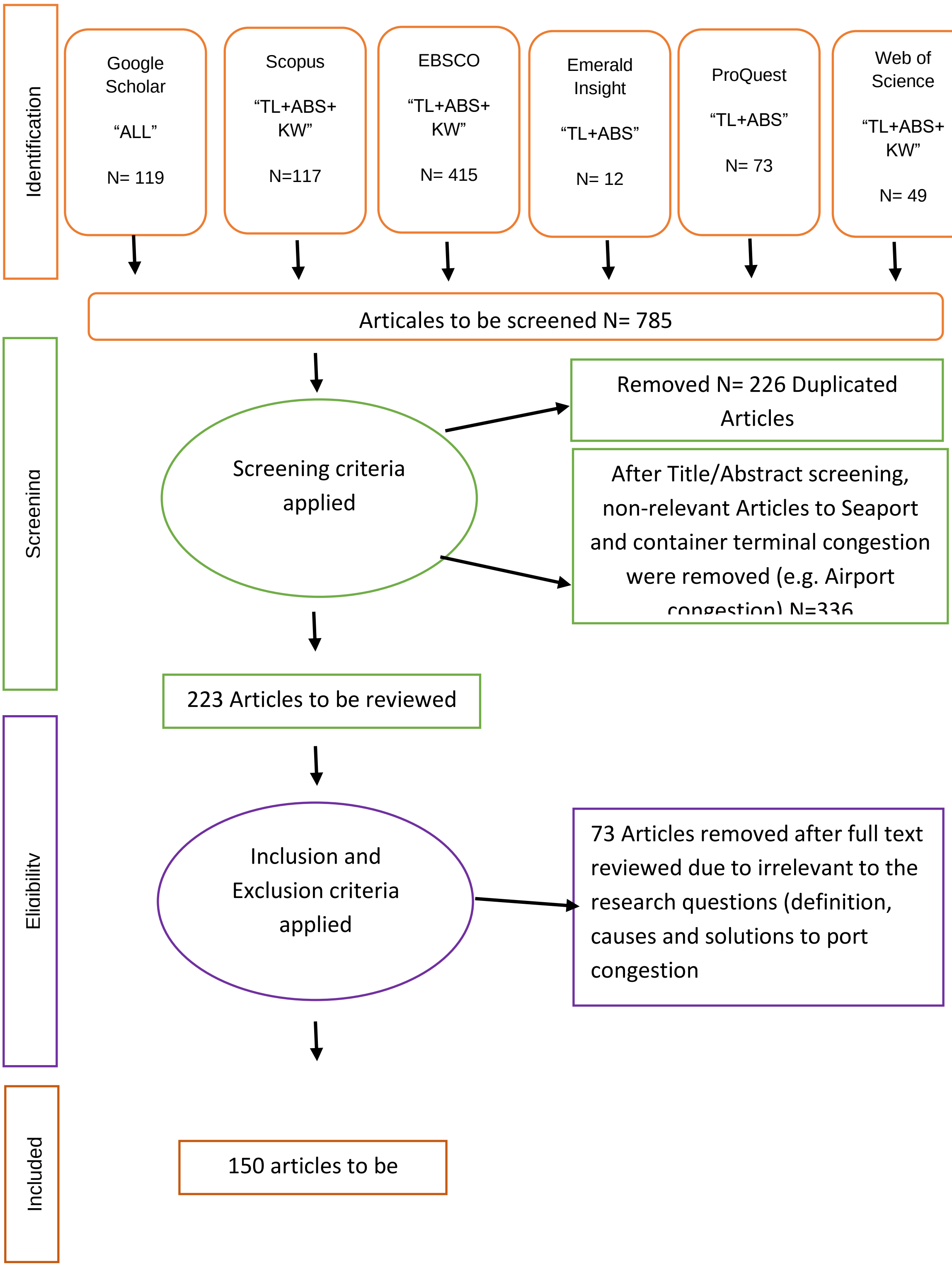
The recorded research process for this thesis is shown in the PRISMA diagram figure (4.2). The “Identification” level points to the six sources for the database used for the review search. The screening level shows the total number of articles screened by title and abstract and the excluded number of duplicated articles. On the level of eligibility, the full text for each selected article was reviewed based on the inclusion and exclusion criteria, and any irrelevant articles on the topic and research questions were excluded. Finally, the level of included provides the final number of articles selected to be included in the review's synthesis.

#### 4.3.4. Step Four: Description of the study characteristics

To analyse the studies in systematic review research studies, the reviewer needs to characterize each selected study individually (Gough et al., 2012). This should be done by coding these characters early in analyzing the process, whether the reviewer is focusing on describing the research effort (a systematic map) or evaluating the studies and aggregating their results (Ibid). This means that the researcher should capture and gather all needed information to address the research objectives from each study and form them in a structure that codes all themes and trends among all the studies being selected for review. The primary purpose of coding selected studies, of course, is to address and answer the research questions' behaviours. However, the value of coding might go far beyond it.

In this thesis, a structured form in an Excel spreadsheet was created to map and code all needed information to address the thesis research questions from each selected study. This structured form was based on the three purposes identified by Gough et al. (2012) for creating a detailed map and coding reviewed studies. These identified purposes: Mapping to describe the nature of a field of research, Mapping to inform a synthesis, and Mapping to interpret the findings of a synthesis.

**Mapping to describe the nature of the research field**. Capturing the characteristics of individual research studies is one of the main functions of coding studies' information in a systematic review in order to describe them as a set or divided into categories (Bragge et al., 2011). They argue that those sets or categories can allow the researcher to clearly describe the interventions that had been categorized or evaluated as a set and identify gaps in the literature about the different theoretical techniques for tackling the problem.




Source: The Author

Figure 4.2. Review searching process showed in PRISMA diagram

A form of a detailed structured map (the Excel spreadsheet) was created for the purpose of this thesis research to code what kind of research has addressed what kind of issues and activities for each selected review study. These issues and activities can be coded as variables such as:

- The studies' geographical distribution where the country or the region subjected to the research was indicated to investigate the global distribution for the port congestion problem. Also, the publication year of the studies was recorded to see when the problem started widely existing and when it seemed to vanish, and whether the causes and the solutions evolved or remained the same.
- Methods used to collect and analyse the data and the type of research (case study, survey, experimental, or technical) to detect the epistemology patterns used to tackle the port congestion problem in the literature.
- Particular contexts, such as the port congestion problem definitions, terms, languages, and terminologies, are used to describe the causes and the solutions of the problem in the selected literature.
- Conceptual issues such as conceptual frameworks, theories, any proposed theoretical perspectives, and approaches that each study relied on to understand or solve the problem of port congestion. This might indicate whether solving the port congestion problem has any grounded theory or is based on practices and experiences.

**Mapping to inform a synthesis**. It is a way of mapping the structured form by focusing on coding only one or several parts of the literature that serve to answer the research questions rather than the whole in the synthesis to inform decisions about the final scope of the review (Gough et al. 2012). Mapping and coding the information gathered from extensive literature enable the researcher to synthesise the selected studies in a narrower, answerable research question and specific criteria that can prevent some series of issues affecting the systematic synthesis process. Gough et al. (2012) also argue that describing and coding the context and the collected data of each reviewed study in the systematic review can give the researcher a clear idea about the differences in these studies and whether this variety of contexts and the way of collecting data is providing a difference in the studies' results. This conclusion is essential for generalising the findings elsewhere.

To map and inform the synthesis in this thesis, the structured form (the Excel spreadsheet) included: the description and the coding of the main subject and the sub-subject for each selected study, the research type (analytical, Empirical or mixed), type of data collected (primary, secondary, or mixed), the methods used to collect this data (quantitative, qualitative or mixed), and the methods used to analyze the data. This mapping and coding allowed the researcher to identify the difference between selected studies and focus on studies that provided and justified a reasonable generalisation for their findings.

**Mapping to interpret the findings of the synthesis**. Like the two previous types of mapping, this type of synthesis helps the reviewer to narrower in-depth the information gathered from the selected studies. The reviewer then can compare the mapped and synthesised studies to uncover patterns, gaps or associations that cannot be appeared without comparison to the broader mapped studies (Gough et al. 2012). This technique gives the researcher a vital understanding and allows him to represent the broader literature on synthesised research and see whether a further primary study should be recommended (Ibid).

In this thesis, to describe and code the interventions (causes for the port congestion problem), these causes were divided into categories based on those identified by Eddrgash (2019). These codes were included in the structured form (the Excel spreadsheet), and all identified causes from each selected study were coded according to the structured form. The codes (the causes) were then compared to reveal patterns and identify the most common causes for the congestion problem in ports and their triggering classification (economic, technical, natural. Social, and political). Also, this coding allowed the research to identify gaps in the literature related to the problem (for example, the relationship between corruption in ports and the increase in port congestion problem). Also, the port congestion definition recruited from each selected study was coded, compared with others, and evaluated to establish a standardised definition for the phenomenon.

#### 4.3.5. Step Five: Quality and relevance assessment.

The main purpose of gathering information in systematic review studies is to examine the nature of their findings and assess how these studies are relevant and valuable to be used for answering the research review question (Gough et al., 2012). To ensure that the most relevant and appropriate trustworthy studies are used to conclude the research review, the researcher should appraise these selected studies' relevance and quality.

Studies differ in their qualities and relevancies, which might impact the review findings. Gough et al. (2012) argue that one of the essential parts of the systematic review process is to assess the quality and relevance of each selected study within the review as they impact the quality of the review itself and contribute to the credibility of the review findings.

There are different approaches for appraising the quality and relevance of the reviewed studies; however, the reviewer in his research should provide a guideline on how the quality and relevance of the reviewed studies will be assessed. There are two critical principles provided by (EPPI-centre 2010) to guide this process:

- Assessing and judging the quality and the relevance of the selected study should always relate to the review purpose and the research question.
- The approach and the criteria used to assess the quality and relevance of the reviewed studies should be made clear and transparent to allow the review readers to understand and judge how the quality and relevance have been assessed.

Two approaches were conducted to test the quality and relevance of the reviewed studies for this thesis. The first one is based on the journals' ranks, where only the quality of the reviewed studies was assessed based on their published journal rank. The second approach was used to appraise the quality and relevance of each reviewed study based on the Mixed Methods Appraisal Tool (MMAT) developed by Pace et al. (2012).

**Assessing reviewed studies based on the journal's rank**. A good quality systematic review is not only a function of proper study design or results from the correct methodology used, but also came as a result of good research management (Gough et al. 2012). Studies to be published in high journals may have been subjected to a peer-review process that helps them contribute to the potential quality of their specific study. This quality contribution came from Gough et al. (2012) when they stated that the traditional peer review provides an external quality assurance from highly experienced academic people who have the same interest in the research topic. In other words, an additional quality check can be provided by academics with a methodological interest as part of the peer-review process to publish research.

Thus, appendix (B) lists all the academic journals (excluding the grey literature) according to the Academic Journal Guide 2018, in one table set to provide the review readers with an overview of the quality of this research. This table shows that most of the selected articles came from reliable sources and are well-read in the Maritime and transportation management industry. In the meantime, the selected studies were divided based on their published journal's rank into five categories: grey literature, not ranked studies, nationally recognized studies, international leading studies and world-leading studies.

**Grey literature:** As can be seen from appendix (B), the academic journals were counted in 112 out of the total 150 selected studies in this systematic review, which pointed out that the 38 remaining studies are non-academic literature, and counts for about 25% of the total of review selected studies.

**Not ranked studies.** These studies have not been ranked according to the Academic Journal Guide 2018. Furthermore, they were counted for 49 articles with 33% out of a total of the150 review-selected studies.

**Nationally recognised studies.** These are the studies that have been ranked with the rank "*" and "**". They were 30 articles with 30% out of a total of the150 reviewed selected studies.

**International leading studies.** Those studies have been ranked as rank "***" according to the Academic Journal Guide 2018. These studies were counted for 24 articles with 16% out of a total of the150 review-selected studies.

**World-leading studies:** Those studies with the highest rank “4” and “****” according to the Academic Journal Guide 2018 were counted for nine articles with 6% out of a total of the150 review-selected studies.

**Assessing reviewed studies based on (MMAT).** The Mixed Methods Appraisal Tool (MMAT) is a tool to assess both the quality and the relevance of selected studies, and it was developed at McGill University by Pace et al. (2012). As most systematic review studies might have quantitative, qualitative, or both (mixed) methods, there is a need for a tool that can be used to appraise the quality of the methods regardless of the variety of studies’ methodologies. The (MMAT) is a checklist and a tutorial that can be used at the same time to assess the methodological quality of quantitative, qualitative, and mixed-methods research studies (Pace et al., 2012). They argued that this tool was developed to give a clear and concise strategy that explains how and why the selected studies were chosen to synthesise the relevant literature. They also discussed the value gained from using this tool. They stated that from the reviewer’s point of view, the efficiency of an appraisal tool is essential for a critical review assessment. They also stated that the (MMAT) tool provides a structure with an associated quality appraisal of used methods in studies by clarifying the criteria used to process and analyse the selected review studies. This structure also reviews the evidence to indicate the highest quality studies that can be analysed without a personal bias (Petticrew and Roberts 2006).

Another advantage Hannes (2011) mentioned for the (MMAT) tool is that it includes rigorous questions that help the researcher build a review addressing the truth, applicability, consistency, and neutrality. Table (4.6) shows the steps and the checklist for the (MMAT) tool.

In this thesis, the (MMAT) tool was used to evaluate the quality and relevance of each of the 150 studies included in this systematic review. The evaluation process for each study was based on the procedures for data collection, used methodology, support to the conclusion, and how relevant the study question was. This evaluation process was made in two steps. The first is the quality assessment of the evidence, and the second is the assessment of the evidence supporting value.

**The quality assessment of the evidence**. Each study of 150 articles included in this thesis was analyzed using ranking criteria employed from the (MMAT) tool. This ranking establishes a manageable screening review that gave traceability and reasoning for the retained150 studies for this research review. It also provides a ranking system foundation for the selected studies to base the evidence used in this systematic review research. Table (4.7) gives a brief explanation of the way of clarifying the quality appraisal for each ranking level designed for this thesis. The table also indicates the number of selected articles (out of 150 studies for this research review) against their specific ranking level. The rationale behind this ranking is two things: to be sure about the fitness of the selected study for the systematic review and its relevance for answering different empirical or conceptual questions (Gough et al., 2012).

If the selected article fits the study purpose but failed to present empirical data with apparent justification, it was given a rank level of low. The rank level of medium indicated the articles which may have addressed one or more of the research objectives (the definition of the port congestion problem, causes of port congestion problem, and solutions for the problem). However, there was unclear support for their claims. Also ranked the article high, which means the article provides a high-quality level of appraisal. It directly addressed one or more of these port congestion problem objectives (definition, causes, and solutions), clearly explaining its findings. An article is ranked high-strong when it presents evidence of the three objectives of the research review.

**Evidence supporting value**. In addition to the quality appraisal provided by the (MMAT), some articles have been ranked as high-strong due to their supporting evidence for all thesis objectives (port congestion definition, causes, and solutions). The rationale behind this ranking goes back to their capability for providing multiple analytical themes from the terms derived from the research, yielding a more substantial research validity. So, as it was previously explained, the critical function of a rigorous systematic review is to use the highest quality of Literature (Rousseau et al. 2008). This thesis has built its conclusions based on this ranking.

Table 4.6. Mixed-Methods Appraisal Tool (MMAT) checklist.

Adopted from Pace et al. (2012).

| Types of methods study components or primary studies | Methodological quality criteria | Responses | | | |
|---|---|---|---|---|---|
| | | **Yes** | **No** | **Can't tell** | **Comments** |
| **Screening questions (for all types)** | Are there clear qualitative and quantitative research questions (or objectives*), or a clear mixed methods question (or objective*) | | | | |
| | Do the collected data address the research question (objective)? E.g., consider whether the follow-up period is long enough for the outcome to occur (for longitudinal studies or study components). | | | | |
| | *Further appraisal may be not feasible or appropriate when the answer is "No" or "Can't tell" to one or both screening questions.* | | | | |
| | *These two items are not considered as double-barrelled items because in mixed methods research (1) there may be research questions (quantitative research) or research objectives (qualitative research), and (2) data may be integrated, and/or qualitative findings and quantitative results can be integrated. | | | | |
| **1- Qualitative** | 1.1. Are the sources of qualitative data (archives, documents, informants, observations) relevant to address the research question (objective)? | | | | |
| | 1.2. Is the process for analysing qualitative data relevant to address the research question (objective)? | | | | |
| | 1.3. Is appropriate consideration given to how findings relate to the context, e.g., the setting, in which the data were collected? | | | | |
| | 1.4. Is appropriate consideration given to how findings relate to research' influence, e.g., through their interactions with participants? | | | | |
| **2- Quantitative descriptive** | 2.1. Is the sampling strategy relevant to address the quantitative research question (quantitative aspect of the mixed methods question)? | | | | |
| | 2.2. Is the sample representative of the population understudy? | | | | |
| | 2.3. Are measurements appropriate (clear origin, or validity known, or standard instrument)? | | | | |
| | 2.4. Is there an acceptable response rate (60% or above) | | | | |
| **3- Mixed methods** | 3.1. Is the mixed methods research design relevant to address the qualitative and quantitative research questions (or objectives), or the qualitative and the quantitative aspects of the mixed methods question (or objective)? | | | | |
| | 3.2. Is the integration of qualitative and quantitative data (or results*) relevant to address the research question (or objective)? | | | | |
| | 3.3. Is appropriate consideration given to the limitations associated with this integration, e.g., the divergence of qualitative and quantitative data (or results*) in a triangulation design? | | | | |

| Ranking | Assessment | No. of articles |
|---|---|---|
| **High-strong** | The study adheres to the qualities of a high assessment but also provides multiple analytical themes from the terms derived in the study, yield a strong validity of the study. | 29 |
| **High** | The study addresses the research question (RQ) and provides clear evidence to support the claim. | 102 |
| **Medium** | The study may offer evidence regarding the (RQ) but it is unclear whether it unmistakable support the context interpreted. | 11 |
| **Low** | The study addresses the (RQ) (fit for purpose) but has other concerns regarding the quality assessment or data source (questioning the relevance of the research). | 6 |
| **Excluded** | Does not fit the (RQ). | 2 |
| | **Total number of articles** | 150 |

Table 4.7. Ranking criteria for quality assessment of selected articles.

To correlate the (MMAT) assessment to the evidence supporting the assigned ranking for each article, the researcher commenced a further analysis demonstrated in table (4.8), where each article was ranked with comments for this rank.

As can be seen from both tables (4.7) and (4.8), two articles were excluded as they did not fit with the research questions (RQ). Twenty-nine articles were found to be high-strong as they fit with the MMAT appraisal criteria and gave evidence to support the three objectives of this review (port congestion definition, causes for the problem, and the solutions). Also, 102 were ranked high as they fit with the MMAT appraisal criteria and gave evidence to support at least two out of the three objectives of this review. On the other hand, only 11 articles were ranked medium, and six articles ranked low as those 11 articles have given support to the (RQ), but it was unclear or mistakable. Also, the six articles ranked low because they addressed the (RQ), but there was no supporting evidence for their conclusions. Therefore, 131 articles out of 150 have a high and high-strong ranking, which indicates the relevance, high quality, and rigour of this thesis review study.

#### 4.3.6. Step Six: Synthesis.

As defined in the Oxford English Dictionary (2004), synthesis is "the process or result of building up separate elements, especially ideas, into a connected whole, especially a theory or system". Also, Strike and Posner (1983, p. 346) simply defined the process as: "The product of activity where some set of parts is combined or integrated into a whole". They explain that "synthesis involves some degree of conceptual innovation or employment of concepts not found in the characterization of the parts and a means of creating the whole".

So, according to these definitions, synthesis is a process that more than just lists the results from selected studies; it is an activity that involves the data interpretation of the selected studies to establish new knowledge.

Several techniques combine the findings from research studies in synthesis, and each technique is suitable for each situation. Gough et al. (2012) stated that grouping and combining the study's results could be done in synthesis in many different ways. They argued that grouping and combining depend on distinguishing the outset of the review, whether it is deductively determined (conceptual framework) or inductively derived from the research studies or a combination of both. They introduced some of these ways in (p. 183) such as meta-ethnography and thematic synthesis as an (inductive) approach, framework synthesis and thematic summarise as (a deductive) approach and mixed methods synthesis as (both an inductive and deductive) approach. In the following the thesis will give a brief introduction to the three most common approaches for synthesis:

| Brief Reference | Rank Level | Comments |
|---|---|---|
| Abe and Wilson 2009 | High | There is a focus on defining port congestion problem at container terminals and establishing congestion index. Identifying causes triggered by technical and economic reasons based on empirical data, and suggested some solutions |
| Abouarghoub et al. 2017 | High | There is a focus on defining port congestion problem at ports based on the literature. Identifying causes triggered by only technical reasons based on empirical data, and suggested some solutions. |
| AbuAlhaol et al. 2018 | Medium | concern based on Q. no. 2.3 .Are measurements appropriate (clear origin, or validity known, or standard instrument)? The measures are not really connected to what they try to measure. However they identify some causes based on technical, economical, natural, and social reasons. |
| Agostini and Saavedra 2014 | High | Identifying the technical causes for the problem and suggested solutions based on theory perspective. |
| Alvarez et al. 2010 | Medium | concern based on Q. no. 2.3 .Are measurements appropriate (clear origin, or validity known, or standard instrument)? The measures are assumed for the simulation (not based on real data) . However they identify some causes based on technical reasons and suggested solutions. |
| Alattar et al. 2006 | High | Identifying technical and natural causes for the problem and suggested solutions. |
| Aldcroft 1961 | Low | Although he identified some technical, economical, political and social causes for the problem and suggested solutions, there was no details on how the data were collected or analysed. |
| Alhameedi et al. 2018 | High-strong | The qualitative and quantitative analysis are put together to form a meaningful interpretation for identifying port congestion definitions and also to indicated some technical, economic, political,. And social causes and their solutions |

Table 4.8. Ranking criteria for (MMAT) quality assessment of selected articles (a sample table out of 18 tables).

**Thematic summaries**. It is the most common way of synthesizing systematic review studies. The reviewer is usually concerned with 'What works?' and 'How it works?'. And it is often used in a situation where a meta-analysis cannot be employed due to immoderate heterogeneity, or no calculation can be done to measure the effect (Gough et al. 2012). In this line, Deeks et al. (2011) explain that the reviewers, who were using thematic summarise, summarize the findings that have been arranged into themes from selected studies based on their conceptual framework to establish an organized structure. In this organized structure, the reviewers need to count how many studies were reported as significant positive statistics, or negative and indefinite findings and make the balance between the positive and the negative to find the answer to the research question (Gough et al. 2012).

**Framework synthesis**. It is a process where the reviewer adopts the original framework (the initial conceptual framework), which was developed to analyse the data of the primary research to be evolved during the synthesis. This came as a result of the reviewer becoming more familiar with the reviewed literature (Ritchie and Speneer 2002). In this context, Gough et al. (2012) elaborate that the framework synthesis begins, in the same way as framework analysis for the primary study, by deeply exploring each study to identify any key issues, repeated patterns, and recurrent themes. They also argue that the reviewer, in this early stage, might need to consult the stakeholders to acquire new knowledge to help him with structuring these themes. Then the reviewer, they said, can evolve the initial conceptual framework as the significance of various concepts becomes clear to code the data. Furthermore, as they argued, this process might evolve a series of frameworks until the conceptual framework crystallizes and is satisfactorily coherent to be used for summarising and tabulating the data (the studies' findings) under key themes. Once this process is completed, the reviewer can start to describe the acquired patterns and draw his conclusion.

**Thematic synthesis**: As the same as the previous two types of synthesis, the thematic synthesis technique can be used to gather the findings from different types of studies and bring them together to answer the review question (Thomas and Harden 2008). It is, therefore, "a way of systematizing and analysis regardless of whether the analysis itself takes an overtly interpretative or realist perspective"

(Gough et al. 2012, p. 193). Therefore, it is a suitable way of synthesizing multidisciplinary data sets and enabling researchers with different philosophical stands to share their knowledge and a shared understanding of their endeavour (Barnett-Page and Thomas 2009).

As the review process of this thesis will analyse different types of data (qualitative, quantitative, and mixed) gathered by researchers from different disciplines and different philosophical stands, thus the thematic synthesis technique is the best choice for synthesizing the findings from the selected studies.

The thematic synthesis process for reviewing selected studies for this thesis will be carried out through three stages:

**Stage 1:** identifying the themes across the selected studies by transforming the findings from selected studies into standard variables to be possible to compare and contrast them. This can be done in two steps. First, identifying what can be constituted as findings for each primary study, and this can be done either by taking what the author reports as results for the selected study or by taking the broad author perspective drawn from the study's conclusion or by reading the whole text (Gough et al. 2012). Second, coding these findings by highlighting the text and associating it with a specific code and then grouping the same codes under one theme after reviewing all selected studies. In this way, more different themes will start to emerge (Ibid). Here, it should be noted that a 'code' is revealing a short phrase or sentence that sums up the text where the finding is expressed as data. In comparison, the theme reveals a 'concept' that has emerged from grouping the same codes identified in more than one study.

**Sage 2:** the codes and themes generated by step one have to be organized into descriptive themes. Then the relationships between these descriptive themes need to be developed and articulated by associating conceptually similar themes. This process is like building a theory that explains how a specific phenomenon can be understood or experienced by the population in question (Gough et al., 2012). Also, the reviewer's interpretation and judgment are critical; nevertheless, this stage only aims to describe the themes (Ibid).

For example, in this thesis review, the reviewer tries to identify the causes of the port congestion problem. These codes (causes) are: ‘insufficient number of port berths’, ‘shortage in storage area capacity, and “weakness in intermodal transportation, communication, and networks in the whole country”. All these codes (causes) can be organized under an overarching theme (superordinate reasons) of “weakness in infrastructure for ports and the whole country”, with subordinate reasons covering the range of reasons (themes) that cause the port congestion problem.

**Stage 3:** The reviewer starts generating analytical themes as a final step in the thematic synthesis process. This step usually offers and generates new conceptualizations and explanations and takes the synthesis process beyond the substance of the selected primary studies (Gough et al., 2012). Gough et al. also argued that stage 2, the generated descriptive themes, sometimes moves spontaneously into a more analytical way. In other cases, considering how the descriptive themes will answer the research questions might push them into further analysis. In the latter case, each theme of these descriptive themes needs to be furtherly thematically analysed to address and answer the research questions.

For example, in this thesis to synthesise the port congestion problem, the researcher synthesized many articles that make him conclude that the articles’ authors considered: the shortage of qualified managers, insufficient port plans and lack of control on lower management to be one of the main causes for port congestion. The researcher called this theme in his synthesis “weakness and mismanagement in ports” as that condensed and summarised what the researcher understood from the texts of many articles. The words “weakness and mismanagement” might not exist within the text of any of the selected articles that were used to establish the theme. However, they were the researcher's interpretation based on his reading and understanding of the selected primary studies. Also, this theme itself was systematized within a group of themes under “the technical causes for port congestion”. As figure (4.3) and appendix (C) illustrate, most of these themes are analytical themes generated by the synthesis process.

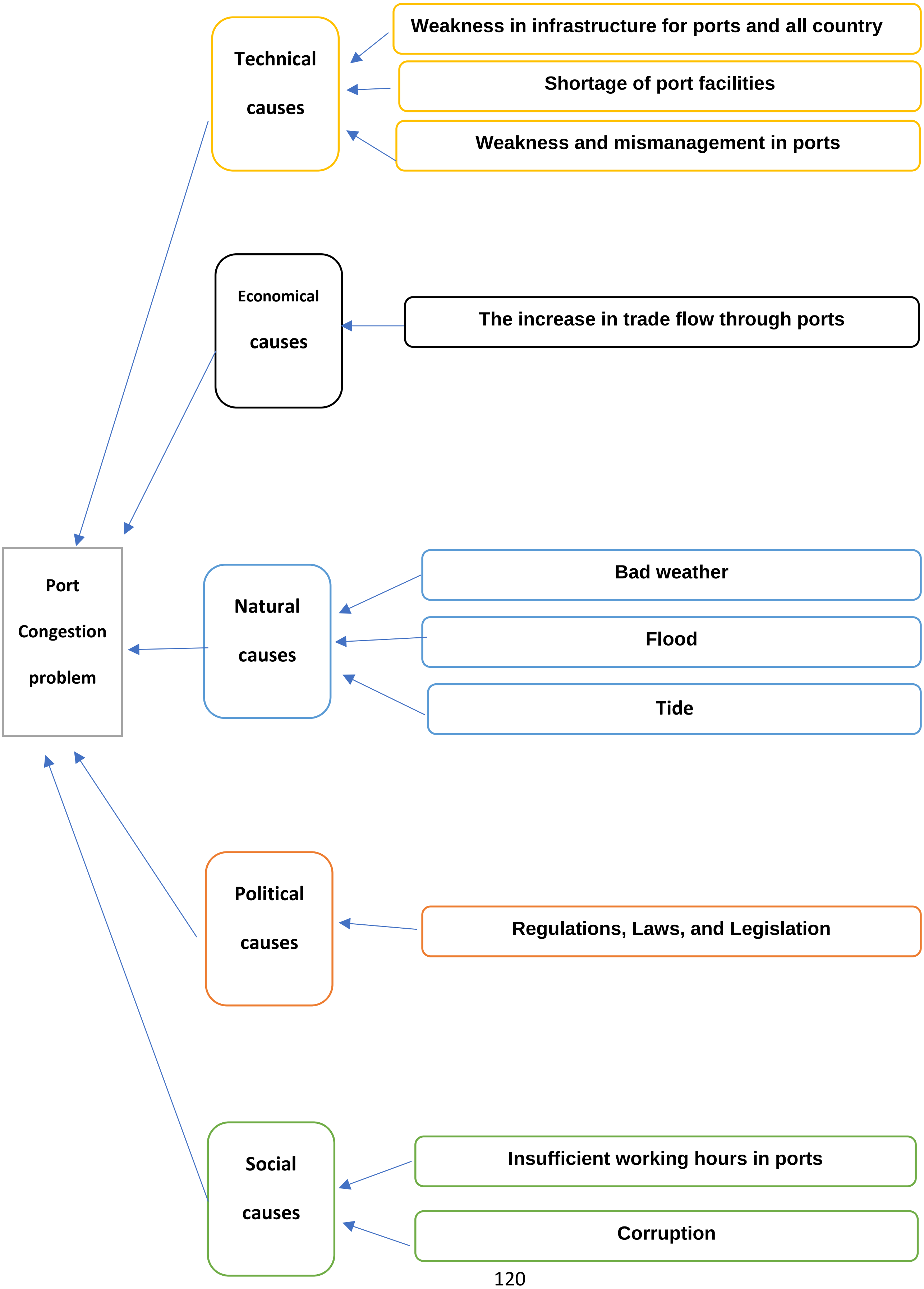
For example, the interpretative concept of “weakness and mismanagement in ports” is the descriptive concept for “shortness in qualified managers”, “insufficient port plans”, and “lack of control on lower management”. Also, the “technical causes for port congestion” describe the analytical concept for these interpretative concepts “weakness in the infrastructure for ports and the whole country”, ‘shortage in port facilities”, and “weakness and mismanagement in ports” the articles’ authors themselves have not expressed explicitly. However, it has emerged from the analytical synthesis process of the selected primary studies.

**Checking the synthesis robustness:** This can be assessed by composing a grid table to show each selected study's contribution to the review synthesis (see appendix C). This kind of grid table can help the researcher to see the following issues (Gough et al. 2012):

- Whether significant findings are only generated from relatively few numbers of selected studies.
- Whether or not the previous issue matters and whether is there any kind of association between specific data or populations and the quality appraisal for the studies and generated themes.

In this context, it should note that some parts of synthesizing may be based on more research studies than others; however, it does not necessarily mean that those parts have higher weight or are more trustworthy (Gough et al., 2012).

Figure 4.3. Interpretative themes and systematic analytical themes for the port congestion problem.



### 4.3.7. Step Seven: Interpret findings and communicate with stakeholders.

**Interpreting the findings:** this step starts with interpreting the findings by analysing the data collected from selected studies. Discussing the findings usually contains a summary of all selected studies and what has been found and not found about the questions addressed in the systematic review research (Denyer and Tranfield 2009). Also, the reviewers have to report their final results from the thematic synthesis. Moreover, they have to indicate whether or not these findings were gained in an aggregative or interpretative way. Furthermore, they should provide a detailed audit that can be traced back to the core contributions to make better ground and justify their conclusion (Ibid). Finally, the conclusion should summarise the review, indicate any limitations to the research, and provide recommendations for both practices and academic fields (Gough et al., 2012).

**Communicating the findings with stakeholders:** One of the most important purposes for using the systematic review technique in research studies is to help practitioners base their decisions on evidence-based knowledge. However, transforming the systematic review conclusion into a guideline for practitioners remains a challenge in the management field (Davies et al. 2002; Nutley et al. 2003).

Also, Gough et al. (2012) argue that systematic reviewers might have achieved an exceptional level in synthesizing and analyzing the studies. However, their review reports might still be limited only to academia unless they try harder to disseminate their results to the outside world. They suggested two models for simply linking academic research and practitioner decision-making where supporting evidence is either provided by reviewers or demanded by decision-making practitioners. They claimed that the first one represented a linear view and called it a classic knowledge-driven (push) model, where the research findings may be revealed to prompt action. The second one they claimed is called a problem-solving/practice-driven (pull) model, which is a reverse of the liner view, where the starting point is with the study end-users and the problem they have, before tracing back the problem in search of useful results.

So, on the one hand, it is often that the researchers try their best to inform the practitioners and decision-makers, pushing their findings to impel actions and bridging the gaps (Gough et al., 2012). This might be done by publishing their studies in academic journals and in practice ways, such as conferences, workshops, and focus groups, to bridge the gaps in the practices' knowledge. On the other hand, it is also common that some practitioners and decision-makers to make efforts to seek studies' products, pulling their findings into their own domain (Gough et al., 2012).

Based on the above discussion, this thesis has used both models for linking its research findings to the practitioners to ensure the best dissemination of the study results. First, it used the interviews of the port stakeholders as a starting point with the end-users for port congestion problems pulling their knowledge and experiences about the problem they face before tracking back in search of useful findings. Secondly, and depending on the Covid-19 circumstances*****, the researcher will try to carry out focus groups or workshops where a number of Libyan port stakeholders (including the 31 interviewees for the previous research), ports' operators and government decision-makers were invited for those workshops. In these workshops, the researcher will present the research findings to inform the policymakers and decision-makers about the causes and the solutions for the port congestion problem based on evidence knowledge. Also, the researcher will discuss these findings with the participants' seeking their reflecting points, comments, and suggestions to bridge the gaps and increase the reliability and the validity of future research studies on port congestion.

*The Covid-19 pandemic circumstances remain active till the end of this thesis which does not allow the researcher to carry out them (see section 6.5, the research limitation and recommendation for future research).

## 4.4. Results analysis.

In this section, a descriptive overview of the results obtained from the selected articles that answer the research questions established early in this research review process is given.

### 4.4.1. The geographical distribution of the academic interest in the port congestion problem

The geographical location of ports that were subjected to research in selected articles was indicated and analysed to investigate the academic interest distribution.

Table 4.9 shows the geographical distribution of research studies worldwide by continent. Ports in Asia have received the most focus from research studies, with (38%) 0f the selected studies investigating the port congestion problem. North America follows this percentage with 13.3% and Africa with 9.3%.

In more detail and looking at the geographical distribution for academic interest by countries, ports in the USA and China have been the focus of most studies, whether they are subjected alone or with other regional ports (figure 4.4a and 4.4b). Investigating congestion in Asian ports, especially countries in East Asia (such as China, Malaysia, Singapore, Thailand, India and Hong Kong), has increased since the region has the biggest and busiest ports in the world (Abe and Wilson 2009). Also, these countries need to rely heavily on seaborne transportation for their international trade, which made their ports more subjected to congestion problems. Also, the dramatic growth of the USA's international trading, which translated to a massive number of moving containers through its ports in the past 15 years, especially on the West and East coast, has caused severe port congestion problems in the supply chain (Herrav-Peralta et al. 2019). Bloomberg (2011) cited in Fan et al. (2012) said that congestion has grown everywhere in the USA transportation nodes, especially in ports which made more than half of vessels need to queue before berthing at ports. This situation has triggered more academic interest and motivated more researchers to investigate the port congestion problems and propose solutions.

Also, as trade and investment liberalization stimulated and increased international trading for developing countries, various congestion problems in their ports and hinterlands have hindered this trade expansion (Gidado 2015). This situation has raised some academic interest to investigate the port congestion problem in some developing countries such as Nigeria, Chile, Iran, Ghana, and Brazil.

However, about 33 articles from reviewed papers have not focused their research studies on a particular port or indicated any geographical location for their study.

| Continents | Number of research studies | Percentage |
|---|---|---|
| Europe | 18 | 12% |
| Asia | 57 | 38% |
| Africa | 14 | 9.3% |
| North America | 20 | 13.3% |
| South America | 5 | 3% |
| Australia | 5 | 3% |
| N/A* | 33 | 22% |

*(NA) means not applicable.

Table 4.9. The distribution of academic interest in port congestion problems by continent geographical locations

### 4.4.2. Time distribution for academic interest in the port congestion problem

As shown in both figure 4.5 and appendix D, while the academic interest in the port congestion problem was established quite early (since 1961), the focus on the problem remained scarce till the year 2000. The last two decades have witnessed an increase in academic interest in the port congestion problem, translating to more paper publications. Moreover, there was significant growth in published papers from 2011 to 2020 (with a peak in 2016 and 2017). About 100 papers were published, which accounted for more than 66% of the total publication selected papers.

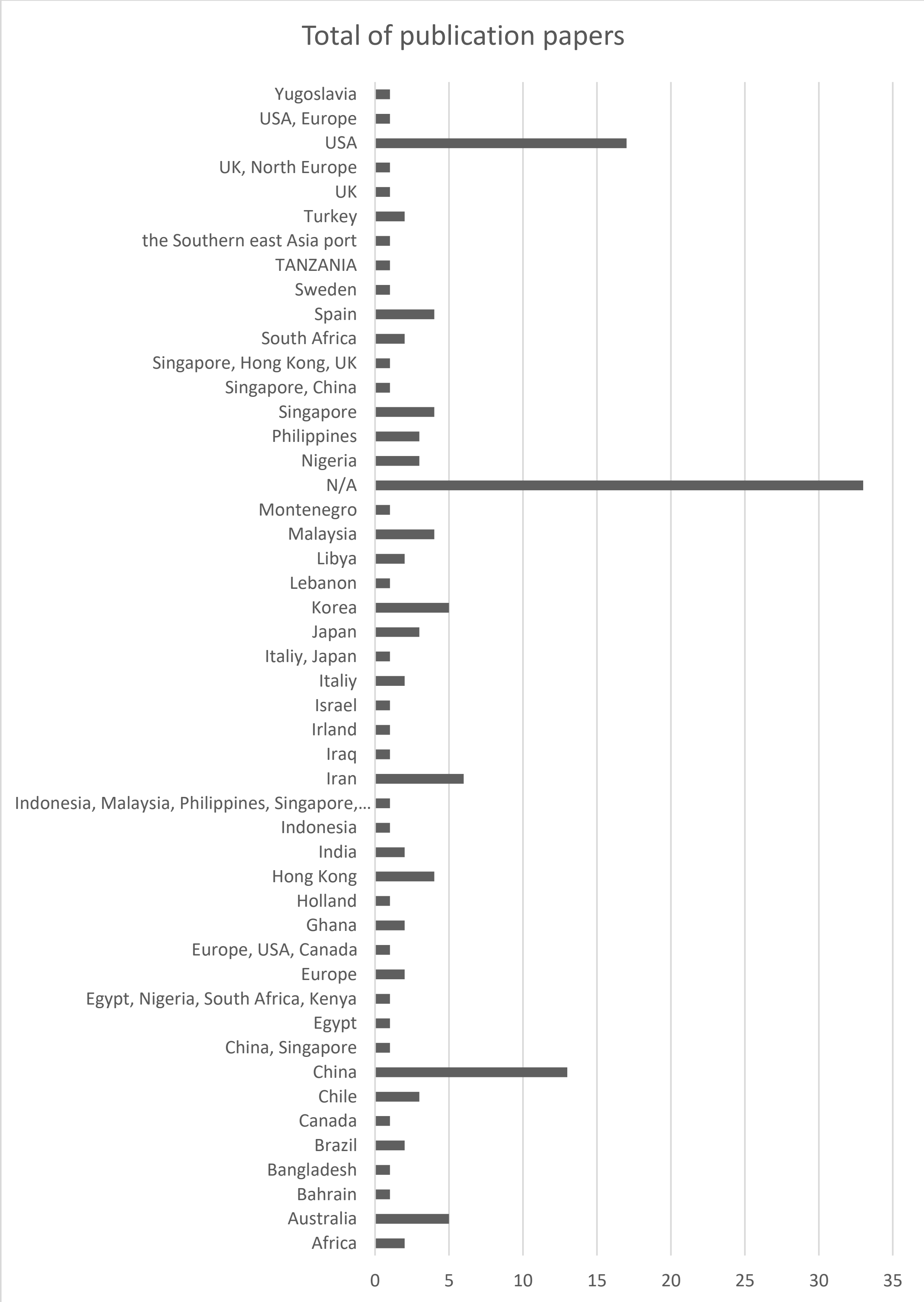



Figure 4.4. Distribution of academic interest in port congestion problems by countries' geographical locations


Modified and developed from the source: safety4sea.com.

Figure 4.4b. Distribution of academic interest in port congestion problem by countries' geographical locations.

In fact, the increase in academic interest in port congestion problems during the last decade is stimulated by the need to solve port operation problems and traffic bottlenecks in ports and their hinterland, which occurred due to the increase in maritime transportation coupled with the increase in vessel size.  This increase in the demand for ports' capacities has caused to congest most of the world's ports. From a previous analysis of the geographical distribution of academic interest in port congestion problems, it can be noted that the academic focus, during the last decade, was concentrated on ports that are highly suffering from congestion problems due to the increase in the demand for their services. Herrav-Peralta et al. (2019) stated that the increase in European Union trade through seaborne transportation from 898 million tonnes in 2013 to 985 million tonnes in 2017 had put too many strengths on European ports. Also, the USA's annual rate growth of international trade using marine transportation has increased by 10% for imports and 4.6% for export in 2015 compared with the year before, causing congestion all over the country's East and West coast ports (Alvarez et al. 2010). Also, the remarkable expansion in China's economy and the rapid increase in mass traffic for imports and exports through its ports to other countries has impacted most of its ports' capacities and caused delayed ships' schedules (Fan et al., 2012). The uncertainty and unpredictability of marine traffic make it hard for most world ports to cope with this fast growth in shipping traffic and has put high constraints on their capacities and caused them to be congested. From this point, academia was alerted and put more attention during the last decade to conduct more research studies trying to investigate the phenomena and provide solutions for the issues caused by the port congestion problem.

In another way, although ports in developing countries have been subjected to port congestion problems since the 1970s (Oyatoya et al. 2011), they have recently received attention from academic researchers such as (Abe and Wilson 2009, Oyatoya et al. 2011, and Gidado 2015). This might be to the recent establishment of globalisation and the increasing participation of these ports in international maritime transportation and networks

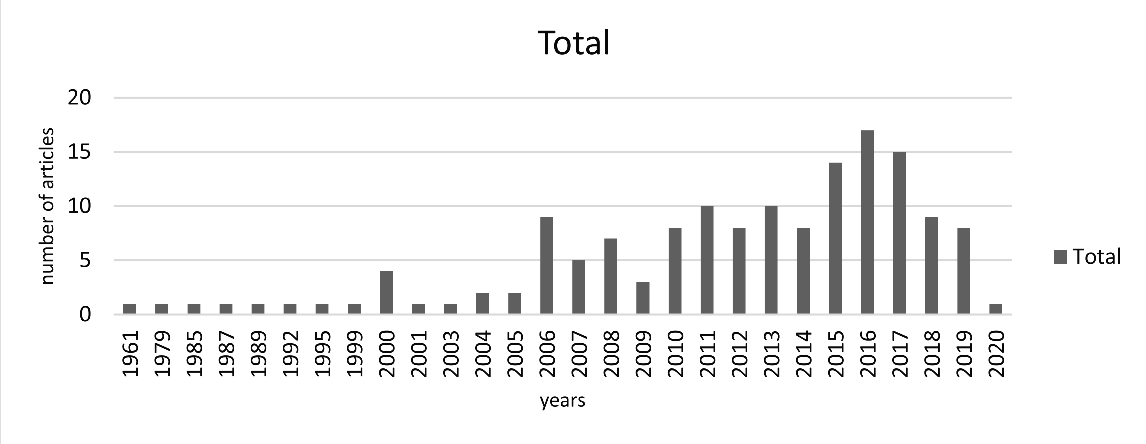



Figure 4.5. Time distribution for the academic interest in the port congestion problem

### 4.4.3. Research Methodologies, methods for collecting data, and data analysis

**Techniques used to investigate the port congestion problem:**

Among these 150 selected papers, the scholars adopted various methodologies and methods for gathering and analysing the collecting data. Before analysing the selected papers' methodologies and their data collecting and analysing methods, there is a need to identify between methodologies and methods. In this context, and according to Baily (1994), methodologies refer to the research process philosophy where they concluded the researcher's assumption and values that serve as a rationale for his research. They also represent the standards and criteria used to interpret the research data and produce conclusions. In the same context, methods represent the approaches, or the tools used by the researcher to gather and analyse the research data (Ibid).

Also, to make the job easy for classifying those selected papers according to their methodologies, the methods for collecting data and data analysis techniques, this research used (Wacker 1998) approach for categorising the characteristics of methodologies and methods adopted by selected reviewed papers. Most operations management scholars have adopted this categorising technique to identify patterns in the literature (Burgess et al. 2006 & Woo et al., 2011). Wacker (1998) grouped the type of research studies into two main classifications, empirical and analytical. While the first one is conducted using an inductive methodology and the theory will be the outcome of the research, the latter uses deductive methodologies where the researcher collects the data to test an existing theory. Moreover, he divided each main classification into three sub-classifications: statistical, case studies, and experimental for empirical techniques; and statistical, conceptual, and mathematical for analytical techniques (see figure 4.6).

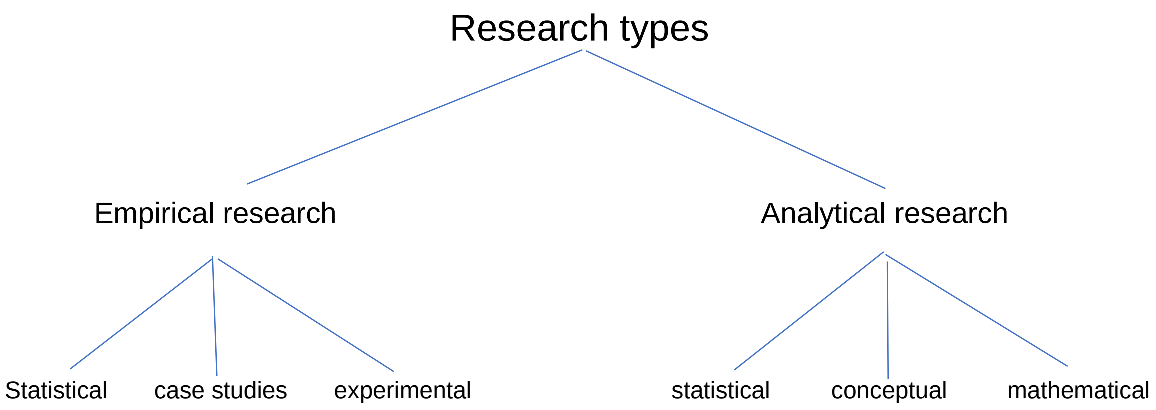



Figure 4.6. Wacker's (1998) classification for research methods in operations management studies

#### 4.4.3.1 Analytical research

Analytical research conducts deductive methodologies to provide conclusions (Swamidass 1986). These deductive methodologies usually use mathematical, logical, and/or mathematical-statistical methods for collecting and analysing data. Moreover, analytical research studies have three subcategories which usually use different theory-developing processes (Wacker 1989):

- **Analytical, conceptual research:** In this type of research, the researcher added new concepts or understandings through logical relationship-building to a traditional phenomenon or problem. Wacker (1989) claimed that this type of research methodology involves new concepts or understandings that were logically developed by relationships between carefully defined notions into an inwardly coherent theory. He gave three examples of this type of research. The first example is when the researcher used his/her past experience to describe and explain relationships for formulating concepts or developing theory. The second one is conceptual modelling, where deduced relationships are posited in the mental model and then evaluated by applying a framework that holds the essence of the investigated problem. The third example of this type of research is a study that deduces facts from the phenomena under observation (Meredith et al. 1989).

- **Analytical mathematical research:** In this type of research, Wacker (1989) argued that sophisticated relationships between carefully defined notions are developed through evolving new mathematical relationships to investigate how the models act under various conditions. These research types develop the relationships mathematically and produce numerical examples based on their derivations or computations. Also, he claimed that these types of research usually do not use any external data for testing the theory. However, they simulated or determined the data to give conclusions. Experimentation, analytical models, and mathematical simulations are examples of this type of research. These methods and models are carried out by employing formal logic and tested using artificial data (Meredith et al. 1989).
- **Analytical, statistical research:** This research type integrates both analytical and empirical research. It integrates logical/mathematical models from the first and statistical models from the second type into a single integrated theory (Moorthy 1993). Also, he claimed a difference between the analytical, statistical type of research and the analytical mathematical type of research since the first one explicitly develops its models for future empirical statistical tests. In fact, this kind of research methodology usually aims to integrate a large body of knowledge into a single model for empirical tests (Wacker 1989).

#### 4.4.3.2 Empirical research

One of the main features of this research study is that external data from organizations or businesses must be used to test the existence and the holding of relationships in the external world (Wacker 1989). In fact, the empirical research studies type might be classified more specifically as real-world empirical methodologies, which have three types of subcategories:

- **Empirical, experimental research:** In this subcategory of research type, the researcher investigates the relationship between variables where he/she manipulates controlled processes to find the exact effect of independent variables on the dependent variable (Wacker 1989). This type of empirical research employs a manipulation-controlled process to demonstrate the causality between variables. It also is known as field experiments research (Meredith et al. 1989). However, there is a difference in collecting data methods between the experimentation under empirical research and the experimentation under analytical mathematical research types. In the latter, the researcher artificially developed the data used to manipulate variables, while the first type uses data usually collected from the real world.
- **Empirical statistical research:** This subcategory of the empirical research type is used when large samples from actual businesses are employed to verify theoretical relations between variables (Wacker 1989). In fact, Wacker claimed that this type of methodology is more likely to be used when the research has more complex issues such as business strategy's effect on organisation performance. There are many methods for collecting data for statistical analyses under this subcategory, such as interviewing processes, focus groups, questionnaires, organisation archival data and Delphi techniques. As the target of each of these methods is to collect and analyse large external data samples statistically, thus from a theory-building point of view, this subcategory of empirical research empirically supports the theoretical relationships in large real-world data samples (Meredith et al. 1989).
- **Empirical case study research:** In this subcategory of empirical research type, the researcher's goal is to develop or build insightful relationships

within a limited set of businesses or organisations (Wacker 1989). This can be done by employing a method that investigates small samples, one company or a limited number of companies, for example, but using many variables to indicate or establish new empirical relationships. Also, the analysing method for this subcategory of empirical research type can elevate the level of the theory's abstraction by analysing the data across time and giving a dynamic dimension to the theory (Meredith et al. 1989).

**Classifying the selected articles according to their research type.** The selected papers were divided into two main classifications based on Wacker's (1989) classification for research types: empirical and analytical. Table (4.10) shows that both types of research have been used to investigate the port congestion problem alone or as a mixed type of research. The empirical type has been used more often with 45% (68 papers). In these studies, the data was collected from ports or container terminals organisation to test the relationships between the variables of the port congestion problem. The analytical type of research came next and in very close percentage to the first one with 35.3% (53 papers), where logical-mathematical and/or mathematical-statistical methods were used deductively to conclude the causes and solutions for the port congestion problem. However, mixing both of them in the same study has been used less with 14.6% (25 papers). In contrast, only four papers out of 150 were not conducted under this classification (the researcher put them under the "other" type of research) as they belong to grey literature (trade journals).

Table (4.10) also shows that case study was used more extensively in both types of research (79 papers, 53%) to investigate the causes of port congestion at one Seaport or container terminal and sometimes at a set of seaports or container terminals in a country or region. It has been used analytically to test the queuing theory for solving the problem of the shortage in port berths capacities and the ship-berth port plans within 36 papers (with a percentage of 24%). In these papers, simulations and modelling techniques based on statistical data from ports or container terminals and ships arriving and services' times were employed to solve the port congestion problem to minimise the ship turned around time. It has also been used Empirically to investigate the port congestion problem to identify the new relationship between the variables that cause the problem across time to elevate the theory's abstraction level within 20 papers (about 13.3% of the total papers). Also, in the mixed type of research, the case study methods were used within 22 papers (around 14.6% of the total selected papers) where both research-type methodologies have been used to draw the papers' conclusions.

Experimental studies were used only under the empirical and mixed type of research and performed in around 32.6% (49 papers) of the selected papers. Consequently, 47 papers were used in empirical studies, accounting for 31.3% of the total. And two papers used within the mixed type of research represent approximately 1.3% of the total. In these Experimental studies, the researchers manipulated controlled independent variables (congestion causes such as the number of quayside cranes, working hours, etc.). They use actual data from ships arriving and statistical data from ports to determine the exact effect on the dependent variable (ship turned around time) and demonstrate the causality between port congestion variables.

The conceptual framework was only used in two analytical research studies (1.3% of the selected papers). The researchers comprised new insights about the port congestion problem through logically developing relationships between the type of port congestion problem and the factors behind its inwardly coherent theory.

Nine papers used the mathematical subcategory only as an analytical research type, accounting for about 6% of the total). In these papers, simulations and modelling techniques based on artificial data were employed to develop new mathematical relationships to investigate how port congestion models behave under different port surrounding conditions.

The statistical subcategory was barely used under both research types, the empirical and mixed type of research. In comparison, no analytical research type used this subcategory. The two statistical studies (one empirical and one mixed) have gathered primary data such as interviews and questionnaires or used secondary data such as organisation data to statistically analyse the relationships between the factors that affect the port congestion problem from a theoretical perspective.

Finally, there were nine papers classed under the “other” subcategory. Six of them used an analytical type of research, and the other Three were neither analytical nor empirical, and the researcher classified them under the “other” type of research (Gray literature).

| | Research type | | | | |
|---|---|---|---|---|---|
| **Sub. classification** | **Analytical** | **Empirical** | **Mixed** | **Other** | **Grand Total** |
| Case Study | 36 | 20 | 22 | 1 | 79 |
| conceptual framework | 2 | | | | 2 |
| Experimental | | 47 | 2 | | 49 |
| Mathematical | 9 | | | | 9 |
| Other | 6 | | | 3 | 9 |
| statistical | | 1 | 1 | | 2 |
| **Grand Total** | **53** | **68** | **25** | **4** | **150** |

Source: The Author

Table 4.10. Research method types for investigating port congestion problems in the selected papers.

#### 4.4.3.3 Methods for collecting data to investigate the port congestion problem in the selected studies

All the 150 selected papers have used these methods: Organisation statistics data, in-depth interviews, literature focus, workshops, and questionnaires alone or combined to collect the research data and investigate the port congestion problem (see table 4.12). They used them with a quantitative or qualitative methodology, and sometimes mixed methods were employed (see table 4.11). A significant share was belonging to the quantitative methodology where 126 papers used this methodology with a percentage of (84%) of the total selected papers (49 papers (32.7%) under analytical type, 66 papers (44%) under empirical and ten papers (6.6%) under the mixed type of research). Qualitative methodology alone has been scarcely applied (only two papers) under the analytical type of research. However, mixed methodologies were used in 19 papers (12.6%), two as analytical research papers, two as empirical research papers, and 15 as empirical, analytical research types.

It is also worth noting that organisation statistics data has been used to gather data in 134 papers with a percentage of (89.3%) of the total selected papers (see table 4.12). Where it was used (alone) for 93 papers (62%), (under analytical research in 32 papers, under empirical research in 55 papers, and mixed research in 6 papers), and combined with other methods in 41 papers (27.3%), (under analytical research in 14 papers, under empirical research in 9 papers, and under mixed research in 23 papers).

Other methods for gathering data such as in-depth interviews, literature focus, questionnaires, focus groups and workshops were less used as the quantitative methodology was a dominating approach in the selected papers.

| **Type of methodology** | **Research type** | | | | |
|---|---|---|---|---|---|
| | **Analytical** | **Empirical** | **Mixed** | **Other** | **Grand Total** |
| Mixed | 2 | 2 | 15 | | 19 |
| N/A | | | | 3 | 3 |
| Quantitative | 49 | 66 | 10 | 1 | 126 |
| Qualitative | 2 | | | | 2 |
| **Grand Total** | **53** | **68** | **25** | **4** | **150** |

Source: The Author

Table 4.11. Research methodology types for investigating port congestion problems in the selected papers.

| Method for collecting data | Research Type | | | | | |
|---|---|---|---|---|---|---|
| | Analytical | Empirical | Mixed | N/A | Other | Grand Total |
| In-depth Interviews, Organization Statistical Data | 1 | 1 | 3 | | | 5 |
| In-depth Interviews, Organization Statistical Data, and Literature focus | | | 4 | | | 4 |
| in-depth Interviews, Questionnaire | | | 1 | | | 1 |
| in-depth Interviews, Questionnaires, Focus Groups, Organization Statistical Data | 1 | | | | | 1 |
| in-depth Interviews, Questionnaires, Organization Statistical Data | | | 4 | | | 4 |
| in-depth interviews, workshops, Organization Statistical Data | | | 1 | | | 1 |
| Literature focus | 7 | 1 | | | | 8 |
| Literature focus, Organization Statistical Data | | | | 1 | | 1 |
| N/A | 1 | 2 | | | 2 | 5 |
| Organization Statistical Data | 32 | 55 | 6 | | | 93 |
| Organization Statistical Data, in-depth Interviews | | | 1 | | | 1 |
| Organization Statistical Data, Literature focus | 10 | 2 | | | | 12 |
| Organization Statistical Data, Literature focus, Questionnaire | | 1 | 2 | | | 3 |
| Organization Statistical Data, Questionnaire | | 1 | | | | 1 |
| A questionnaire, Literature focus, in-depth Interviews | | | 1 | | | 1 |
| A questionnaire, Organization Statistical Data | 2 | 2 | 2 | | | 6 |
| A questionnaire, Organization Statistical Data, and Literature focus | | 2 | | | | 2 |
| survey through Telephone Interview | | 1 | | | | 1 |
| Grand Total | 54 | 68 | 25 | 1 | 2 | 150 |

Source: The Author

Table 4.12. Methods for collecting data to investigate the port congestion problem in the selected papers.

#### 4.4.3.4 Methods for analyzing data to investigate the port congestion problem in the selected studies

The quantitative methodology with empirical research type has dominated the research methods in the selected papers for investigating the port congestion problem (see previous tables). Consequently, and in general, data analysis techniques such as simulations and modelling have been used widely for analysing the data in the selected papers. Table 4.13 shows that the modelling technique has been applied in 69 papers, about 46% of the selected articles. Also, the simulation was used in 53 papers which is around 35% of the selected papers.

The statistics analysis approach and Mathematical programming have been used less in the selected papers, with 22 papers (14.6%) for the first and only two papers (1.3%) for the second. Qualitative analysis techniques such as interpretive phenomenology were applied in only Three papers, approximately 2% of the selected papers.

Other types of analysis techniques used scarcely in 16 selected papers were registered under the “Other” subcategory.

| Analysis technique | Count of Reference | percentage |
|---|---|---|
| Interpretivist phenomenology | 3 | 2% |
| Mathematical programming | 2 | 1.3% |
| Modelling | 69 | 46% |
| Others | 16 | 6.6% |
| Simulation | 53 | 4% |
| Statistical analysis | 22 | 14.6% |

Source: The Author

Table 4.13. The count of selected papers used for each type of analysis technique

Table 4.14 gives more details about the use of the analysis techniques according to the research type. The Simulation approach was applied as a single technique to 46 papers from the selected papers (19 papers as analytical research, 26 as empirical research, and one as a mixed type of research). It also combined with modelling technique in 5 papers from the total selected papers (2 papers under the analytical type of research, two papers under the empirical type of research and one paper under the mixed type of research). Moreover, it also combined under the mixed type of research to interpretive phenomenology analysis technique in one paper and statistics analysis approach in another.

In the same way, modelling techniques have been used as the primary approach or together with other techniques. It was used as a single approach at 57 papers from a total of selected papers (16 papers under the analytical type of research, 33 papers under the empirical type of research and eight papers under the mixed type of research). However, it was combined with the simulation technique in five papers (2 papers under the analytical type of research, two papers under the empirical type of research, and one under the mixed type of research). It also was combined with statistical analysis in five papers (One analytical type of paper, two empirical type papers and two mixed-type papers). Moreover, it was combined under the mixed type of research, in One paper, with the qualitative interpretive phenomenology technique.

Also, the Mathematical programming technique has been applied only in two empirical research papers.

Other techniques for analysing quantitative data have been used but for one time and in a few numbers of selected papers (16 papers out of the total of 150 papers) such as systematic literature review, Social Network Analysis, simple cause and effect analytical methods, Principle of Entropy Maximisation (PEM), knowledge, attitude, and practice (KAP), analytical framework "differentiation Framework", and Importance-Performance Analysis (IPA).

| **Analysis techniques** | **Analytical** | **Empirical** | **Mixed** | **Other research types** | **Grand Total** |
|---|---|---|---|---|---|
| interpretive phenomenology, statistics analysis | | | 1 | | 1 |
| Mathematical programming | | 2 | | | 2 |
| Modelling | 16 | 33 | 8 | | 57 |
| Modelling, interpretive phenomenology analysis | | | 1 | | 1 |
| Simulation | 19 | 26 | 1 | | 46 |
| Simulation, Modelling | 2 | 2 | 1 | | 5 |
| Simulations, interpretive phenomenology analysis | | | 1 | | 1 |
| Statistical analysis | 5 | 3 | 7 | | 15 |
| Statistical analysis, modelling | 1 | 2 | 2 | | 5 |
| statistical analysis, simulation | | | 1 | | 1 |
| Other techniques | 10 | | 2 | 4 | 16 |
| **Grand Total** | **53** | **68** | **25** | **4** | **150** |

Source: The Author

Table 4.14. Analysis techniques type according to the type of research for investigating port congestion problems in the selected papers.

#### 4.4.3.5 Theories used to investigate port congestion problem in the selected studies

According to Sander (2012), a theory, in general, is concerned with explaining observing phenomena by investigating and formulating the relationships. This usually comes in terms of cause and effect, between variables that might or might be not investigated before. However, the operations and management field of research still lacks a theoretical base as it is more focused on practical problems than the theoretical perspective (Walker et al., 2015). Table 4.15 shows that only about one-third (56 papers) of the selected papers for this review research have based their studies on solving the port congestion problem from a theory base perspective. The rest tackle the problem based on inductive rather than deductive research studies.

| Theory use | Count of Reference | percentages of papers |
|---|---|---|
| No | 94 | 63% |
| Yes | 56 | 37% |
| **Grand Total** | **150** | |

Source: The Author

Table 4.15. Papers that used theory to investigate the port congestion problem

Table 4.16 shows the list of theories used by this review selected articles to address and study the port congestion problem in Seaports and container terminals. It can be seen from Table 4.16 that those 13 different theories were applied in 37% of the selected papers. Most of these theories were applied in one article except “Fuzzy sets theory” and “Game theory”, which were used in two articles and “Queuing theory”, which has been extensively used in the papers that based their studies on a theoretical base.

| Applied theory | Count of Reference | Percentages from total applied theory papers (56 papers) | Percentages from total selected papers (150 papers) |
|---|---|---|---|
| A theory of rationing by waiting | 1 | 1.8% | 0.66% |
| auction theory | 1 | 1.8% | 0.66% |
| Fuzzy sets theory | 2 | 3.6% | 1.3% |
| Game theory | 2 | 3.6% | 1.3% |
| Graph theory | 1 | 1.8% | 0.66% |
| maximum flow theory | 1 | 1.8% | 0.66% |
| N/A | 94 | - | 63% |
| Pricing Theory | 1 | 1.8% | 0.66% |
| probability theory | 1 | 1.8% | 0.66% |
| Queuing Theory | 45 | 80% | 30% |
| learning theory | 1 | 1.8% | 0.66% |
| stakeholder theory | 1 | 1.8% | 0.66% |
| theory of self-internalization | 1 | 1.8% | 0.66% |
| transaction costs theory | 1 | 1.8% | 0.66% |

Source: The Author

Table 4.16. Percentages of papers by each applied theory to investigate the port congestion problem.

### Queuing theory

The percentage of using the Queuing theory to study port congestion problems against other applied theories was 80%, where precisely 45 papers applied this theory out of the total of 56 papers that based their investigation of port congestion problems on the theoretical perspective. However, It only accounts for 30% of the total selected papers.

Queuing theory has been applied as the theoretical base for investigating and examining the factors affecting the port congestion problem but with different research methodologies. Table 4.17 shows that it has been applied under analytical research in 18 papers with 40% from selected papers that applied theory) to derive approximate analytical expressions for waiting times to model the random arrival process for ships and trucks and provide performance estimates for port facilities and services. This analytical approach for applying the queuing theory has been recognised by several scholars as one of the favourable approaches to analysing the port congestion problem in academia (Shabayek and Yeung 2002).

The Queuing theory has also been conducted with empirical research studies to study the bottleneck nodes in ports and container terminals at 21 papers out of 45 papers (with a percentage of 47%) that applied theory as a theoretical base for their research. In this type of research, researchers manipulated independent variables which affect port congestion (such as the number of births, number of tugboats available, number of quayside cranes, the storage yard capacity,.etc ). They used actual data from port organizations for determining the exact effect on dependent variables (such as vessel turned around time, the truck turned around time and port gates times) to help port managers with a valuable set of decision-making formulas.

In the mixed type of research, the queuing theory has been used only in six papers out of 45 that applied the theory 13%. In these studies, the researchers used artificial data to build models and simulations for analysing and identifying the efficiency and port productivities weak points and then evaluating the results with statistical analysing based on actual data from ports.

| **Research type** | **Count of Reference** | **Percentage** |
|---|---|---|
| Analytical | 18 | 40% |
| Empirical | 21 | 47% |
| Mixed | 6 | 13% |
| **Grand Total** | **45** | |

Source: The Author

Table 4.17. Using the Queuing theory regarding the research type

Queuing theory was also applied with different analysis techniques for analysing data collected in the selected papers that used the queuing theory as a research theory base. Table 4.18 indicates that queuing theory has long been used with both analysis techniques Mathematical Modelling and simulations in selected papers with a theoretical base to deal with port congestion issues.

Queuing simulation models have been conducted as an analytical tool sometimes or based on actual empirical data to solve port traffic problems and increase port efficiency. This was in some case studies, alone in (17 papers) and mixed with Mathematical Models in 3 out of 45 papers that used a theory base (with percentages respectively of 37% and 7%). By studying and analysing ships' arrival patterns and estimating the number of port berths, quayside cranes, tugboats and port gates, the Queuing simulations models helped the decision-makers increase the productivity and efficiency of their ports (Saeed and Larsen 2016).

| Type of analysis | Count of Reference | Percentages |
|---|---|---|
| Modelling | 21 | 47% |
| Simulation | 17 | 37% |
| Simulation, Modelling | 3 | 7% |
| Statistics analysis | 3 | 7% |
| Statistics analysis, modelling | 1 | 2% |
| **Grand Total** | **45** | |

Source: The Author

Table 4.18. Using the Queuing theory regarding the type of analysis technique

Also, table 4.18 shows that Queuing Mathematical models have been built up as a single method for analysing data in 21 papers. And they were companied by Queuing Simulation modelling in three papers and with a combination of Statistical Analysis in one paper. This accounted for around 47%, 7%, and 2% of the selected papers that used a theory base. Queuing Mathematical models have been applied analytically in the planning of ship-berth links and in solving berth allocation and scheduling problems. Also, it has been used empirically in an experimental type of paper to find the balance between the cost of investment in fixed assets and total congestion surcharge costs. Queuing Mathematical models have a good advantage in analyzing different scenarios at minimum cost. They are beneficial for modelling a wide range of port systems to avoid vast and unnecessary investment (Kiani et al. 2006).

Queuing Statistical Analysis technique, as shown in Table 4.18 has been carried out only on Four selected papers which are already counted as theoretical base papers. It was used as a single approach in Three papers with a percentage of 7%, where the port’s capacity utilisation rates were determined over time to indicate and identify the underutilization of port infrastructure and the hinterland as causes of port congestion in developing countries. Also, it was combined with Queuing Mathematical model technique in one paper to forecast and predict the number of goods subject to inspection in seaports. And provides relevant information for decision-making and resource planning to avoid bottlenecks in customs checking processing and port gates.

#### 4.4.4. Academic interest in investigating the port congestion problem according to the governance sector type of port organizations

Ports and container terminals are places where the infrastructures, superstructures and presented services usually belong or are supplied by the different types of governance sectors (public, private or mixed between public and private). Four models fall under the type of governance sector (The World Bank 2007). All resources such as infrastructures, superstructures, and presented services belong to and supply by the government public sector in the public service model. These resources are fully privatized in the private service model of port governance. The third and fourth models are mixed from both public and private sectors where they share, but in different ways, the previous resources at models called: landlord model and tool port model. However, these two models of port governance (Landlord and Tool port models) have not been clearly identified when the researchers investigate the port congestion in those selected articles rather than being mentioned as mixed sectors for port governance.

For this reason, this research review has divided the selected papers, based on the academic interest in investigating port congestion problems according to the sector type of port governance, into Four groups of selected papers (see table

4.19). Papers investigate the problem at the public port’s sector type, papers at the private port’s sector type, and papers using the mixed or both port’s sector types to investigate the congestion problem at ports. The fourth group of papers which represent not applicable papers (N/A) have not mentioned any information about the sector type of port governance under investigation for the port congestion problem. This might be because these papers considered that the type of port governance has no relationship effect on the kind of bottlenecks under investigation.

It can be seen from Table 4.19 that a significant number of selected papers, 99 papers out of 150 papers with a percentage of 66% of the total, have used both port’s type of sector (Landlord model and Tool port model) to study and tackle the port congestion problem. Ports under the public service model came next, where 22 papers out of 150 papers, with a percentage of around 15% of the total, focused their research on the public port sector type to investigate and solve the problem of port congestion. In contrast, only six papers (4% of the total) have studied and investigated the problem in the private sector (private services model).

| Sector Type | Count of Reference | Percentages |
|---|---|---|
| Both Sector | 99 | 66% |
| N/A | 23 | 15% |
| Private Sector | 6 | 4% |
| Public Sector | 22 | 15% |
| **Grand Total** | **150** | |

Source: The Author

Table 4.19. The number of selected papers investigating the port congestion problem according to the sector type of port governance.

The academic researchers' less interest in studying and investigating the port congestion problem at private services model ports could be related to two reasons. The first might be due to this type of port governance having high levels of efficiency and productivity, which made it less suffering from port congestion problems. The second reason could be that only a few countries worldwide have applied this kind of governance for their ports which made it less subject to academic interest in terms of port congestion problems. The fourth group of papers (N/A) percentage was approximately 15% which represents 23 papers out of 150 selected papers.

#### 4.4.5. The definitions for Port congestion problems in selected papers

Although many research papers about the port congestion problem have been published, only a few of them have given a definition for the port congestion problem. Table 4.20 and figure 4.7 show that less than a quarter of the selected papers have defined the phenomenon, accounting for only 21% of the total. Also, slightly more than half of the selected papers that gave definitions for the problem (17 papers out of 32 papers), the definitions were established or produced by their author(s), whereas the rest of these papers (15 papers out of 32 papers) have borrowed their definitions from previous literature.

| Is there any definition | What type of definition | | | |
|---|---|---|---|---|
| | N/A | Previous Literature | Produced by Author(s) | Grand Total |
| No | 118 | | | 118 |
| YES | 32 | 15 | 17 | 32 |
| **Grand Total** | **118** | **15** | **17** | **150** |

Source: The Author

Table 4.20. The number of selected papers that produced Port congestion definitions according to the producing type.

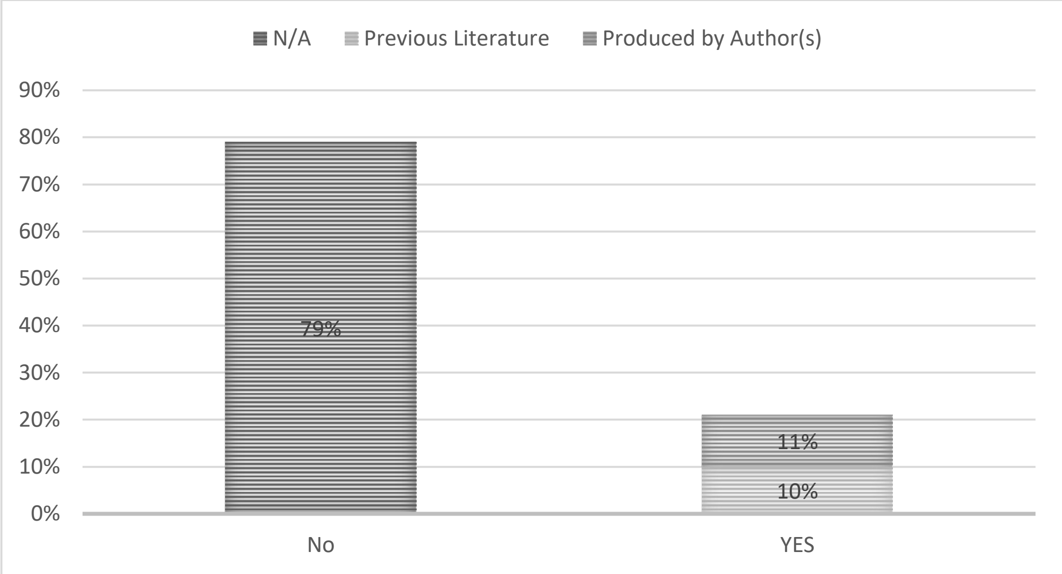



Figure 4.7. The percentage of selected papers that produced Port congestion definition according to the producing type.

Appendix (E) shows all definitions that have been used to define the port congestion problem in selected papers against the brief citation for these papers. Seventeen papers used their conceptual framework to define the phenomena, while the rest of the selected papers (15 papers) accounted for the previous literature to define the problem. Two definitions were used most often to define the port congestion problem in the selected papers that borrowed their definitions from previous scholars. The definition by Talley (2006) has been used in 4 papers out of 15 selected papers (which are: Fan et al. 2012; Jin et al. 2015; Saeed et al. 2018; Ndipmun 2010). Also, Onwumere (2008) definition has been referred to as a definition for the problem in 4 papers (which are: Alhameedi et al. 2018; Magibho 2017; Oyatoye et al. 2011; Patalinghug et al. 2015). The definitions from previous scholars were used less often (sometimes by two papers and one paper at other times) see figure 4.8.

Papers such as (Magibho 2017; Oyatoye et al. 2011; Potgieter 2016) used two or more (sometimes Three) different definitions from previous scholars to capture the whole picture and understand the problem. Also, only Talley and Ng (2016) produced Three different definitions for the port congestion problem where they looked at the port congestion problem from their different perspectives and generated Three different definitions for them (see appendix E).

The first definition of the port congestion problem (the oldest one) in the selected papers was produced by Jansson and Shneerson (1982) and cited in Noritake (1985), while the most recent one was generated by Wang and Meng (2019).

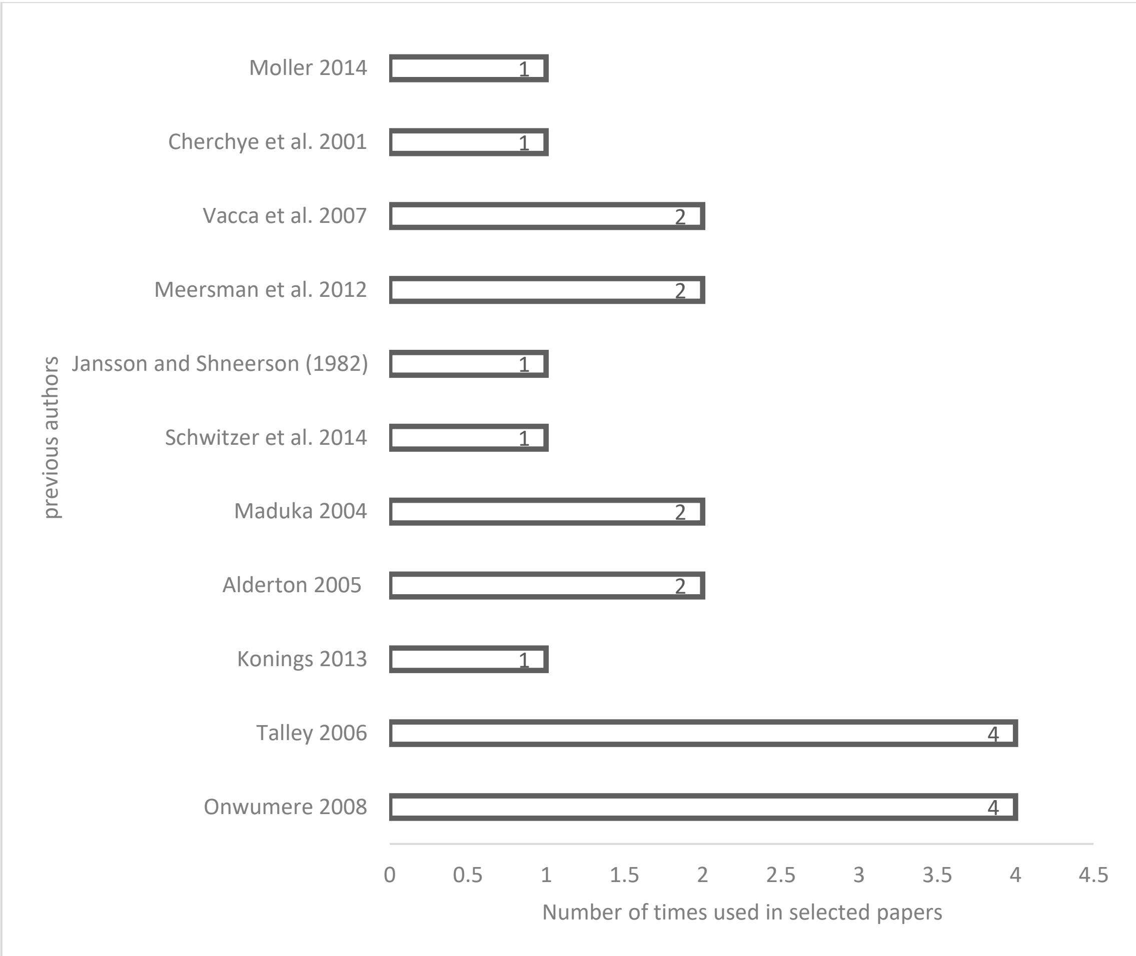



Figure 4.8. The number of times the previous definitions used in selected papers defined port congestion.

#### 4.4.6. Causes for the Port congestion problem in the selected papers

The most frequent causes for port congestion problems that the reviewed literature has indicated were thematical gathered and grouped through synthesising into five analytic themes based on the type of classification of causes that trigger the congestion problem at ports (see chapter (2)). These analytic theme categories are “Technical classifications”, Natural classifications, Economic classifications, Policies classifications, and social classifications, which can be considered key classifications for the causes of port congestion. Table 4.21shows that most of the reviewed papers have dealt with technical causes and economic causes as reasons behind the congestion problem at ports. Whereas, out of the 150 selected papers, about 145 papers with a percentage of 97% have indicated the technical causes behind the problem, and about 123 papers with a percentage of 82% have identified economic causes for the port congestion problem. Policies, Social, and Natural reasons for causing the congestion problem at ports were less identified in the reviewed literature. There were only 37 papers, which is 25% of the selected papers, indicating policies' reasons for causing the port congestion problem. Furthermore, about 30 papers, which is 20% of the total, have mentioned social issues behind the problem. Also, only 22 papers, about 15% of the selected articles, have considered that natural causes might cause the port congestion problem.

Three papers have not indicated any causes for the port congestion problem. One of these three was considered in this systematic literature review as it produced a definition for the port congestion problem. Furthermore, the other two articles were considered because they provided the researcher with some insights into the port congestion problem that help him understand the effects and consequences of the phenomena on the shipping industry.

| ***Causes classification type for port congestion*** | **Count of selected papers that mentioned this type of causes** | **Percentage** |
|---|---|---|
| *Technical causes* | 145 *papers* | 97% |
| *Economical causes* | 123 *papers* | 82% |
| *Natural causes* | 22 *papers* | 15% |
| *Policies causes* | 37 *papers* | 25% |
| *Social causes* | 30 *papers* | 20% |

Table 4.21. Count of the selected papers that mentioned each type of cause classifications of port congestion.

#### 4.4.6.1 Technical causes for port congestion at the selected papers

The technical causes for the port congestion problem have been indicated in the vast majority of the reviewed articles (see table 4.22). These technical causes were thematically divided, during the synthesising process, into Three interpretative themes. These themes are: weakness in the infrastructures, shortages in facilities, and mismanagement (see the methodology section of this chapter figures 4.3 and appendix C). Then, those interpretative themes were considered under Three types of port congestion (Seaside, Landside, and Hinterland-side) to make it easy for relating each group of technical causes' theme to the type of port congestion (see chapter two of the literature review).

First, this review study looked at these technical causes through interpretative themes. At the same time, these causes have been categorised through three kinds of bottlenecks that usually cause to slow down the system in any organization (see table 4.23). These three theme categories are: weakness in the infrastructures, shortages in facilities, and mismanagement. It can be concluded from Table 4.23 that those technical causes due to shortages in facilities have been considered the most technical issues that cause port congestion in the selected literature. The causes under this theme category have been reported 263 times in the selected literature out of 642 times, representing about 41% of the total technical causes reported as the main causes for port congestion problems in the selected papers. The technical causes under the mismanagement theme category came next with 211 reported times in the selected literature, representing about 33% of the total technical causes reported as the main causes for port congestion problems in the selected papers. However, the technical causes under the weak infrastructures theme have been reported less with only 168 times in the literature, which only represented about 26% of the total technical causes reported as the main causes of port congestion problems in the selected papers.

| Interpretative themes | count of each theme of the technical causes in the selected papers | Percentages |
|---|---|---|
| Mismanagement | 211 | 41% |
| Shortage in facilities | 263 | 33% |
| Weak infrastructures | 168 | 26% |
| **Grand Total** | **642** | |

Table 4.22. Count each Interpretative theme of the technical causes for port congestion in the selected papers.

Secondly, and from another perspective, this study review looked at the technical causes of the three types of congestion problems at the seaports. These technical causes were categorised under Seaside congestion, Landside congestion, and Hinterland-side congestion (see table 4.23). The most prevalent technical cause identified by the selected papers is the one responsible for landside (portside) congestion at ports. About 57% of the total technical causes for port congestion have emerged from bottlenecks on the landside of the port (such as congested port gates, congested port ways…., etc.). In contrast, half of this percentage (27%) is due to issues at the seaside of the port (such as increased vessel size, insufficient berths capacity…, etc.). However, Hinterland-side bottlenecks only accounted for 16% of the total technical causes of port congestion (see tables 4.26 & 4.27 and figures 4.23 & 4.24).

| Technical issues according to congestion type | Sum of Count | Percentages |
|---|---|---|
| Landside | 366 | 57% |
| Seaside | 174 | 27% |
| Hinterland side | 102 | 16% |

Table 4.23. Count for appearing of each type of technical cause for port congestion in the selected papers.

Table 4.24 and figure 4.9 show that “Congested port gate” is the most frequently landside technical cause for port congestion followed by the causes of “congested port ways”. The first was indicated as a shortage in facilities caused port congestion at 63 papers out of 147 papers that have reported causes for port congestion problem which forms about 43% per cent. The second was mentioned as a mismanagement issue in 44 papers which formed a percentage of 30% of the total 147 papers that have reported causes for the port congestion problem.

However, the less frequently reported landside technical causes are: “storing in the port is the cheapest option where importers use the ports to store their goods for a long-time causing delay other cargoes” and “Inefficient yard template planning”. These Two technical causes were only mentioned as mismanagement technical causes in Three selected papers, per each, formed a percentage of 2% out of the 147 papers that have reported causes for the problem.

In the same way, the reason for “increasing in the vessel size” was the most frequently reported seaside technical cause for port congestion, followed by “Insufficient Berth Capacity”. The first one has been considered as a shortage in facilities causes port congestion at 52 papers formed a percentage of 35% out of the 147 papers that have reported causes for the port congestion problem. The latter was mentioned as a weakness in infrastructures that causes port congestion problems in 38 papers which formed a percentage of 26% of the total 147 papers that have reported causes for the port congestion problem.

However, the less considered seaside technical cause is the “Shortages in Tugboats”, which was mentioned as a shortage in facilities cause for port congestion at only seven papers with a percentage of 4.7% from the total 147 papers reported causes for the port congestion problem.

| Interpretative Themes | Technical cause for congestion | Sum of Count |
|---|---|---|
| | **Landside congestion** | |
| Mismanagement | congested port ways | 44 |
| | inefficiency in port operations and poor port productivity | 35 |
| | Inefficient Management | 32 |
| | increasing the complexity of operations. | 20 |
| | unqualified staff | 8 |
| | storage in the port is the cheapest option importers use the ports to store their goods for a long-time causing a delay in other cargo | 3 |
| | Inefficient yard template planning | 3 |
| | **Mismanagement issues appeared in selected papers** | **145** |
| Shortages in Facilities | congested port gate | 63 |
| | Shortages in Cranes | 24 |
| | Other Port Facilities Shortage | 24 |
| | shortage of equipment spare parts | 14 |
| | **shortage of facilities issues appeared in selected papers** | **125** |
| Weakness in infrastructure | Other Weaknesses in Ports Infrastructure | 38 |
| | Insufficient Storage Area | 34 |
| | insufficient port capacity | 24 |
| | **weakness in infrastructure issues appeared in selected papers** | **96** |
| | **Total times that issue for technical landside congestion appeared in selected papers** | **366** |
| | **Seaside congestion** | |
| Mismanagement | Inefficient ship berth plans | 20 |
| | Accidents that could suddenly damage port equipment or ship entry route | 8 |
| | Poor maintenance for quayside facilities | 14 |
| | **Mismanagement issues appeared in selected papers** | **42** |
| Shortages in Facilities | increase vessel size | 52 |
| | The increased prevalence of vessel-sharing alliances has caused the terminals to receive containers from multiple shipping lines | 20 |
| | Shortages in Tugboats | 7 |
| | **shortage of facilities issues appeared in selected papers** | **79** |
| Weakness in infrastructure | Insufficient Berth Capacity | 38 |
| | Low Chanel Depth | 15 |
| | **weakness in infrastructure issues appeared in selected papers** | **53** |
| | **Total times that issue for technical Seaside congestion appeared in selected papers** | **174** |
| | **Hinterland-side congestion** | |
| Mismanagement | lack of information exchange opportunities between exporters and hauliers on possible matched trips | 23 |
| | inefficient hinterland access | 1 |
| | **Mismanagement issues appeared in selected papers** | **24** |
| Shortages in Facilities | congested hinterland access | 59 |
| | **shortage of facilities issues appeared in selected papers** | **59** |
| Weakness in infrastructure | Weak intermodal Infrastructure | 13 |
| | week in internet communications and banking services | 6 |
| | **weakness in infrastructure issues appeared in selected papers** | **19** |
| | **Total times that issues for technical hinterland side congestion appeared in selected papers** | **102** |
| | **Grand Total** | **642** |

Table 4.24. Count the existing times in selected papers for each technical cause according to their interpretative themes and their type of port congestion.

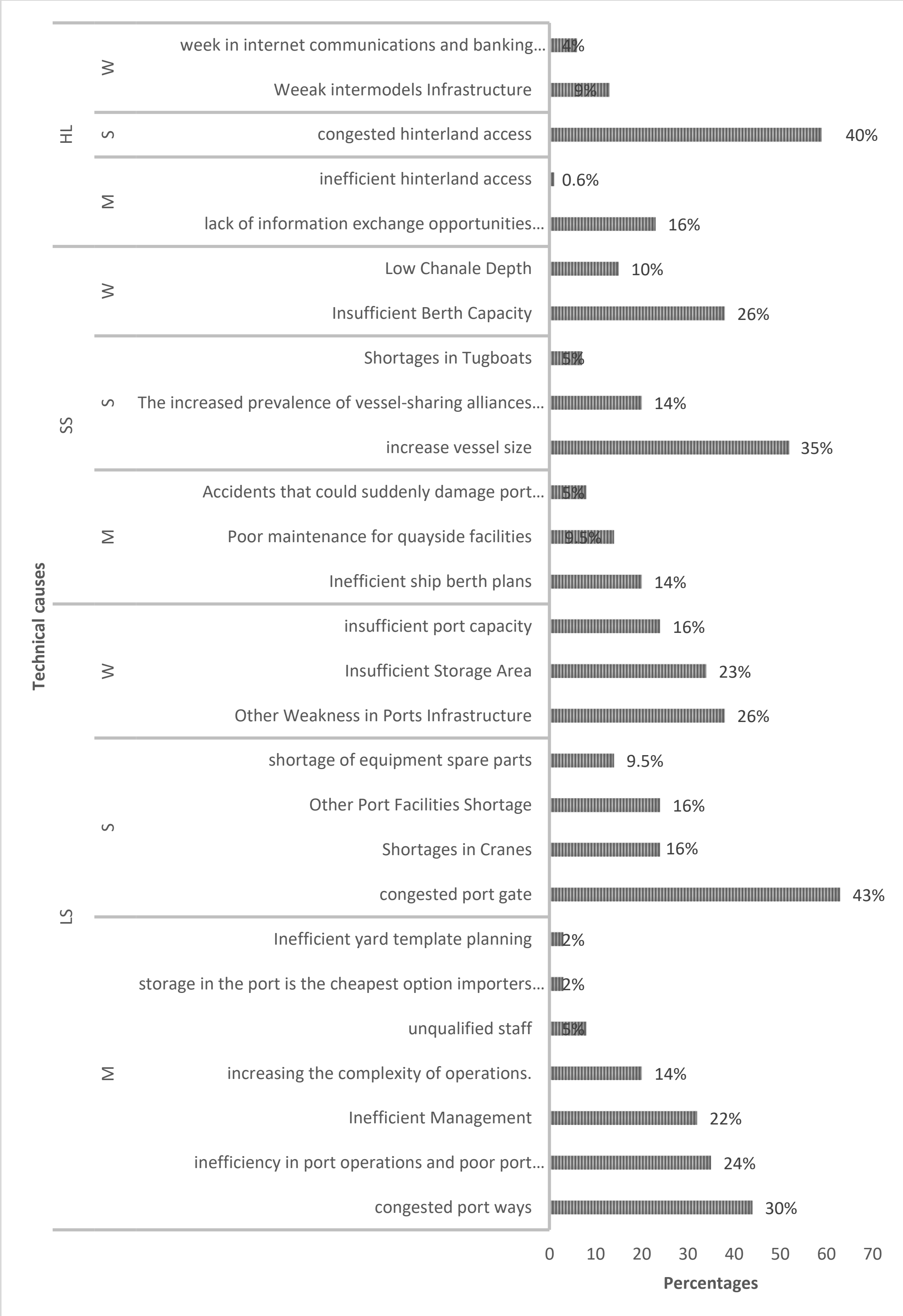



Figure 4.9. Percentage of the existing times in selected papers for each technical cause according to their interpretative themes and their type of port congestion.

For the hinterland-side technical causes, the “congested hinterland accesses”, under the category of shortage in facilities, were the most prevalent reported issue for port congestion. It was claimed to cause congestion at 59 papers formed a percentage of 40% of the selected literature that has reported causes for the congestion problem at ports. However, the most-less frequently reported hinterland-side technical cause was “insufficient hinterland accesses”. It only appeared as a mismanagement technical cause for port congestion in only One selected paper with 0.7% of the total 147 papers that have reported causes for port congestion problems.

To sum up the above results, shortages in facilities represented by both “congested port gates” in landside (portside) congestion and “congested hinterland accesses” in hinterland-side congestion were seen in the reviewed literature as the main technical causes behind the congestion problems at Seaports and container terminals.

#### 4.4.6.2 Policy causes for port congestion at the selected papers

The causes for the port congestion problem that were triggered by inefficient or bad policies, whether the government or the port management implemented those policies, fall under the analytical theme “policy causes”. These causes were only indicated in 37 out of the 147 selected papers, representing only 25% per cent (see table 4.24 and figure 4.21). Also, according to this research synthesising process, these policy causes can be only considered under the Mismanagement interpretative theme.

The most frequent policies cause, as can be seen from table (4.25), are “Bureaucracy and severe customs regulations” and “poor port regulations”. Each cause of those policy causes has been identified as a significant cause for port congestion in ten papers which formed a percentage of 7% of the total 147 selected papers that indicated causes for port congestion problem. This measure is followed by the “Security Regulations for 100% Inspection Requirement in ports”, as it was reported to be a reason for causing port congestion problems at nine papers with a percentage of 6% from the total 147 selected papers. However, the less reported policy causes are “Centralism and Monopolism” and “Inadequate Development Government Policies and Rules”. Each of them was only mentioned as a cause for port congestion, with only four papers representing 3% of the total 147 papers that gave the reasons behind the port congestion problem.

| Policies causes type | Count of Reference | Percentages |
|---|---|---|
| Bureaucracy and Sever Customs regulations | 10 | 7% |
| Centralism and Monopolism | 4 | 3% |
| Poor Port Regulation | 10 | 7% |
| Security Regulations for 100% Inspection Requirement in ports | 9 | 6% |
| Inadequate Development Government Policies and Rules | 4 | 3% |
| Total | 37 | |

Table 4.25. Count of the existing times in selected papers for each type of policy causes port congestion problems.

#### 4.4.6.3 Social causes for port congestion in the selected papers

Causes for the port congestion problem that falls under the analytical theme "social causes" were only indicated in 30 papers out of the 147 selected papers, representing only 20% per cent (see table 4.26). Also, these social causes can only be considered under the Mismanagement interpretative theme.

Strikes and labour inefficiency were taken a large percentage of the social causes of the port congestion problem. The first was indicated by 15 papers representing around 10% of the total 147 papers that indicate causes for port congestion. Moreover, the second was reported in nine papers which formed about 6% of the reviewed literature that indicated causes for port congestion. However, fewer working hours and the Excessive number of port workers have been less reported as social causes of port congestion. The first was mentioned in 5 papers, and the second was reported only in one paper with percentages respectively 3% and 0.6% (see table 4.26).

| Social causes type | Count of Reference | Percentages |
|---|---|---|
| Excessive Number of Port Workers | 1 | 0.6% |
| Labour inefficiency | 9 | 6% |
| Less Working Hours | 5 | 3% |
| Strikes | 15 | 10% |
| **Grand Total** | 30 | |

Table 4.26. Count the existing times in selected papers for each type of social cause for the port congestion problem.

#### 4.4.6.4 Economic causes for port congestion in the selected papers

The Economic causes that cause the port congestion problem to arise at ports have been indicated in a substantial number of the reviewed articles (see table 4.21). However, the most frequent one in these articles is the cause of "Increased international trade flow", which was mentioned as the main cause of the port congestion problem in 106 papers out of 147 papers that indicated and reported the causes for port congestion with a percentage of 72% per cent. However, Seasonality was the less frequent one where it was reported only in Two papers as an economic cause for the port congestion problem with a percentage of 1.4% per cent from the total 147 papers that have reported causes for the port congestion problem (see table 4.27).

| Economic causes type | Count of Reference | Percentage |
|---|---|---|
| Increased International Trade Flow | 106 | 72% |
| Increased Local Demand | 71 | 48% |
| container traffic is highly concentrated among a few ports | 14 | 9.5% |
| Seasonality | 2 | 1.4% |
| Grand Total | 193 | |

Table 4.27. Count the existing times in selected papers for each type of Economic cause for the port congestion problem.

#### 4.4.6.5 Natural causes for port congestion in the selected papers

Causes for port congestion problems such as bad weather, Tide, and flood were considered under the analytical theme "Natural causes" in the synthesising process for this systematic literature review. This type of cause has not been prevalent in the reviewed literature. They were reported to cause port congestion problems only in 22 papers, which formed a percentage of 15% of the 147 papers that indicated causes for port congestion (see table 4.21).

Bad Weather and Tide form the most frequent natural causes, in the reviewed literature, of the congestion problem at ports. Bad Weather was reported in 14 papers with a percentage of 10%. In contrast, the Tide was indicated in nine papers with 6%. However, flooding as a natural cause for port congestion was reported only in three papers, representing around 2% of the 147 selected papers that indicated causes for the port congestion problem (see table 4.28).

| Natural causes type | Count of Reference | Percentage |
|---|---|---|
| Bad Weather | 14 | 10% |
| Tide | 9 | 6% |
| Flood | 3 | 2% |
| Total | 26 | |

Table 4.28. Count the existing times in selected papers for each type of Natural cause for port congestion problem.

### 4.4.7. The solutions for the Port congestion problem in the selected papers

Out of the 150 selected papers, 140 papers have suggested solutions for the investigated port congestion problem, which is formed around 93% of the reviewed literature.

The most frequent solutions for the port congestion problem that the reviewed literature has suggested were thematical gathered and grouped through synthesising into 48 descriptive themes. Then these descriptive themes were thematically categorised into three interpretative themes. These themes are based on the type of solutions for solving the problem of slowing down any system operation: Mismanagement, shortages in facilities, and weakness in infrastructures. Table 4.29 shows that most of the reviewed papers have suggested management solutions for the congestion problem at ports. Management solutions to reduce port congestion problems have been indicated 287 times in the reviewed literature, representing 76% of the total solutions for the congestion problems at ports as they were seen in the selected papers. This is followed by solutions for infrastructures weakness with 70 times appearing in the reviewed literature forming 19% of the total solutions. And lastly, solutions for solving problems of shortages in facilities have been reported only 20 times in the reviewed literature, which accounted for only 5% of the total solutions for port congestion problems in selected papers. Table 4.30 and figure 10 give more details on the frequent existence of each descriptive solution in the review literature. As it can be seen from them that the solutions for mismanagement categorised of congestion problem: “improving cargo stacking plans”, “improving ship to berth plans”, and “improving handling operation efficiency”, among others, are the most reviewed literature suggested frequent solutions to solve the problem of port congestion. The first one has been reported 46 and 43 times for the other two, which formed percentages of 33% and 31%, respectively, from the total 140 selected papers that reported solutions for the port congestion problem.

| **Type of solutions according to the interpretative themes** | **Counting in selected papers** | **Percentage** |
|---|---|---|
| Solution for mismanagement | 287 | 76% |
| Solution for weakness in infrastructures | 70 | 19% |
| Solutions for shortages in facilities | 20 | 5% |

Table 4.29. Count the existing times in selected papers for each interpretative theme for solutions to the port congestion problem.

They were followed by another mismanagement solution which is “Implementing the truck

appointment system (TAS) to reduce the truck turnaround time and port gate congestion”, which was reported 29 times in the selected papers as a solution for port congestion with a percentage of 21% from the total. Also, these figures were followed by the “Increasing port capacities” as a solution for the infrastructures’ weakness and the “investing in high tech. port equipment” as a solution to shortages in facilities. These two descriptive solutions have been suggested as solutions for the port congestion problem in the reviewed papers respectively 22 times and 19 times with a percentage of 16% and 14% from the total 140 selected papers that reported solutions for the congestion problem at ports.

## 4.5. Discussion

Employing a systematic literature review based on structures and patterns that exist in the body of knowledge about the port congestion problem, this study has provided a synthesis of empirical evidence for the real causes and the potential solutions that succeeded to overcome the congestion problem in ports. The researcher, in this section, summarises and discusses the review findings obtained from analysing and synthesizing the selected articles concerning the four research questions established early in this research review process.

### 4.5.1. What is the relevant definition that best defines the congestion problem in ports?

Successful, effective management of the congestion problem at ports should be started by introducing an accurate and comprehensive definition of the problem. Also, even though many studies have investigated the port congestion problem. However, according to the overall analysis of the selected papers, only a few researchers have defined the problem, whether this definition was established by the author(s) him/themselves or borrowed from other scholars. Also, although these attempts for defining the port congestion problem have been started since 1982 (Jansson and Shneerson (1982)), a set definition for the problem, like most other social science concepts, have yet to be agreed upon.

| theme | Type of solution | Count |
|---|---|---|
| Management Solutions | Improving cargo stacking plans | 46 |
| | Improving ship-to-berth plans | 43 |
| | improving handling operation efficiency | 44 |
| | Implementing the truck appointment system (TAS) to reduce the truck turnaround time and port gate congestion | 29 |
| | Upgrading and developing port rules and Tariff policies | 19 |
| | Automated gate services via information technology (IT) systems or webpages | 10 |
| | Increasing port operation efficiency | 8 |
| | Easiness of the 100% scanning regime by a rapid primary scan of all containers followed by a more careful secondary Scan of only a few containers that fail the primary test | 7 |
| | Adopting policies and strategies that could encourage shippers to use all country's ports instead of concentrating the traffic on one port | 6 |
| | Extending the gate hours | 6 |
| | Involving the private sector in operating and managing ports | 6 |
| | Recruit qualified and experienced people | 5 |
| | Training port staff | 5 |
| | Regulations modified to reduce cargo dwell time through punitive measures and persuasions on shippers to take delivery in good time | 5 |
| | Improving port management efficiency | 5 |
| | Implementing congestion tolls on trucks can be used for shifting the daily demand for truck trips to the off-peak time window by use of pricing | 4 |
| | Ship-to-ship containers transfer in the open sea as an alternative way to avoid port congestion and increase port efficiency | 4 |
| | Establishing good coordination between port operators and shippers by introducing an IT system for information flow among them | 4 |
| | Improving the layout of the vehicle guide path between the quayside and the stack side | 4 |
| | Freight volume forecasting and detecting workload peaks and congestion in the inspection process of seaports provide relevant information for decision-making and resource planning. | 3 |
| | Improving ships' traffic plans through waterways and channels to reduce their waiting time and ensure safe routing. | 3 |
| | Implementing the VDTW (called vessel-dependent time windows) method where the truckers delivering outbound containers for the same vessel have to follow a specific time window of arrivals | 3 |
| | Deregulate the port labour system | 2 |
| | Good development of ports with the interface to the transport modes with better integration of these modes with each other at the land end | 2 |
| | Short Sea Shipping (SSS) as an alternative and efficient option for transporting cargo between ports | 2 |
| | Increasing working hours for port gates | 2 |
| | Implementing congestion tolls can be rationally altered and consequently disperse container ships' arrival times at the destination port as well as eliminate or decrease container ships' queuing times for port entry | 2 |
| | increasing working hours for port customs | 2 |
| | Decentralisation of the management at ports | 1 |
| | Implementing the Chassis Exchange Terminal (CET) to avoid extra crane handling by putting containers on a chassis and applying a chassis pool to reduce truck congestion at seaport container terminals and to improve truck efficiency in trips to these terminals | 1 |
| | Implementing truck-sharing service (TSS) to reduce the number of empty trips to improve the system-wide transport capacity along with bringing environmental benefits by reducing traffic congestion and air pollution around the port gates and the surrounding city. | 1 |
| | Empty container reuse to reduce the number of truck trips to and from the container terminals | 1 |
| | Shifting customs' responsibilities to others in the Logistic supply chain | 1 |
| | Involving the private sector in investing in hinterland intermodal | 1 |
| Infrastructures' solutions | Increasing port capacities | **22** |
| | Improving the infrastructures for the hinterland intermodal | **17** |
| | Improving port infrastructures | **12** |
| | increasing the number of port gates | **9** |
| | increasing port area capacities by establishing dry ports | **7** |
| | Increasing port berths capacity. | **1** |
| | Investing in new access routes to the port | **1** |
| | Increasing port area capacities by establishing sub-hub ports to support the hub port. | **1** |
| Facilities solution | investing in high-tech port equipment | 19 |
| | the rubber-tyred gantry crane (RTG) system is the most desirable yard operating system among others for fast operating and eliminates the problem of port congestion. | 1 |

Table 4.30. Count of existing times for solutions for port congestion in selected papers.

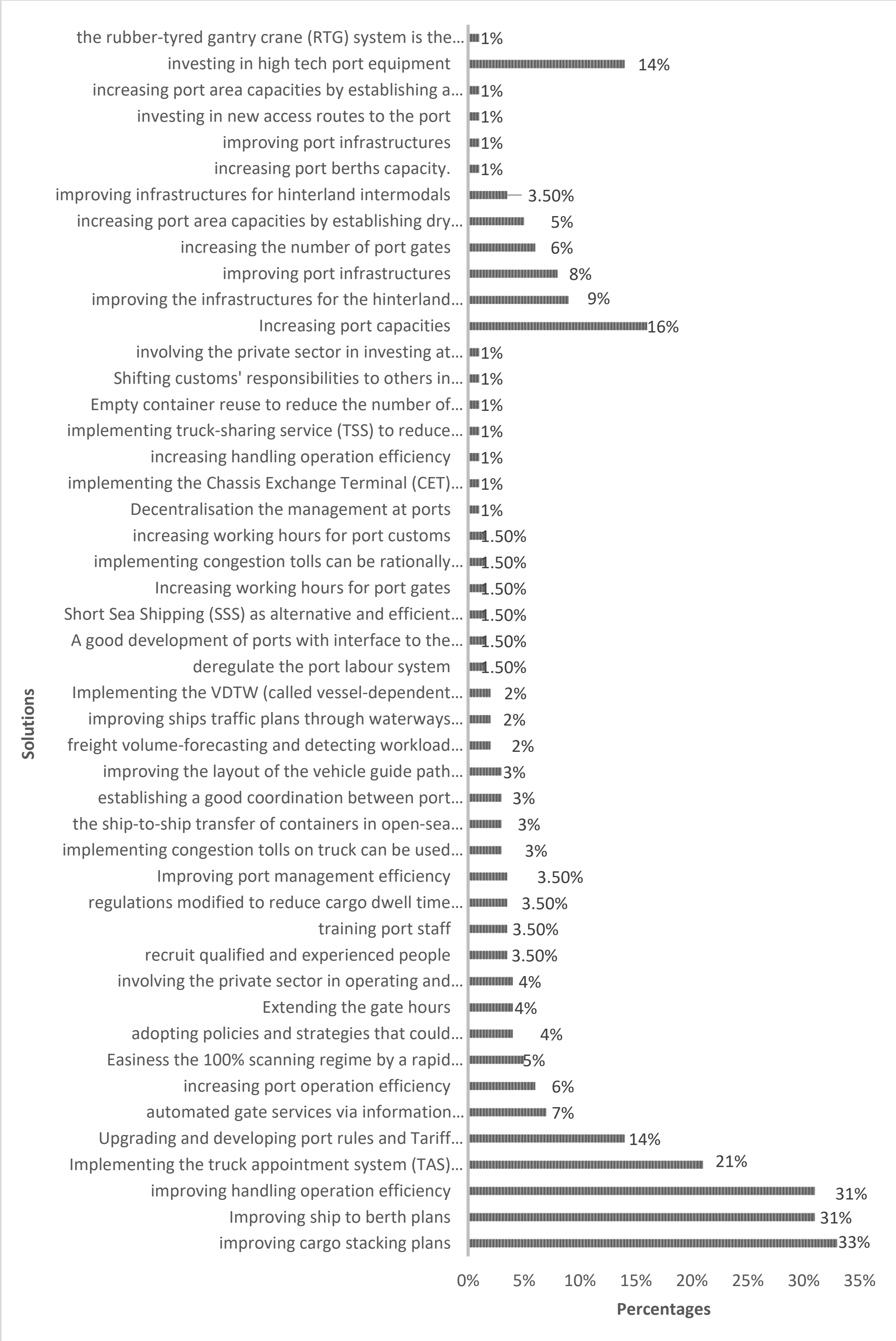



Figure 4.10. Percentages of the existing times for each solution for the port congestion problem in selected papers.

Researchers in the reviewed papers defined the port congestion problem differently as they expressed the problem based on different reasons that caused it to arise. There is, however, a clear connection between some of those definitions as they have more or less the same concepts (see table 4.31).

It can be seen from table 4.31 that Noritake (1985), Naude (2016), Motono et al. (2016) and Abouarghoub et al. (2017) have defined port congestion with the same conception as a situation that arises from increasing vessel traffic on a port and its berths facilities cannot handle this increase on ships traffic.  This definition produced by these papers was based on the increase in vessel traffic calling a port due to the increase in international trade or improvement in the port country's economy to define port congestion.

However, this definition identified only one situation of the port congestion problem which is caused by increases in international trade in a port.

Also, the definition produced by Maduka (2004) and has been used by two selected papers has the same concept as Fararoui and Black (1992) definition. Both papers defined the congestion problem in ports as a situation that arises due to massive, uncleared cargo from vessels, resulting in other vessels queuing outside the port waiting for berthing. This definition was based on one of the general reasons behind the port congestion problem, and it limited the port congestion definition only to this type of situation. In fact, this general reason for the port congestion problem could be related to the other two detailed reasons, which will adequately lead to the other two types of port congestion situations. First, the lack of port operation efficiency cannot cope with the massive unloading of cargoes and present a situation of port congestion. The second might be short in the capacities of storage areas which causes no more space for incoming cargoes, which leads to other situations of the different port congestion problems. However, the concept of Fararoui and Black (1992) and Maduka (2004) definitions did not include these situations, so it is not enough to express and understand the problem.

| Reference | Definition concept | Type of congestion | What is the definition | Used by/ produced by |
|---|---|---|---|---|
| Abouarghoub et al. 2017 | Increasing ships traffic (increasing international trade flow) | Congestion based on Economic causes | "When the economy of a country is improving, the traffic via its ports is increasing along with positive economic development, as a result, a queue of arriving vessels can form, and vessels may have to wait for long periods to be serviced". | Produced by Author(s) |
| Noritake 1985 | | | "Congestion in a port occurs when more ships to be served to arrive at the port than its berths can handle within a given time." | Produced by Author(s) |
| Naudé 2016 | | | "Port congestion is formed when the number of vessels arriving at a port within a given time frame exceeds the number of vessels that can be served by the port during that time frame." | Produced by Author(s) |
| Motono et al. 2016 | | | "Landside congestion is defined as a state where trailers take additional waiting time in the queue either at the destination terminal gate or on the access road to the gate." | Produced by Author(s) |
| - Maduka 2004 | Massive, uncleared cargoes | Congestion based on technical causes (Landside) | 3- "Port congestion as massive un-cleared cargo in the port, resulting in a delay of ships in the seaport." | Oyatoye et al. 2011 MAGIBHO 2017 |
| Fararoui and Black 1992 | | | "Port congestion occurs when cargo arrives at the port at a faster rate than that at which it can be cleared, which may be caused by a sudden change in trading conditions (seasonal or economic changes), as in the case of less-developed countries, shut-downs or slow-downs due to strikes or transport accidents, as happens in ports of industrialized countries". | Produced by Author(s) |

Source: The Author

Table 4.31. Concepts for the definitions of port congestion problems in the selected papers

| Reference | Definition concept | Type of congestion | What is the definition | Used by |
|---|---|---|---|---|
| Alderton 2005 | Lack of port capacities on the whole | Congestion based on technical causes (Seaside and Landside) | “Port congestion arises when port capacity is insufficient to cope with the traffic arriving at the port | Wanke (2011) MAGIBHO (2017) |
| Vacca et al. 2007 | | | “Congestion in the port is contributed by the growth in international trade together with the reality that many port facilities are running at or near capacity leading to traffic and port congestion.” | Rajamanickam and Ramadurai (2015) Rajasekar and Rengamani (2017) |
| POWLES 2004 | | | “Port Congestion problems are due to the fact that the ports have run out of space and poor terminal flow”. | Produced by Author(s) |
| Lee et al. 2007 | | | “Port traffic congestion may happen when too much workload needs to be handled within a small area at the same time”. | Produced by Author(s) |
| El-Naggar 2010 | | | “It happens when the port facilities capacity is fully utilized at all times. In this manner, changes in demand have to be accommodated by forcing ships to wait (at anchorage) until ships that arrived previously had been serviced. “ | Produced by Author(s) |
| Abe and Wilson 2009 | Lack of storage capacity | Congestion based on technical causes (landside) | “Congestion index: The sum of the loaded and unloaded containers in TEU at the major container ports in the country i in the year t, divided by the sum of the estimated full physical capacity of the major container ports in the country i in the year t”. | Produced by Author(s) |
| Onwumere 2008 | Lack of berths capacity at ports | Congestion based on technical causes (Seaside) | “Port congestion as a situation wherein a port; ships on arrival spend more time waiting to berth, in this context, more ships will queue at the channel and the outside of the port waiting to get space at the terminal for berth slot.” | Patalinghug et al. 2015 Oyatoye et al. 2011 MAGIBHO 2017 Alhameedi et al. 2018 |
| Fan and Cao 2000 | | | “It indicates the demand for the use of sea space exceeds the available capacity during that time period”. | Produced by Author(s) |

Source: The Author

Table 4.31. (cont.) Concepts for the definitions of port congestion problem at the selected papers

| Reference | Definition concept | Type of congestion | What is the definition | Used by |
|---|---|---|---|---|
| Meersman et al (2012) | How it is happening and What consequences of the effect | Congestion based on technical causes (Seaside) | a situation where a transport user, such as a ship, causes to delay another transport user (another ship), and this delay translated to extra cost upon the third party (usually the customer) | Produced by Author(s) and used by Potgieter 2016 |
| Talley 2006 | How it is happening and What consequences of the effect | Congestion based on technical causes (Seaside and Landside) | port congestion problem as a situation happened from the interface among port users in the port resources' utilization and resulted in extreme congestion costs | Fan et al. 2012<br>Jin et al. 2015<br>NDIPMUN 2010<br>Saeed et al. 2018 |
| Talley and Ng (2016) | How it is happening and What consequences of the effect | Congestion based on technical causes (Seaside and Landside) | "Port waiting-time congestion occurs when port users seeking to use a port service have to wait to use the service and consequently interfere with one another to the extent that their waiting times to use the service increase | Produced by Author(s) |
| Wang and Meng (2019) | How it is happening and What consequences of the effect | Congestion based on technical causes (Seaside and Landside) | "The congestion effect refers to the phenomenon that more customers choosing to use the same facility reduces the facility's utility." | Produced by Author(s) |
| Jansson and Sheerson (1982) | Demand and supply as the main variable for congestion | Congestion based on technical causes (Seaside and Landside | "Congestion costs exist if the other short-run costs of port operations, per unit of throughput, are an increasing function of the actual capacity utilization. When actual demand exceeds capacity, extreme congestion costs arise, which we call queuing costs. When a port is said to be congested, it is commonly meant that ships are queuing, waiting to obtain a berth." | Potgieter 2016 |

Source: The Author

Table 4.31. (cont.) Concepts for the definitions of port congestion problems in the selected papers

| Reference | Definition concept | Type of congestion | What is the definition | Used by |
|---|---|---|---|---|
| Guan and Liu (2009) | Increasing truck flow Increasing International trade flow | Congestion based on Economic causes | "(Congestion) is a situation where waiting cost at the marine container terminal gate occurs because there are more truck arrivals than the gate system can handle". | Produced by Author(s) |
| Ramírez-Nafarrate et al. 2017 | Low port handling efficiency and lack of coordination of inland flows | Congestion based on technical causes (Landside and hinterland-side) | "Port terminal congestion is a situation where the lack of coordination of inland flows is generating long waiting and service times for the trucks, as well as inefficient cargo handling operations in the yard of the port terminal." | Produced by Author(s) |
| Konings (2013) | | | "Port congestion is a problem at terminals, where increased congestion prolongs turnaround times for trucks receiving containers. Such congestion can arise due to the local regional environments of the terminals and from inefficient terminal and haulier operations, which can stem from poor information flows among the actors, meaning hauliers and terminals who have noted that such flows between hauliers and terminals are critical for their efficient operations." | Jacobsson et al. 2018 |
| Schwitzer et al. (2014) | Effect on supply chain | | Port congestion more broadly as bottlenecks, delays and other supply chain disruptions caused by several different factors | Potgreter (2016) |
| Chinedum (2018) | | | "Port Congestion is a scenario associated with delays, queuing and extra time of voyage and dwell time of ships and cargo at the port, which always has unpleasant consequences on Logistics and supply chain." | Produced by Author(s) |
| Cherchye et al. (2001) | The general concept of congestion | | "Congestion is characterized by the decreasing of outputs produced as a consequence of the large increase of inputs used." | Simoes and Marques (2010) |
| Moller (2014) | | | "A bottleneck can be defined as a subset of congestion in a system that causes the entire process in each stage to slow down." | Zain et al. (2010) |

Source: The Author

Table 4.31. (cont.) Concepts for the definitions of port congestion problems in the selected papers

Similar to the above definition, but more broadly, Alderton (2005), Vacca et al. (2007), and Onwumere (2008) used the lack of port capacity to define the port congestion problem. Where Both researchers Alderton (2005) and Vacca et al. (2012) based their definition on shortages in port capacity in general (could be port berths capacity or storage area capacity, or it might be both). They have defined the problem as a situation where a port capacity cannot cope with the increase in vessels' traffic on this port (increasing in international trade) and result in queuing ships afront of the port. Although the concept of this definition includes both seaside and landside congestion situations, it only relates the congestion problem to the lack of port capacity or the increase in ships' traffic (increasing international trade on this port). In fact, this limitation is made from it an incomplete definition of the port congestion problem. However, this definition has been used by four selected papers. It is the same argument that can be claimed for the definitions produced by Powles (2004), Lee et al. (2007), Abe and Wilson (2009), and El-Naggar (2016). Also, Onwumere (2008) expressed the port congestion problem as a situation where coming ships need to wait outside the port in a queue to get berth slots for loading or unloading their cargo. This definition of the port congestion problem was based on the reason that there are no available berths inside the port for arriving ships. Like the previous one, this definition has limited the port congestion problem in port capacity but just with one particular type of port congestion problem that happens at the seaside and only as a function of the lack of berths capacities at the port. Also, the lack of berths capacity at a port as the cause for port congestion could be related to other detailed reasons such as the insufficient number of port berths, inefficient ship to berth plans or shortage in tugboat services. All these Three reasons could lead to Three different port congestion situations where Onwumere (2008) definition does not perfectly express these congestion situations. It is the same argument that can be claimed for the definition produced by Fan and Cao (2000). However, the definition produced by Onwumere (2008) for the port congestion problem has been used by four selected papers.

Talley (2006) and Meersman et al. (2012) took a different perspective to define the port congestion problem, and their definitions were used by Four selected papers for the first and by Two papers for the second. The first one defined the port congestion problem as a situation that happened from the interface among port users in the port resources' utilization and resulted in high congestion costs. The second paper defined the problem as a situation where a transport user, such as a ship, causes a delay to another transport user (another ship). This delay translated to extra costs for a third party (usually the customer). The conceptions of these two definitions were based on how the problem happens. And, the consequences and the effect of the port congestion problem, rather than the causes of the phenomena. Nevertheless, this definition is given a good idea about the effect of port congestion; however, it explains only one type of port congestion (seaside port congestion problem) and does not justify why the problem might be happening. The same argument can be claimed for the definitions produced by both papers by Talley and Ng (2016) and Wang and Meng (2019).

Also, and in a more general concept, Jansson and Shneerson (1982) used the congestion surcharge to define the problem as a condition where extreme extra costs arise due to the actual demand exceeding the existing capacities and causing the ships to queue waiting for berthing. This definition looks to a holistic view of the demand and the supply of port capacities as the main variables for seaside and landside congestion surcharges but without considering the hinterland-side congestion.

Guan and Liu (2009), Ramirez-Nafarrate et al. (2011), Konings (2013), and Jacobsson et al. (2018) concentrate their research studies on congestion at container terminal ports. These papers look at the port congestion problem as bottlenecks in the port hinterland occupied with poor handling operation by the port that make the port congestion situation arise. Based on this perspective, they defined the problem as a situation that arises in container terminal ports due to the lack of coordination of inland flows occupied with the low port handling operation efficiency, which causes to congest the port gates and increases the ships' service time in container terminal ports. This definition perfectly defines the landside and the hinterland-side of the port congestion problem; however, it does not consider the congestion situation that arises at the seaside of the port, such as berths capacity, shorts in tugboats and other issues.

Another perspective to define the port congestion problem was taken by Schwitzer et al. (2014), which is cited in Potgieter (2016), and Chinedum (2018). They defined the congestion problem based on its effects on the supply chain as a situation that caused unpleasant consequences on logistics systems and the supply chain because of delays and extra time for vessels and cargoes at ports which usually impose extra charges on customers. The concept of this definition has expressed the effect of the port congestion problem on the supply chain; however, it does not answer the questions of how and why the problem occurs in the original.

Cherchye et al. (2001), cited in Simoes and Marques (2010) and Moller (2014) cited in Zain et al. (2016), used a general concept to define port congestion. The first paper defined congestion as a situation where a large increase in input causes to decrease in output, and this means that a significant increase in demand will lead to a decrease in supply. In comparison, the second paper defined port congestion as a situation where a subset of issues in the system cause to slow down each step in the entire process. Although the concept of these two definitions contains the logical principle for how the market system works, it does not explain or justify why the demand increases largely or the occurrence of these systems' issues.

To sum up the above discussion, there is a clear variation in how scholars in the selected papers have defined the port congestion problem. This variation in defining the problem is emerging from the fact that the causes of the port congestion problem in ports are complicated and multi-dimensional (Gidado 2015). They also differ from one country to another and even from port to port.

### 4.5.2. What are the theories, research methods, and analysis techniques used to investigate the port congestion problem?

Researchers in the reviewed papers used various methods and research designs to study and investigate the port congestion problem. In the following sections, these various methodologies will be discussed relating to the objectives of this systematic literature review research.

#### 4.5.2.1 Theories used to investigate the port congestion in the reviewed papers

Over the last two decades, there have been broad arguments and discussions around the nature of the field of management and operations research. Most field researchers consider the field of operations and management as a discipline lacking a theoretical foundation, and it mainly addresses practical problems (Walker et al. (2015); Chicksand et al. (2012)). This can be seen clearly as about two-thirds of the selected papers for this review research have not based their research on a theory base but rather investigated the problem of port congestion from a practical perspective (see table 4.15).

Moreover, Walker et al. (2015) and Chicksand et al. (2012) claimed that most theories that have been adopted in the field of operations and management had been imported from other disciplines rather than being developed in their fields. This is also clear from table (4.16), which shows that all 13 theories used in the 56 selected papers have been borrowed from other disciplines such as marketing, accounting, and economics fields of research. However, the theoretically based studies in the field of operations and management have changed over time and the number of based theory studies in this field has increased in the last 20 years. Walker et al. (2105) claimed that this change was due to the influence of globalisation and the new technology that developed in the past years. They also argued that this development has made the operations and management field researchers adopt other discipline theories after several years of establishment and less use by others. Figure (4.11) shows that starting from the year 2000, the investigation of the port problem has relied more on theory than it was before. Furthermore, table (4.32) shows that those 13 theories have been applied to investigate the port congestion problem just once or at a maximum of two times since 2006. However, queuing theory is the only one that has been applied to studying the problem since 1979 and continued till the day of committing this review research.

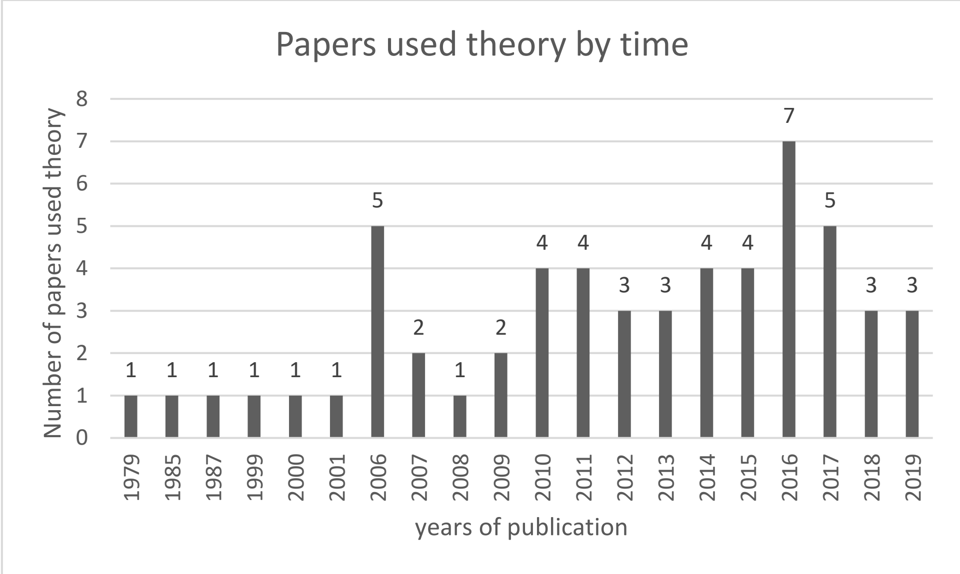



Figure 4.11. Selected papers that used theory during the time.

Walker et al. (2105) also claimed that over time the majority number of top-cited articles are the papers that have based their research on a theoretical perspective. Table 4.33 shows that about 28 papers, out of 112 academic papers (it has excluded the grey literature from counting), that have used theory for investigating port congestion ports have been published in high-ranking journals. Walker et al. (2015) highlighted two kinds of theories and perspectives in the operations and management field of research. They claimed that the first kind is called the “theory-building perspective”, where the theory is usually generated from new ideas or metaphorical expressions developed in a conceptual model to improve the explanation for a problem. The second type, they claimed that is known as “theory testing” where existing theory is used in a new form to understand the problem better.

In the above context, the reviewed selected papers have used both types of theoretical perspectives. First, the theory-building perspective was used in two forms as a conceptual framework and as case study research (see table 4.10). It was used as a conceptual framework for logically but less formally structured meanings and concepts in a sequential design structure in studies where existing theories are insufficient or inapplicable (Seuring and Müller 2008). This form of theory-building perspective was used in two selected papers, where each paper formed a conceptual framework to comprise new insights into the port congestion problem. These insights emerged through logically developing relationships between the type of port congestion problem and its impact factors into an inwardly coherent theory. The second form of theory-building perspective is the case study. It considers an appropriate method for theory building (Yin 2013), whereas its theoretical contribution is the development of an analytical framework that is used to explain and analyse the results of empirical research (Garrison and Vaughan 2008). In fact, the development analytical framework is used to explain the causal relationships between variables and to deeply explore the situations under study (Yin 2013). The case study form for theory building was used in 20 selected papers to investigate the port congestion problem and to identify the new relationships between the variables that cause the problem across time to elevate the theory's abstraction level. The second type of theory perspective used the theory testing approach more extensively in the selected papers, especially with queuing theory. Ports are considered a significant area for the studies that applied the queuing theory to focus on port service characteristics and efficiency (Jansson and Shneerson 1982). This was obviously in the selected papers as the queuing theory was used, alone in 42 papers and with other theories in Three papers, to evaluate the effectiveness of port congestion measures in some papers and identify the port congestion causes in others.

Queuing theory, by definition, is the mathematical study of waiting for lines or queues (Veloqui et al., 2014 p 616). According to the overall analysis of the selected papers for this review research, the empirical methods using the analytical queuing techniques is the traditional approach to assess uninterrupted port traffic flow in the literature.

Services and operation systems at ports and container terminals can be seen as a typical queuing process. Where vessels calling the port or trucks arriving at the gate can be thought of as customers waiting to be served, and the port facilities render services to vessels and trucks as servers (Hoque and Biswas 2007). In fact, services here represent berthing ships to the quayside and the handling operations of cargoes from ships to trucks in the import direction and from trucks to ships in the export direction. However, the random arrival of both vessels and trucks to the port makes it difficult to predict the traffic intensity and prevent the congestion problem, which leads to an increase in the turnaround time for the ships and trucks.

| Count of Reference | Publication years | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Name of theory** | **1979** | **1985** | **1987** | **1999** | **2000** | **2001** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **Grand Total** |
| **A theory of rationing by waiting** | | | | | | | | | | | | | | | 1 | | | | | | 1 |
| **auction theory** | | | | | | | | | | 1 | | | | | | | | | | | 1 |
| **Fuzzy sets theory** | | | | | | | | | | | | 1 | | | | | | 1 | | | 2 |
| **Game theory** | | | | | | | 1 | | | | | | 1 | | | | | | | | 2 |
| **Graph theory** | | | | | | | | | | | | | | | | | | | | 1 | 1 |
| **maximum flow theory** | | | | | | | | | | | 1 | | | | | | | | | | 1 |
| **Pricing Theory** | | | | | | | | | 1 | | | | | | | | | | | | 1 |
| **probability theory** | | | | | | | | | | | | | | | | | 1 | | | | 1 |
| **Queuing Theory** | 1 | 1 | 1 | 1 | 1 | 1 | 5 | 2 | | 1 | 3 | 3 | 2 | 3 | 3 | 4 | 6 | 4 | 2 | 1 | 45 |
| **Learning theory** | | | | | | | | | | | | | | | | 1 | | | | | 1 |
| **stakeholder theory** | | | | | | | | | | | | | | | | | | | | 1 | 1 |
| **theory of self-internalization** | | | | | | | | | | | | | | | | | | 1 | | | 1 |
| **transaction costs theory** | | | | | | | | | | | | | | | | | | | 1 | | 1 |
| **Grand Total** | **1** | **1** | **1** | **1** | **1** | **1** | **5** | **2** | **1** | **2** | **4** | **4** | **3** | **3** | **4** | **4** | **7** | **5** | **3** | **3** | **59** |

Table 4.32. Developing the use of theory in investigating port congestion problems in selected papers by time period.

| Theory name | Count of selected papers by Rank of journals | | | | | |
|---|---|---|---|---|---|---|
| Type of journal | * | ** | *** | **** | no | Grand Total |
| A theory of rationing by waiting | | | | | 1 | 1 |
| auction theory | | | 1 | | | 1 |
| Fuzzy sets theory | 1 | | | | 1 | 2 |
| Game theory | | | 1 | 1 | | 2 |
| Graph theory | | | | | 1 | 1 |
| maximum flow theory | | | 1 | | | 1 |
| Pricing Theory | | 1 | | | | 1 |
| probability theory | | | | | 1 | 1 |
| Queuing Theory | 9 | 2 | 6 | 2 | 26 | 45 |
| learning theory | | | 1 | | | 1 |
| stakeholder theory | | 1 | | | | 1 |
| theory of self-internalization | 1 | | | | | 1 |
| transaction costs theory | | | | | 1 | 1 |
| **Grand Total** | **11** | **4** | **10** | **3** | **31** | **59** |

Table 4.33. The number of selected papers that used theory for investigating the port congestion problem against their published journal's ranking.

In congestion studies, there is a need to estimate the value of time. The time at analysis process is usually considered either part of the cost of congestion or the benefits from projects directed to relieve congestion. The queuing theory models have been considered effective methods to develop measures for the value of the time for both the shippers and the port operators (Kiani et al., 2006). They also provide the managers with a viable toolset of decision-making formulas for designing systems and services at ports (Oyatoya et al., 2011).

An efficient port operation system depends on different physical elements such as the number of Sea berths, ship traffic intensity, handling equipment, storage area capacity, and port-to-hinterland intermodal productivity.  Due to the complexity of the port operation process, port productivity can be seen from two perspectives. From the ship operators' point of view, productivity implies the time needed to serve their ships with minimum waiting time, while port operators see productivity as the number of cargoes transferred through their ports during a specific period with minimum unlocated port resources.  This conflict in the cost-benefit interest between the port operators and the ship operators was studied in several selected papers. These papers try to find a balance point between unlocated port resources, and the congestion problem surcharges. The queuing theory methods in these port congestion studies are for optimising the port's operation, resulting in minimising the overall turned around time of ships and trucks and ensuring the economic use of allocated port resources.

#### 4.5.2.2 Methods and techniques used to investigate the port congestion in the reviewed papers

Research usually reflects different methods and techniques for process improvement studies as each of these methods and techniques is customized to the necessity of the study (Klein 1994). The selected papers for this systematic review have used different methodologies to investigate the port congestion problem, where each methodology was customized to the need of each research. Overall, most of the selected papers saw quantitative assessments under both analytical and empirical research types for investigating the port congestion problem. They have been used to investigate and solve port congestion by balancing between ship turned around time and port berths unproductivity, turned around time for trucks at port gates, modelling tugboats services, investing in new quayside cranes, and increasing the efficiency of the ship to berth planning. Assessing performance and productivity using a quantitative methodology is rational for studying the relationship between earnings and expenditures to balance profits and costs. Moreover, quantitative methodologies provide the decision-makers with research-based scientific evidence in order to prevent port congestion and validate the substantial investment needed for building new facilities inside ports such as new berths, and storage areas, or buying new equipment.

A mixed-method research strategy also has been seen as a suitable research methodology for investigating the port congestion problem in the selected papers. This strategy required balancing qualitative and quantitative approaches for data collecting and analysing. The focus of the qualitative process in this integration is to deeply understand the actors that drive the dynamic or complex nature of the port congestion problem with little or sometimes no identified variables. The understanding invariably depends on the philosophical stance that knowledge about any phenomena is through the people's perceptions and experiences (Creswell 2003). On the other hand, the quantitative process depends on the findings from the qualitative analysis. It is used to investigate the main dimensions of port congestion to generate a concept, theory or congestion model from a large set of variables (congestion causes and solutions). This kind of integration between qualitative and quantitative methods strengthens and overcomes each approach's weakness and improves insights that might be unclear from using a single-method approach (Creswell and Clark 2017).

The conflicting goals -in preventing congestion at ports between reducing ships' turnaround time and the unproductivity of sea berths, minimizing trucks turned around time and the cost of increasing port gates- seem to contribute to considerable utilisation of queuing theory methods in the selected papers. Mainly, queuing models and queuing simulations are the most preferred analysis approaches used by researchers in the selected papers to investigate the relationships between the variables of the port congestion problem.

**Model's techniques.** Modelling methods have been significantly applied to the selected papers to study the parameters that could be used to minimize the overall ship turnaround time and maximize the productivity of the port operation. These methods significantly contributed to preventing the issue that rose from the seaside of congestions problem and gains savings for both port operators and shippers. Most of the reviewed literature looks to the port berthing capacity; as always, the case of port congestion and increasing the number of port berths could solve the problem. They have used these models only considering the interface between the vessel and the Sea berth. They have applied the basic concept of queuing theory to balance the cost of congestion and the cost of building new port resources. However, a few others argued that improving the efficiency of the ship to berth plans and cargo handling operation is the solution for port congestion. Furthermore, any decision to invest in new port equipment must reflect the rapid changes in cargo flows with consideration given to both expenses (the cost of building new berths and the cost of delaying ships). In this context, three selected papers have used this approach of queuing models to prevent congestion in cargo flow at the container terminal facilities to overcome congestion problems and improve performance rather than investing in new container terminal equipment.

The shortage in storage area capacity and improper stacking locations are critical bottlenecks that cause to increase in the overall ship service time and result in congestion at ports and container terminals. Tackling these bottlenecks by reducing ship service time, some selected papers have built models to see whether establishing a dry port near the port or the container terminal could solve the problem of insufficient yard capacity. While some other papers have used these models to help port operators increase and enhance the storing and stacking procedures.

Overall, selected studies that use queuing modelling approach usually consider both vessels and port facilities as the only two components which dealt with them as “Customers” and “Servers”, in such a way that represented the basic concept of the traditional Queuing theory. However, other papers used these models’ techniques without relating to the queuing theory.

**Simulation techniques.** In the reviewed Literature about the port congestion problem, there was an increased tendency, especially in the past few years, to use simulation models as an analysis technique for investing and forecasting the congestion problems in ports (Naude 2016). The simulation model’s objective is to mathematically imitate real-world scenarios to generate results that help managers with strategic decision-making (Render et al., 2006). In other words, it is a technique used to build a system or a process by using artificial data to avoid changes or investments in the real system or process until the most acceptable and satisfactory results are determined.

The complexity of relationships among the port system variables causes a dynamic management problem that made from ports a perfect candidate for simulation models (Cetin and Cerit 2010). In many selected papers, simulation scenarios have been applied to ease the congestion resulting from the interaction between the multi-model transport: railways, roads, and waterways in ports. More precisely, these papers conducted simulation models to determine the effect of the increase in ships’ traffic on the port facilities and the interface with the Three types of intermodal. Therefore, some of these papers have suggested alternatives to overcome the congestion in the railway system and truck gates. In contrast, other papers proposed a generic simulation model to predict the traffic intensity and congestion at port operation areas. In these types of papers, the conducted experiments highlighted the significance of the interaction between port operation and intermodal systems.

Other complexity of relationships among the port system variables makes the need for an accurate, rational distinction of the effect of non-structural mechanisms for improving port capacity across the entire level and without tracking all port element details (Islam and Olsen 2011). Simulation models are the perfect technique for capturing the impact of non-structural mechanisms on an explicit capacity element such as berth, storage yard, gate etc., to rationalise the established policies and actions (Ibid). In this context, the capacities of operations and services at ports are usually constrained by the limitation on berths capacity and the lack of port equipment, which lead to congestion situations most times. These constraints often make the decision-makers trading-off between cost priorities (congestion surcharges and investing in new facilities). Several papers in the reviewed literature have used simulation models to measure the impact of improving the ship to berth plans and handling cargo operations on the efficient use of port berths capacity. Also, in other selected papers, simulation models have been used to investigate the impact on the capacity of port storage areas by improving stacking and cargo location plans. Based on those studies, the simulation scenarios were conducted to help the decision-makers with their strategic plans for expanding port capacities as a solution to avoid port congestion. The results obtained from these papers have proved the growing importance of the simulation models in reducing the degree of future congestion in ports and container terminals. In fact, this effectiveness justifies the recent growth in the implementation of Simulation scenarios as a planning model tool to determine the equilibrium point between the investing cost in fixed assets and the total costs from congestion surcharges.

**Comparing both techniques.** The critical goal in both areas of research, port planning and port operations, is to prevent congestion problems by increasing the productivity of port facilities and enhancing the port operations efficiencies where simulation and modelling techniques are two primary methods conducted in most selected papers to achieve this goal. There is a difference between these two techniques in how data is collected, analysed and then drawn conclusions. The Modelling technique is an analytical mathematical approach that usually draws a conclusion driven by analysing data gathered from a particular organisation(s) to answer a specific question(s) related to system operations. The simulation technique is also an analytical approach. However, it uses a computer program (numerically) to simulate these operations based on artificial operational data conducted in an experiment to answer the research question(s). However, there are some situations where the Mathematical models cannot be used, and then the Simulation scenarios have to be applied.

As with all research methods, there are advantages and disadvantages to both techniques that need to be considered. In the selected papers, several researchers have conducted both methods and reported their conclusions about the strength and weaknesses of those techniques.

Over Simulation the mathematical modelling approach has the advantages of fast development, less data required, and easier understanding with a quicker interpretation of the model results (Alvarez et al. 2010 and Neagoe et al. 2021).

(Kiani et al. 2006) applied both techniques for investigating and analysing the port operations system to reduce port congestion and compared the results gained from both techniques. They claimed that prior to conducting the mathematical models, a simplification for the situation under investigation in readily solved form is needed, while very complicated situations can be evaluated by simulation models but with increasing research costs.

In other selected papers, Dragović et al. (2006) Argued that the simulation models are much better than the mathematical model when it came to investigating port congestion in random and complex environments, such as in the situation of container terminal congestions. This was agreed by the study (Huang et al., 2007). This research used both techniques to estimate the optimum berths number of in a container terminal to prevent congestion problems. They reported that the mathematical model tends to provide underestimated findings when vessels and quays in the system have not been considered by measures of ships' length and quays' size. It provides overestimated finding if those measures were classified.

While they reported, the results from simulation scenarios were in between those two mathematical models' results with the optimum berths' number. This came from the fact that mathematical models could only provide the researcher with fast solutions if the actual conditions for the situation under study are compatible with the model assumption. In contrast, simulation models can deal with complex situations but need to be implemented for a long-term period.

The recent high development in ships' size (Mega ships), ports' technologies, and the deep integration of Seaports in the supply chain nodes, have dramatically complicated the port operation systems on container terminals ports (Huang et al., 2007). As a result, most recent researchers rely more on queuing simulation models as a suitable analysis technique for modelling congestion problems at the container terminal. In addition, the increasing development in simulation software and the capacity of computer rams that recently happened make simulation modelling less complicated than before. Table (4.34) and figure 4.13 show that recently, researchers at the selected papers attended to begin keening more about the simulation model techniques after the mathematical models' techniques were the overall approach in the past.

Finally, although papers that conduct simulation model techniques have shown great success in investigating port congestion problems in container terminal ports, they are still more expensive and time-consuming compared to less cost, fast and flexible mathematical modelling techniques.

| Years | Modelling | Simulation |
|---|---|---|
| 1979 | 0 | 1 |
| 1985 | 1 | 0 |
| 1987 | 0 | 1 |
| 1989 | 1 | 0 |
| 1992 | 1 | 0 |
| 1999 | 1 | 0 |
| 2000 | 3 | 1 |
| 2001 | 1 | 0 |
| 2004 | 1 | 0 |
| 2005 | 1 | 1 |
| 2006 | 2 | 5 |
| 2007 | 2 | 2 |
| 2008 | 3 | 3 |
| 2009 | 2 | 0 |
| 2010 | 5 | 1 |
| 2011 | 4 | 5 |
| 2012 | 2 | 3 |
| 2013 | 4 | 5 |
| 2014 | 3 | 4 |
| 2015 | 6 | 6 |
| 2016 | 10 | 5 |
| 2017 | 6 | 6 |
| 2018 | 4 | 3 |
| 2019 | 5 | 0 |
| 2020 | 0 | 1 |
| Total | 68 | 53 |

*Missing years = no publications

Table 4.34. The number of selected papers that used modelling or simulation techniques for investigating the port congestion problem against their published years.

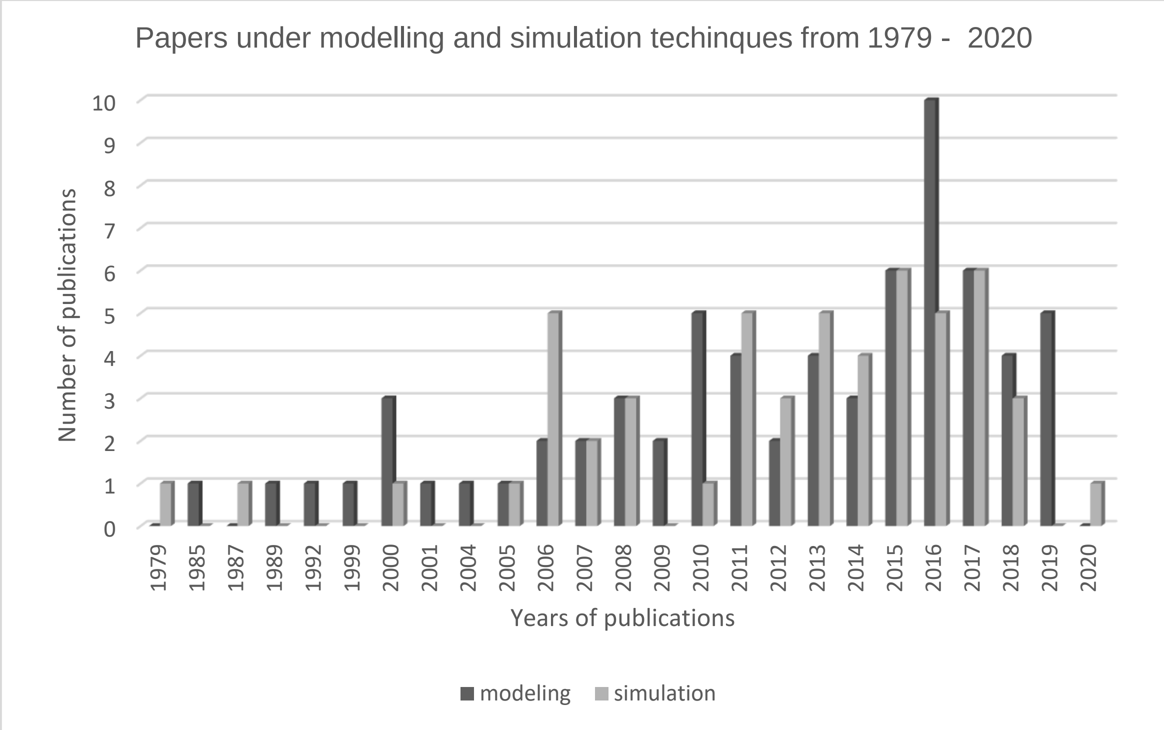



Figure 4.12. The number of selected papers that used modelling or simulation techniques for investigating the port congestion problem against their published years.

### 4.5.3. What are the common reasons that are reported to cause a congestion problem at ports in the reviewed literature?

There was a clear difference in the reported causative reasons in the reviewed literature for congestion problems at ports and container terminals around the world. However, the authors in these selected articles have implemented various theoretical ways to identify these causes and explain the solutions that should be taken to solve the port congestion problems. Most of them looked to the problem as an internal technical issue that caused the problem to happen. Moreover, they have based their identification, of these causes, on Three main technical obstacles that cause a slowdown of any organisation system (weaknesses in infrastructures, shortages in facilities, and mismanagement). While only a few others have broadened their view of the congestion problem to include other external factors such as climate obstacles and economic issues. To ease the port congestion problem classification, this review research through a synthesising process has categorised the causes of the port congestion problem, reported in the selected papers, into five analytical themes and three interpretative themes and 44 descriptive themes. This categorise process was based on the results of the research study (Eddrgash 2019). In that stage, the researcher interviewed 31 participants from the Libyan ports' stakeholders and consulted his three supervisors as an external review panel to build up a holistic picture and deep insights into the congestion problem at ports (see section 3 the methodology of this chapter). However, for synthesising the findings from these selected papers, there was a need for a new kind of categorising where these causes for port congestion problems can be better identified and described. This new categorise divided the port congestion causes into internal and external causes and then looked at these causes from both perspectives, the classifications that triggered the port congestion and the three obstacles that slow down any organisation system (see figure 4.13).

**The internal causes for port congestion:** The internal causes here are referred to issues inside the port system on the whole that causes the congestion problem to arise, whether these issues are directly related to the port itself or indirectly related to it. These indirect issues or causes could be related to the country's government systems but concerning the port system such as road systems, train networks, banking systems, internet communication systems, policies, rules, and regulations issued by the government but affect the port system. Any congestion in these systems will indirectly affect the port system and cause it to slow down and congestion situations at the port.

The efficiency and productivity of any organisation's operating system are dependent on three main factors that cause to strengthen or weaken this system. These three factors are the organisation's infrastructure, facilities, and management. Therefore, this can be applied to any port organisation system where any weakness in the port infrastructure, such as insufficient port berths or low-depth port channels, will cause to slow down its operating system and create congestion. Also, any shortages in port facilities, such as not enough tugboats or quayside cranes, will eventually cause it to reduce its services operations and delay ships at its berths.

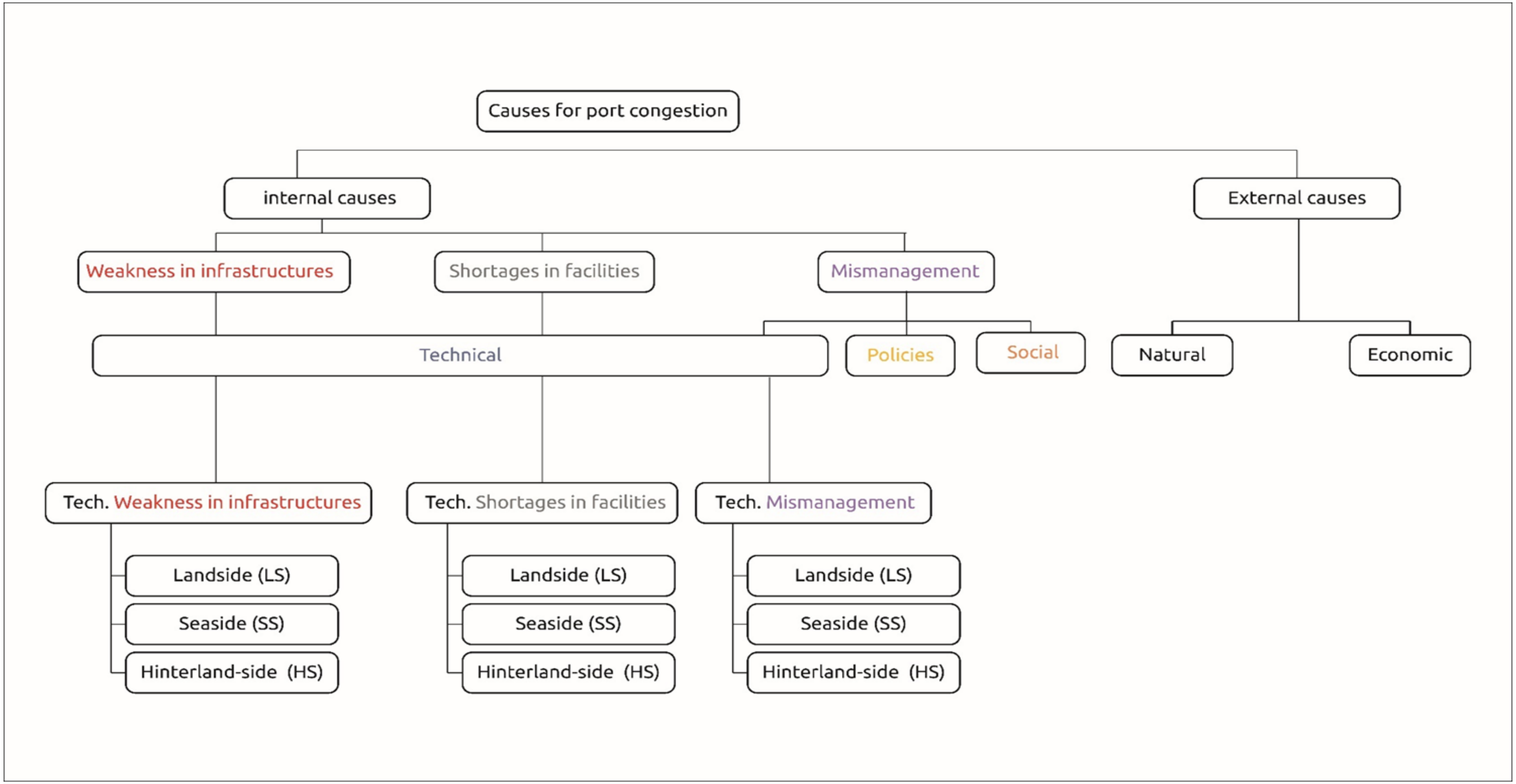



Figure 4.13. Causes of port congestion problem according to the thematic categories.

Also, any mismanagement of those infrastructures or those facilities such as poor maintenance for quayside facilities or inefficient berth plans, even though there was no weakness or shortage in both berths and cranes, will finally result in a situation of port congestion. Thus, as shown in figure 4.14, the congestion problem at ports will be a situation arising from issues in one or maybe two or could be the three categories together of the weakness in infrastructure, shortages in facilities and mismanagement. Furthermore, to reduce the congestion problem at ports or prevent congestion in port operations and management, the three categories should strengthen efficiencies. However, these three categories could also be related to three other categories (out of five) based on the classifications that triggered the port congestion.

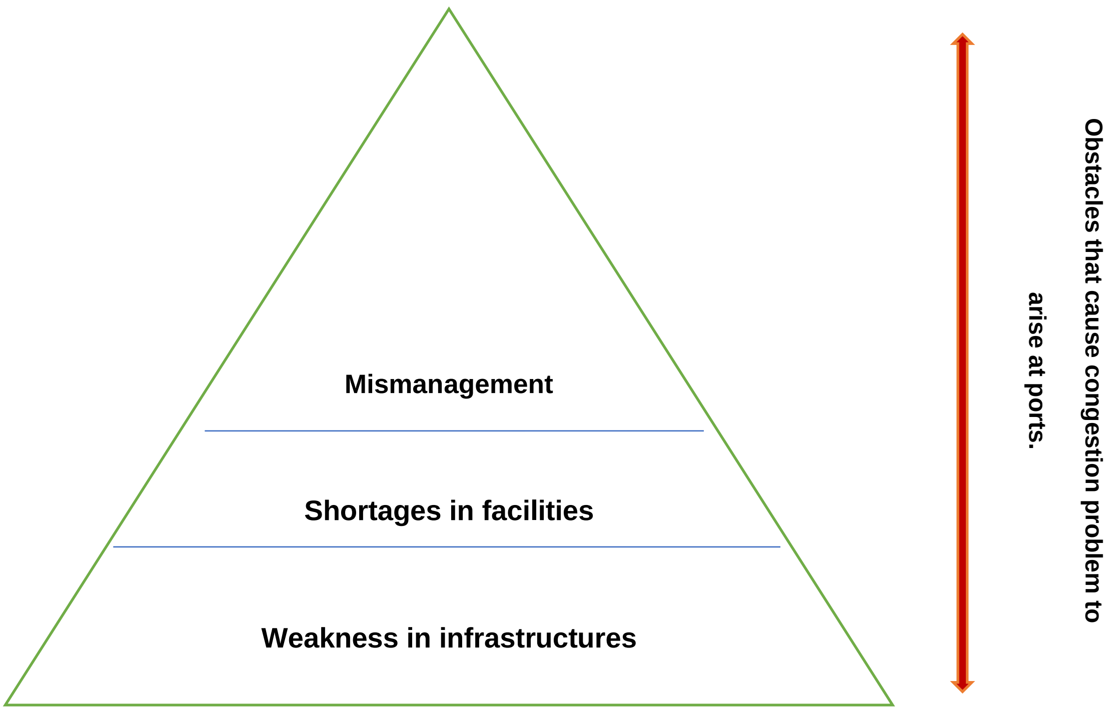



Figure 4.14. Causes of port congestion problems according to the causes for slowing down the operating system at any organisation.

These three classifications are the technical causes, policy causes, and port congestion's social causes. In this context, Mismanagement could be related to social causes such as “strikes” or to policy causes such as “centralism and monopolism” in managing ports or governing institutions as a whole. Also, it could be related to technical causes of landside congestion such as “congested port ways” or technical causes of seaside congestion such as “inefficient ship to berth plans” or under hinterland-side congestion such as “lack of information exchange between exports and hauliers”. However, weakness in infrastructures and shortages in facilities could only be related to technical causes classifications under the three types of port congestion landside, seaside, and hinterland-side port congestion (see figures 4.14 and 4.15).

**The external causes of port congestion:** These external causes refer to the issues that cause the port congestion problem to happen due to uncertainty in the maritime industry. This uncertainty could be seen in environmental and behavioural uncertainty (Saeed et al., 2018). Environmental uncertainty is usually caused by natural effects such as weather conditions, tides, and floods in the maritime sector. In contrast, behavioural uncertainty in the maritime industry is represented by a sudden increase in cargo volumes due to economic reasons such as increasing international trade, an increase in local demand, concentrated cargo traffic on specific ports or seasonality. Thus, natural causes and economic causes are the external causes of the port system that might cause port congestion situations to arise at ports (see Figures 4.14 and 4.15).

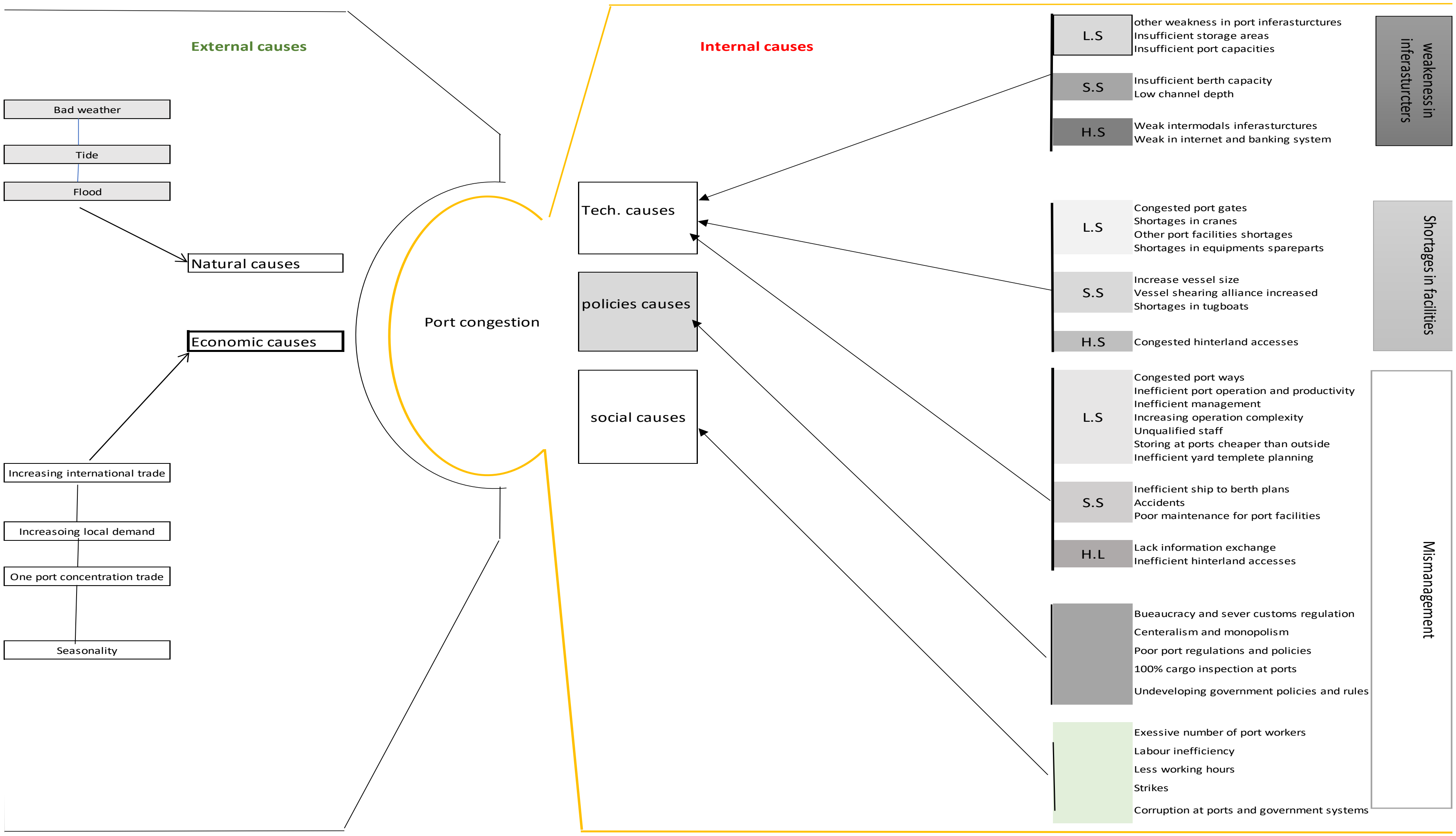



Figure 4.15. Final causes for the port congestion problem according to the discussed thematic categories.

### 4.5.4. Common solutions that were suggested to solve the congestion problems at ports in the reviewed literature?

According to the analysis, most solutions suggested by the reviewed literature were proposed to solve the internal causes of the port congestion problem. It is also clear that most of these reviewed papers looked at the congestion problem as an issue in managing and operating the ports. They suggested their solutions based on that, while there was less concentration on solutions for solving the issues arising from weak infrastructures and shortages in facilities. This might be related to the fact that most world ports that suffer from congestion are neither because of Inadequate development in their infrastructures nor shortages in their facilities. But due to inefficient management from the port operators and poor port policies and regulations issued by the country's government itself. Thus, to reduce and prevent port congestion problems, organisations such as port operators, shipping lines, and governments need to work together to efficiently solve the raised port congestion and issues.

Table 4.35 is a developed form of table 4.30 where the solutions have been assigned according to the type of organisation's role. From this table, around 69% of the management solution should be done by the port operators, while 20% of these solutions are government roles. Of course, this depends on the type of port governing model where the percentages of government role will increase at the port public model type and consequently decrease at full private model ports. Also, the management solutions that have to be adopted by shipping lines are accounted for 21% of the total management solutions.

The above figures wholly changed when it comes to the solutions for improving the weak infrastructures, where a significant percentage of 87% has emphasised the role of the government against only 16% for the port operators. However, the solutions for shortages in facilities are 100% in the role of port operators, though it is still dependent on the port model type of governance and management.

| Theme | Type of solution | Count | Role of solution | | |
|---|---|---|---|---|---|
| | | | Port operators | Shipping lines/shippers | Government |
| Management Solutions | Improving cargo stacking plans | 46 | x | | |
| | Improving ship to berth plans | 43 | x | | |
| | Improving handling operation efficiency | 44 | x | x | |
| | Implementing the truck appointment system (TAS) to reduce the truck turnaround time and port gate congestion | 29 | x | | |
| | Upgrading and developing port rules and Tariff policies | 19 | | | x |
| | Automated gate services via information technology (IT) systems or webpages | 10 | x | | |
| | Increasing port operation efficiency | 8 | x | | |
| | Easiness of the 100% scanning regime by a rapid primary scan of all containers followed by a more careful secondary scan of only a few containers that fail the primary test | 7 | | | x |
| | Extending the gate hours | 8 | x | | |
| | Involving the private sector in operating and managing ports | 6 | | | x |
| | Recruit qualified and experienced people | 5 | x | | x |
| | Training port staff | 5 | x | | |
| | Regulations modified to reduce cargo dwell time through punitive measures and persuasions on shippers to take delivery in good time | 5 | | | x |
| | Improving port management efficiency | 5 | x | | |
| | Implementing congestion tolls on trucks can be used for shifting the daily demand for truck trips to the off-peak time window by use of pricing | 4 | | | x |
| | Ship-to-ship containers transfer in the open sea as an alternative way to avoid port congestion and increase port efficiency | 4 | x | x | |
| | Establishing good coordination between port operators and shippers by introducing an IT system for information flow among them | 4 | x | x | |
| | Improving the layout of the vehicle guide path between the quayside and the stack side | 4 | x | | |
| | Freight volume forecasting and detecting workload peaks and congestion in the inspection process of seaports and providing relevant information for decision-making and resource planning. | 3 | x | | x |
| | Improving ships' traffic plans through waterways and channels to reduce their waiting time and ensure safe routing. | 3 | | x | x |
| | Implementing the VDTW (called vessel-dependent time windows) method where the truckers delivering outbound containers for the same vessel have to follow a specific time window of arrivals | 3 | x | x | |
| | Deregulate the port labour system | 2 | | | x |
| | Good development of ports with an interface to the transport modes with better integration of these modes with each other at the land end | 2 | | | x |
| | Short Sea Shipping (SSS) as an alternative and efficient option for transporting cargo between ports | 2 | | x | x |
| | Implementing congestion tolls can be rationally altered and consequently disperse container ships' arrival times at the destination port as well as eliminate or decrease container ships' queuing times for port entry | 2 | x | | |
| | Increasing working hours for port customs | 2 | | | x |
| | Decentralisation of the management at ports | 1 | x | | x |
| | Implementing the Chassis Exchange Terminal (CET) to avoid extra crane handling by putting containers on a chassis and applying a chassis pool to reduce truck congestion at seaport container terminals and to improve truck efficiency in trips to these terminals | 1 | x | | |
| | Implementing truck-sharing service (TSS) to reduce the number of empty trips to improve the system-wide transport capacity along with bringing environmental benefits by reducing traffic congestion and air pollution around the port gates and the surrounding city. | 1 | x | x | |
| | Empty container reuse to reduce the number of truck trips to and from the container terminals | 1 | x | x | |
| | Shifting customs' responsibilities to others in the Logistic supply chain | 1 | | | x |
| | Involving the private sector in investing in hinterland intermodal | 1 | | | X |
| | Total - Percentages | 278 | 47 % | 18 % | 35 % |

Table 4.35. Port operators, shipping lines and the government's role in each solution for the port congestion problem.

| themes | Type of solution | Count | Role of solution | | |
|---|---|---|---|---|---|
| | | | Port operators | Shipping lines/shippers | governments |
| Infrastructures' solutions | **'Increasing port capacities** | 22 | | | **x** |
| | **Improving the infrastructures for the hinterland intermodal** | 17 | | | **x** |
| | **Improving port infrastructures** | 12 | | | **x** |
| | **Increasing the number of port gates** | 9 | **x** | | |
| | **Increasing port area capacities by establishing dry ports** | 7 | | | **x** |
| | **Increasing port berths capacity.** | 1 | **x** | | **x** |
| | **Investing in new access routes to the port** | 1 | | | **x** |
| | **Increasing port area capacities by establishing sub-hub ports to support the hub port.** | 1 | | | **x** |
| | **Total/percentages** | **70** | **22 %** | **0** | **78 %** |
| Facilities solutions | **Investing in high-tech port equipment** | 19 | **x** | | |
| | **The rubber-tyred gantry crane (RTG) system is the most desirable yard operating system among others for fast operating and eliminates the problem of port congestion.** | 1 | **x** | | |
| | **Total/percentages** | **20** | **100 %** | | |
| External solutions | **Adopting policies and strategies that could encourage shippers to use all country's ports instead of concentrating the traffic on one port** | 6 | | | **x** |
| | **Freight volume forecasting and detecting workload peaks and congestion in the inspection process of seaports provide relevant information for decision-making and resource planning.** | 3 | **x** | | **x** |
| | **Total/ percentages** | **9** | **33 %** | | **66 %** |

Table 4.35. Cont. Port operators, shipping lines and the government's role against each solution for the port congestion problem.

All the above numbers are figures for solutions that suggested solving the internal causes of port congestion, whether triggered by technical, social, or policy issues. However, solutions for solving the natural or/and economic classifications causes as external causes were not clearly indicated in the reviewed literature.

Two solutions can be considered to solve the external economic cause: “Adopting policies and strategies that could encourage shippers to use all country's ports instead of concentrating the traffic on one port”. Also, the “freight volume-forecasting and detecting workload peaks and congestion in the inspection process of seaports and provides relevant information for decision-making and resource planning” for solving seasonality and the increase in international trade and the local market demand. Both solutions were indicated in the reviewed literature with a 33% share of port operators’ role and a 60% share of the government's role in solutions. In contrast, the natural causes as external reasons for the port congestion problem remain with no suggested solutions in the reviewed literature. This might be because these subjects need to target another area of the field, subject literature.

## 4.6. Summary

This chapter sought to discover whether the eight Superordinate reasons and Subordinate reasons identified in Eddrgash (2019) cause and influence the problem of congestion at world ports. Furthermore, if so, what is the existing evidence in the previous literature that informs and exerts the strongest influence? For this purpose, a systematic literature review method, where the evidence-based research framework developed by Gough et al. (2012), was used. The review process investigates the common theoretical classifications triggering the port congestion problem and categorises the traits that can stimulate and cause the port congestion problem in most of the world's ports. These causes will be used as a list variable in the next chapter (chapter. 5) to find the common factors behind port congestion problems at ports.

In this context, a search process in the most famous search engines in the operations and management field was used to search for literature about the port congestion problem. Then, inclusion and exclusion criteria followed by an appraisal technique were used to select only the papers that serve the aim of this research and could answer the four research questions that were established in the early stage of this systematic review research. The findings and results revealed that while the academic interest in the port congestion problem was established quite early (in 1961), the focus on the problem remained scarce until 2000. Moreover, the last two decades have witnessed an increase in academic interest in the port congestion problem, translating to more paper publications. Moreover, this increased interest was due to the increase in world port congestion problems, especially in the USA and chain ports.

The results also indicated a clear variation in how scholars in the selected papers have defined the port congestion problem where no consensus on a definition set has been established for it. This variation in defining the problem emerges from the fact that the causes of the port congestion problem in ports are complicated and multi-dimensional. They also differ from one country to another and even from port to port.

The results also revealed that most of the reviewed publications had used a quantitative methodology under both analytical and empirical types of research design. The finding also consented to the argument that most of the field research considers the field of operations and management as a discipline lacking a theoretical foundation. It mainly addresses practical problems as about two-thirds of the selected papers for this review research have not based their research on a theory base. However, they instead investigate the problem of port congestion from a practical perspective. The most applied theory that the other third used was the queuing theory which was used to find the balance between the cost of investing in a new asset and the cost of port congestion surcharges. Also, modelling and simulation techniques were the most analysed methods used in the reviewed literature. This could be due to their greater advantages in forecasting and simulating the relationships between the causes of port congestion problems as investigating variables.

The results also indicated the most prevalent causes of port congestion which have been reported in the reviewed literature. These causes were divided into internal and external, categorised under five classifications that triggered the problem to arise and related to the three obstacles that caused the operating system to slow down. Also, the solutions for those causes, as suggested by the reviewed papers, have been categorised and related to the system slow-down categories. The revealed results suggested that the port congestion problem is highly related to management issues parallel with weak infrastructures and shortages in facilities. Therefore, improving the infrastructure and investing in new facilities are needed. However, more concentration on enhancing and increasing the efficiency of port management, port policies and the government regulation system is highly suggested.

# Chapter Five: Online survey for identifying the common factors behind the port congestion problem

## 5.1. Introduction:

In this chapter, an online survey was carried out to identify the common factors of port congestion problems at seaports. This identification was based on the theoretical, conceptual framework developed early in the (Eddrgash 2019), and on the port, congestion causes identified and yielded from the systematic literature review method (chapter 4). An online questionnaire was built, distributed, and analysed to obtain and model the common factors behind the problem. This chapter first provides a detailed account of the survey methodology that the researcher has employed in this study. Then it presents the research findings, discusses the results, and concludes with the study conclusion and remarks.

## 5.2. Online Questionnaire as a survey method

The questionnaire is one of the most widely used study tools in operations and management research fields. Each participant must answer the same group of questions correctly before a quantitative analysis can be conducted (Saunders et al., 2012). In other words, it is a list of tested and then chosen structured questions that are used to seek reliable answers from a selected population sample to investigate a phenomenon through their perception and experiences (Collis and Hussy 2009). The employment of the questionnaire is popular due to its fast gathering of extensive data in a short time using low-cost techniques (Saunders et al., 2009). It also enables answering questions without the potential bias from the researcher (Bryman and Bell 2007).

Recently, there was a significant development in how the questionnaire is utilised, designed, distributed, and analysed. One of these questionnaire development techniques is the online questionnaire or the online survey (Evan and Mathur 2005). According to Bryman and Bell (2007), online questionnaires have become increasingly attractive to business researchers, especially management research studies. Online questionnaires have a lot of advantages and strengths that explain the increase in using them in research. Table 5.1 summarises some of these strengths.

| The method Strength | Explaining why | References |
|---|---|---|
| **Flexibility** | • Can be distributed and conducted in several ways such as send it with email or just send the link with the email or invitation link in webpages or social media.<br>• Easy toleration for respondents' demographics such as languages by producing multiple versions of questions. | Schonlau et al. 2002<br><br>Ilieva et al. 2002<br><br>Bryman and Bell 2011 |
| **Fast time process** | • Less and efficient time for administration.<br>• Enables for real-time access for interactions with participants in different geographical locations. | Kannan et al. 1998 |
| **Convenience** | • Allows the participants to response at a time that convenient to them. | Hogg 2003<br>Mullarkey 2004 |
| **Very ease for both gathering and analysis of data** | • Easy for tabulating and analysing the responses. | Wilson and Laskey 2003 |
| **Diversity of questions** | • Enables for various types of questions such as multi-choice, scale, single response, and other type of questions. | Evans and Mathur 2005 |
| **Less expensive and smooth for following** | • Low cost and less expensive due to free or cheap survey software, no postage cost, and easy for following up to increase responses rate by simply send reminder emails. | Schaerfer and Dillman 1998.<br>Sheehan and McMillan 1999.<br>Jackson 2003. |
| **Large data sample in easy way** | • Enables for producing large data due to the access to global databases and the low cost for administrating it. | Parker 1992.<br><br>Schaefer and Dillman 1998 |
| **No missing data as it requires the completion of all questions** | • It can be designed to eliminate non-response items or to prevent entering incorrect answers.<br>• It can be designed in a certain logic that prevent the participant from proceeding to next question before completing the previous one. | Ilieva et al. 2002 |

Source: The Author

Table 5.1. Online survey major strengths

## 5.3. Questionnaire development process for online survey

The process of developing a questionnaire is usually based on the type of information that the researcher seeks to obtain, and more attention is given to the research hypotheses (Baruch and Holtom 2008; saunders et al. 2012). The collection process for this study data was based on the survey respondents' perceptions and experiences in relation to the research topic (the causes of port congestion problems at seaports). Therefore, good question design principles have been employed in the questions' development process, where only non-lengthy positive questions that all participants can answer are used in the questionnaire avoiding asking leading questions (Cooper and Schindler 2001). Also, the content of the questionnaire must be kept simple and comprehended for the readers to enable the accomplishment of the survey questionnaire.

### 5.3.1. Designing the questionnaire

According to Saunders et al. 2009, the questionnaire design and structure significantly impact the rate of response, validity, and reliability of the gathered data. Consequently, a more significant effort must be given to design a questionnaire that enables complete and accurate data to be gathered. This can only be true when the researcher is aware of what and how the questions should be asked to measure the participants' perceptions and gain the information that answers the study questions and objectives (Bryman and bell 2007). So, in order to increase the responses' rates, enhance the validity, and strengthen the reliability, the researcher should focus on a careful design and layout for the questions, explaining very well the purpose of the survey, and carry out pilot testing for the questionnaire before the final distribution (Saunders et al. 2012). Thus, in this PhD study, a greater effort has been made to develop this survey questionnaire and choose the suitable constructs measures for gathering the data to satisfy the aims and objectives of this PhD research.

The questionnaire of this study came in ten pages (size A4) in the final version of its design. It included a front letter and a thank you page at the end. The front covering latter was for explaining the research target and guaranteeing the security and confidentiality of the collected data. It also indicated that the study is seeking to identify the causes of the port congestion problem through the respondents' perceptions and experiences. It also confirmed that participation in this survey is entirely voluntary, and the respondent has the full right to withdraw from the survey at any time. Moreover, it asked that the respondent should be at the manager level to participate in this survey. Finally, it gives the full contact details of the researcher of this study, just in case anyone from the participants seeks more information.

The questionnaire of this survey research included two parts. The first part covers the respondents' demographic information, such as gender, age, level of education, organization type that they work at, managerial level, working area, and years of experience. The second part was divided into two sections. In the first one, the respondents were asked to select a proper definition for the port congestion problem to measure and reach a consensus amongst the industry experts on defining it. In the second section, the respondents had to respond to a list of statements describing the reasons behind port congestion problems at ports with a Likert scale of seven points.

The questions and the categories in this survey have been designed to motivate the participants to respond and complete all the questions of the questionnaire. Moreover, the researcher made a great effort to keep the survey questions straightforward and easy to read to ensure comprehension of the questions and avoid any misunderstanding, which gives a greater chance of completing the survey. See Appendix (F) for more details about the survey questionnaire.

**Question type and question format in the survey questionnaire.**

In social sciences, two main types of questions (open-ended and close-ended) are commonly employed in survey questionnaires (Collis and Hussy 2009; Saunders 2012). The open-ended structured question has a good advantage as it allows the participants to draw their perceptions in their own words; however, it is considered a difficult way of a question when it comes to analysing the collected data (Collis and Hussey 2003). With closed-ended structured questions, permitting grouping from predetermined answers is more convenient and accessible for both processes of collecting and analysing factual data, and it is widely used in the positivist paradigms (Collis and Hussy 2009). This is a result of the fact that comparing the participants' responses is easier with the predetermined answers in closed-end questions than open answers in open-ended structured questions (Saunders et al., 2012). Moreover, the close-ended questions encourage and increase the response rate as they are associated with the way that the participants' responses to survey questions are based on their predisposition and mentality (Alreck and Settle 1995).

In this PhD survey research, the survey questions seek to identify the participants' perceptions and experiences about the definition and the reasons behind the congestion problems at seaports. Thus, the researcher used closed-ended questions to maintain the context of the questions same for all participants. Also, the researcher associated closed-ended questions with scaled-response or multi-choice-response formats depending on the question's nature to encourage more participation, increase the response rate, and avoid any response bias. However, only a few open-ended questions have been used in the form of "others, please specify." at the end of some Demographical questions in part one.

A common use rating scale in questionnaires is the Likert style due to its measurement features to indicate the participants' degree of agreement or disagreement on constructed statements (Saunders et al., 2012). This rating scale is usually based on four to seven-point rating scales (Ibid). In this PhD survey research, a seven-point Likert scale has been employed in all rating questions to ensure uniformity in recording the managers' perceptions. The advantages of this type of point Likert scale are that it allows for more discriminating responses (Sierles 2003) and helps gain manageable data for analysing by more advanced parametric and multivariate statistical analysis (Collis and Hussey 2003). In addition, questions of multi-choice answers have been used to prioritise items to allow the researcher to cross-check and compare both results (the Likert scale and the multichoice).

**Questionnaire layout**

To obtain a significant response rate from any questionnaire, the researcher should place a greater focus on the questionnaire layout. A proper questionnaire layout is fundamental to decreasing the non-responses and eliminating response errors (Dilman 2007). Moreover, yielding a great response rate for a questionnaire design does not depend only on the questions' construction but also came as a result of other important things such as the general looking of the questionnaire, explicit and lucid instructions, and the facilitation and the orders of the questions

(Saunders et al. 2009). Finally, the questionnaire length is critical as long ones tend to have less response rate (Churchill and Iacobucci 2002).

In online surveys, the interviewer's absence might cause a lack of guidance for the respondents on how to answer the survey questions (Couper et al. 2001). Thus, more focus should be placed on the questionnaire layout to overcome the interviewer's absence. One of the online surveys advantages is the variety of features and design tools that the online survey software packages have, such as colours, text, size, and order logic for questions (Evans and Mathur 2005). Using these layout instruments and features, the researcher can guide the participants from the cover page through the questions using both verbal interface elements like question-wording or/and visual such as fonts, colours, images, and graphs (Couper et al. 2001; Dillman 2007).

Software packages for Online surveys such as Qualtrics, Survey Monkey, and others are facilitated with a set of style templates for survey forms, page designs, colours, and typefaces that can help researchers produce fast, attractive, and professional appearance questionnaires (Saunders et al.2012). The questionnaire for this PhD research was generated, hosted, and distributed by means of the Qualtrics online survey website at (www.qualtrics.com). This online survey website provides the user with some of the functionalities' keys in addition to its layout instruments. Some of these functionalities' keys help the user automatically generate the survey panels, give scores for each survey respondent, and manage the distribution emails of the survey. Qualtrics also allows the user to track the response rate and actual time spent by each respondent to finish the survey. Furthermore, the data collected can be easily exported to Excel or SPSS analysis software packages for proper descriptive and statistical analysis.

The questionnaire was divided into four primary constructs. The first one concerned demographical information. In comparison, the other three parts included the measurement scales of this PhD survey research and involved 50 observed items (See Appendices F & G). These items are as follows: 6 items to reach a consensus amongst the industry experts on defining port congestion; 36 items to identify the internal causes of port congestion problem; 8 items for identifying the external causes of port congestion problem (more details on this, please see the section of measurement scales).

A user-friendly design was used for this PhD survey, where a matrix shape style for all the rating questions has been designed to save space (Saunders et al. 2012) and shorten the questionnaire as much as possible. Also, a format grid line has been employed to help the reader follow the questions quickly and easily. The Cardiff university logo was placed on all the questionnaire pages to give the official appearance to the survey. Moreover, significant attention was placed on the design of the survey cover letter to maximise the response rate and reduce the response error (Dillman 2007). The cover letter was designed to attract and quickly pick up the participant's interest. This was done by adding the title and the objectives of the study to the cover letter. Also, it included the type of sample that the researcher needs to participate in, and the survey filling time. In addition, it explicitly included a statement that ensured all information gained from the respondents would be dealt with in a highly confidential and anonymous manner. Moreover, the contact details for the researcher have been given in case any of the respondents need more information.  Finally, the survey was distributed electronically online through emails to global network contacts related to seaport activities (port stockholders).

**Questions order and flow in the questionnaire**.

The questions' order and the questions' flow are vital keys in the questionnaire layout as they might increase/decrease the response rate. Saunders et al. (2012) argue that the flow through questions should be according to the respondent's logic rather than ordered on the data requirement base. To achieve this target, the survey questionnaire should begin with the most straightforward question and according to what has already been explained to the participants on the cover page (Dilman 2007). Therefore, the questionnaire of this PhD study started with the demographic questions as they are the easiest and the simplest ones in the questionnaire. Then it was followed by the port congestion definition style of questions to measure the consensus amongst the industry experts on defining the port congestion phenomenon. Finally, questions about identifying the cause of the port congestion problem were left until the end of the questionnaire. All questions' wording was kept as simple as possible, and their answers were just by a rating scale. This type of logical order and question flow made the survey an easy task to be accomplished for the participants (Dilman 2007).

### 5.3.2. Coding, cleaning, and data entering.

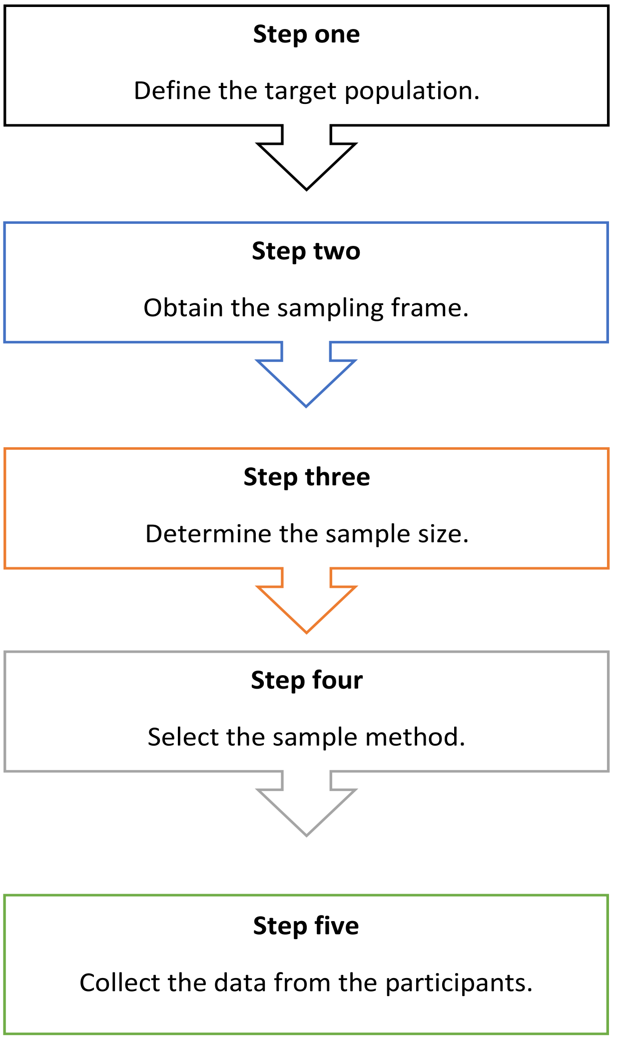
Before conducting any software packages to analyse the collected data, the researcher needs to code and clean any missing data before entering it as input data. According to Saunders et al. (2009), this process involves translating information collected from the questionnaire into numbers or/and letters. Furthermore, a guide for this process should be established prior to this translation. They also argue that the researcher might use the actual numbers that came from answering some of these questions as codes while he/she should design a coding scheme to code the information gained from other questions. Once the coding process is finished, it is easy to record the data from the coding sheet to the analysing software. Nevertheless, this process might seem easy; however, errors and mistakes in transferring data can still happen. So, to overcome this type of issue, data must be double-checked before and during the data entry into the analysing software, especially if the survey has a large number of participants.

#### 5.3.2.1 Sampling strategy.

The strategy for sampling and processing data was under extensive discussion in the social sciences field of research. This discussion normally involves the processes of how to define the target population, how the research could obtain the sample frame, determine the size of the target sample, and the selection of the most suitable sampling technique (Churchill and Iacobucci 2002; Malhorta and Birks 2007; Saunders 2012). For the objective of this study, five steps have been taken to help with deciding the most proper sampling strategy (figure 5.1).

#### 5.3.2.2 Define the target population.

According to Bryman and Bell (2011, p. 176), the target population can be defined as “the universe of units from which the sample is to be selected”. It is also an indication of a group of individuals or a gathering of items under the concern of study purpose (Collis and Hussey 2014). Since this survey research aims to generalize the conclusions about the causes of port congestion, the researcher's focus was to gather data that can represent the whole target population by choosing a necessary logical population and data sampling for this research study.




Source: Adapted from (Churchill and Iacobucci 2002; Malhorta and Birks 2007; Saunders 2012)

Figure 5.1. Main steps of the sampling strategy process.

An appropriate selecting sample can sufficiently represent the characteristics of the population (Mason 2010). Moreover, obtaining an adequate sample size and accurate data that serve the study objective needs to target an accurate population of stakeholders (survey respondents) (Ibid). According to Freeman (2001), stakeholders refer, in general, to individual/s, organisations or systems that is/are influenced, impacted, or affected by the actions of policies or organisations.

#### 5.3.2.3 Seaport stakeholders

According to the above discussion and seeking these PhD research objectives, this survey study targeted the seaport stakeholders from different managerial levels of global seaports and maritime networks. These stakeholders usually are port actors or port users such as Port operators' companies, Port authorities' entities, ship owners, shippers (traders), shipping lines' agencies, customs government institutions, cargo clearance agencies, government maritime administration (such as port states and ministries).

Seaport operators play a focal role in enhancing the efficiency and productivity of a seaport as they are the main provider of services to the port users. Most port operators tend to increase their productivity level by attracting new vessels without putting more investment in increasing port facilities' capacities, which might eventually lead to congesting their ports and increasing ships' turnaround times (Besleovnik 2008; Imai et al. 2008). Thus, they can be considered as one of the important populations that should be included in this survey study to identify the causes of port congestion problems.

Companies of shipping lines and vessel owners and their port representatives (shipping agencies) generally measure the performance of ports and container terminals based on various important key parameters. One of these important key parameters is the turnaround time for their vessels at ports as they always look to minimise the time that their ships spent to be served at ports and usually try to avoid congested ports (Chang et al., 2008). This makes those individuals working at the management level at these three organisations (shipping lines, ships' owners, and shipping agencies) important stakeholders to be considered in this survey.

Additionally, the Port Authority and the port state were considered important port stakeholders due to their regulatory role over seaports and container terminals. Depending on the port control model (public port, tool port, landlord port, or private port), they are the authorized entity for implementing local government rules and international conventions. Thus, including various managerial levels from those, entities as port stakeholders are very important to this PhD research as they seek to eliminate port congestion situations at their ports. Similarly, the representatives from the government ministry that controls ports and has the role of decision-makers in the ports sector were considered important port stakeholders to be included in this survey. This is because they should be interested in developing such solutions and policies that help them regarding the congestion problems at their countries' ports (Perssonm 2008; Gidado 2015: Carballo et al. 2016).

Customs entities and private customs clearance agencies have been considered among the port stakeholders in this survey. This results from considering them among the important actors responsible for port cargo flow processes. Their efficiency and performance influence and impact the port operation productivity and, in most situations, are the direct cause of port congestion problems (Onyemejor 2015; Alhameedi et al. 2018).

Finally, this survey targeted shippers, traders, and cargo owners and considered port stakeholders as they usually seek and are interested in having their cargo flow through ports efficiently. Furthermore, they attempt to avoid importing or exporting via congested ports as much as they can.

All the above port stakeholders were targeted as population samples for this survey to obtain their perceptions and experiences towered the causes of port congestion problems.

#### 5.3.2.4 Sampling frames

It is a list of population elements that will be used to draw the target sample (Bryman and Bell 2007; Collis and Hussey 2009). Employing an accurate and comprehensive list of the population is essential for having representative samples (Churchill and Iacobucci 2002). This survey study selected a frame list of participants at different managerial levels from port users and actors (the seaport stakeholders discussed above) to draw the survey sample based on three reasons. Firstly, because managers are the most familiar element of port stakeholders with port issues and port problems, they are the ones that have enough knowledge and good experience about the port activities. Therefore, there is no need to explain the used terminology or any other commonly known port issues in the survey wording and languages. The second reason is related to their decision-making authority, so it would be easy and quick for them to participate in this survey and freely give any relevant information that might add value to this study. The third reason is that, among others, they hold the position and share the responsibility for the inefficient performance of their organisations. Consequently, they will be the ones whom the port congestion situations will impact.

#### 5.3.2.5 Sampling technique

The sampling technique in positivist studies is a fundamental element for gathering information about the population (Hussey and Hussey 1997). Thus, the sampling technique that provides a more excellent way of selecting a well-represented sample will lead to more study outcomes that can be generalised to the research population (Bryman and Bell 2011).

Probability and non-probability are the two main types of sampling techniques available and can be used in social studies (Saunders et al., 2012). The probability technique is fundamentally based upon selection bias, where each population of the total sample has a known probability of being chosen, which reduces the error degree to the minimum (Bryman and Bell 2011). In addition, the probability sampling technique is widely used by experimental studies that used random sampling as a fundamental way of probability sampling (Collis and Hussey 2003).

The sampling technique of non-probability (non-random form), usually used in the exploration of some studies and survey questionnaires, provides a diversity of alternative ways based on subjective opinion (Saunders et al., 2009). Although this type of sampling technique has limited results' generalisation, it still can allow for generalising the findings when a large sample size is implemented, and the likelihood of generalised errors has a shallow occurrence (Bryman and Bell 2011; Saunders et al. 2012).

**The use of a non-probability sampling technique in this research.** In this survey research, the researcher used two non-probability sampling techniques: purposive sample type and snowball sampling type. This choice was due to the difficulty of acquiring access to the global port sector organizations (port stakeholders worldwide). **In the purposive sampling technique**, respondents are chosen based on their experience and knowledge of the research topic (Saunders et al., 2012). This particularity made this type of sampling the most effective one in research studies (Welman et al., 2005). While **the snowball sampling technique** is used to increase the sample size by asking one or more respondents to nominate other participants that are willing to participate, and might be useful for adding value to the research (Saunders et al., 2012).

In this survey study, the purposive sample was selected based on criterion guidance (see the section on seaport stakeholders and the section on sampling frame) from port stakeholders worldwide who positively participated and wholly finished all the survey questions. At the same time, the snowball sampling technique was employed after identifying new members that were suggested and recommended by respondents from the purposive sample. These two sampling techniques are believed to enhance the survey's response rate as other techniques might not yield the same rate of response.

#### 5.3.2.6 Sample size

One of the essential key roles in all statistical analyses is the size of the sample under investigation. The calculation for the sample size is usually determined by the undertaken type of analysis, the required level of certainty, the available population size, and a reasonable margin of error (Saunders et al., 2012). Also, according to Luck and Rubin (1987), the highly sophisticated the statistical analysis, the greater large of size the sample needed. This is due to the use of a large size sample that helps to overcome and decrease the margin of errors and increase the sample validity for generating good generalisation, which comes as a consequence of their representation of a larger proportion of the population (Sekaran 2003).

Thus, the calculation for the sample size required to analyse this survey data was based on the survey analysis technique, the Exploratory factor analysis (EFA). The obtained factors may not be able for good generalisation if they are gained from a small sample size compared to a large one (Pallant 2016). According to Hair et al. (2010), the size of the data sample must be greater than the variables. In this context, Pallant (2016, p.184) pointed out a different statistician's view around this point (see table 5.2.), and he suggested a sample size of 300 be safe for EFA analysis. In the light of the previous discussion and based on the rule of thumb (Hair et al. 2010), the researcher's main concern was to gather at least 220 respondents to represent the total population of this survey. Expecting a very moderate responses rate, (25%) questionnaires were dispersed to respondents hopefully to gain the required size of the survey sample.

| Sample size for EFA | Source |
| --- | --- |
| Minimum 300 respondents, or a minimum of 150 respondents if the solution provides factor loading above 0.80. | Tabachnick and Fidell (2007) |
| 100 respondents as a poor sample size, 300 as good and 1000 as excellent | Comrey and Lee (1992) |
| Sample size can be ignored if a factor has 4 or more loadings >0.6; sample size > 150 if 10 or more loadings >0.40; sample size should be more than 300 if there are few low loadings not interpreted. | Guadagnoli and Velicer (1988). |
| Respondents should be 10 times as many as the variables. | Nunnally (1978) |

Adapted from Pallant (2016, p. 184 and Field (2018, p. 797).

Table 5.2. Sample size suggested for Exploratory Factor Analysis.

### 5.3.3. Measurement Scales

Since measurement scales and instrument items are critically important for the survey's estimates accuracy, Saunders et al. (2012) advised that the researcher, for efficiency reasons, should use the validation instrument that is already available in the literature, if it exists rather than developing a new one. However, in this study, the researcher needed to develop a new measurement scale for the causes of port congestion problems due to the lack of these types of measurement scales in previous literature about port operations for measuring this construct. This was followed by developing an online survey questionnaire to gather data on the constructs, and multiple items, seven-point Likert scales, measured all those constructs. See appendix (G) for the final version of this survey questionnaire.

#### 5.3.3.1 Instrumentation

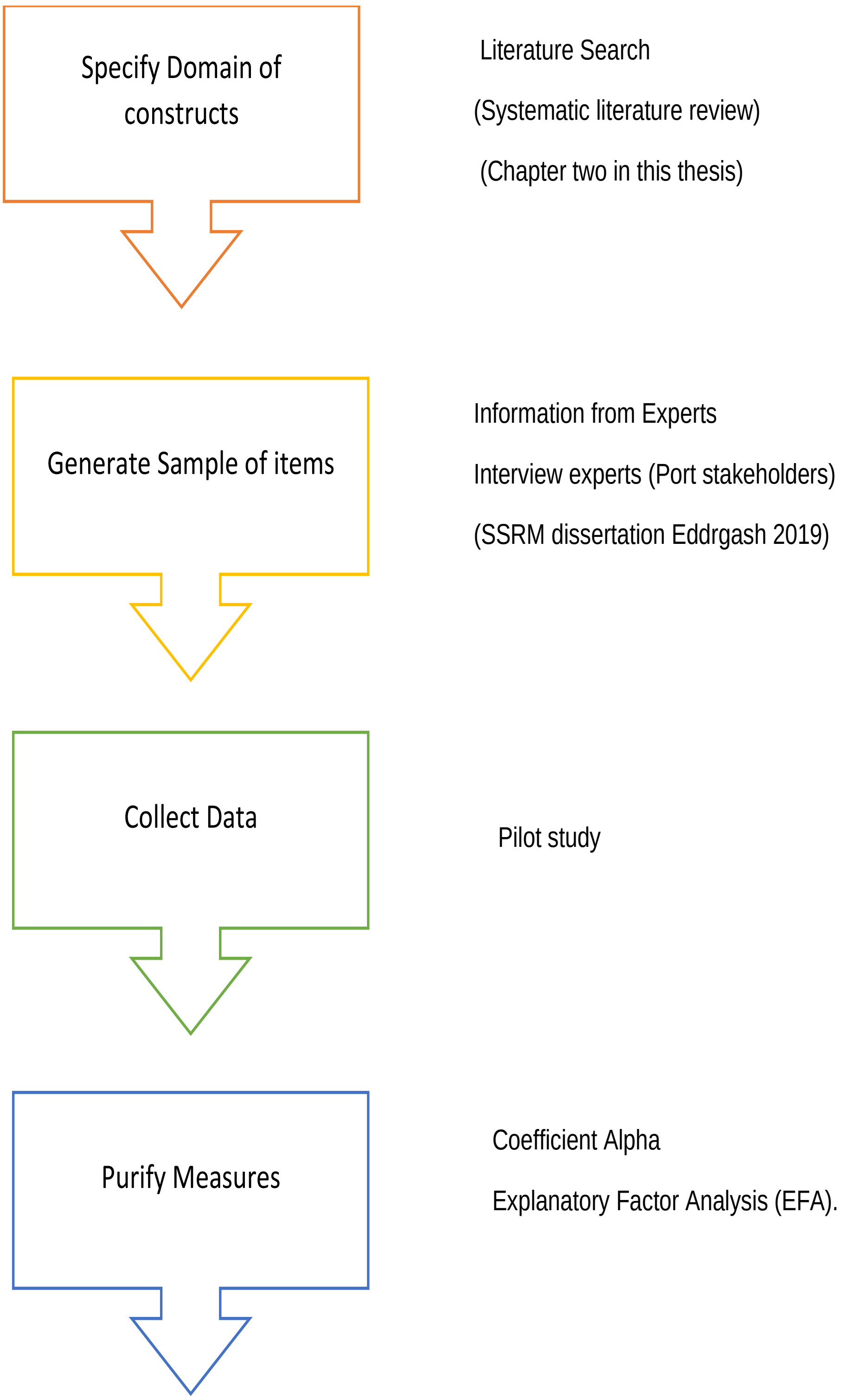
Dependent and independent latent variables were used in this research to measure the port stakeholders' perceptions regarding identifying the causes behind the congestion problems at ports. To acquire this identification, the researcher has developed measurement scales during the previous chapter (the systematic literature review research) based on the theoretical, conceptual framework developed early Eddrgash (2019). Tables (5.3 to 5.8) illustrate all scale measurements and their items used as measurement instruments to capture the respondents' perceptions of the causes of port congestion problems in this survey study. These instruments were tested first through a pilot study targeting a small population sample of port stakeholders in Libya and Malta. This step aimed to identify the unworkable instrument items and to test the reliability and validity of these measurement scales.

#### 5.3.3.2 Development procedure for the measurement scales

The development of measurement scales is a crucial process in which the theoretical framework that has been developed in an early stage is associated with the empirical testing for the target study. A measurement scale is an instrument where a set of collected items are combined in a composite score to be employed for revealing the levels of theoretical variables that were not ready to be observed by direct means (De Vaus 2001). He argued that measurement scales that were systematically developed could potentially help in generalising the study results; however, poor development might lead to wrong conclusions (Ibid). Thus, the researcher in this survey study has followed the procedure steps suggested by Churchill (1979) for developing a systematic scale measurement (see figure 5.2). These steps are:

#### 5.3.3.3 Specify Domain of construct.

According to Churchill (1979), the first step is to specify the domain that enables the items' hypothesised generation subsequence to fit each dimension of key constructs. The researcher should clearly explain the criteria included and excluded in defining the constructs in this step. In this regard, it is very important for the researcher to search and consult the previous literature about his/her research topic to fulfil this target.




Source: Churchill (1979).

Figure 5.2. Employed techniques for developing measurement scales.

In this PhD research, the literature about the port congestion problem was systematically reviewed and dimensions for new main constructs and their definitions were identified, (look at chapter 4, The ystematic literature review study). Furthermore, based on the obtained theoretical information, the researcher has developed the conceptual framework that is used to build up the measurement scales.

The second step in Churchill's (1979) process for developing measurement scales is **generating the measurement items**. This step is to generate additional measurement items by using exploratory studies such as conducting interviews and/or making focus groups targeting expert people in the industry (Churchill 1979). Owing to this step, the researcher has used the measurement items that were developed early in the (Eddrgash 2019). In that stage, five classification items for identifying port congestion causes were developed and set through interviewing process targeting a group of port stakeholders within different managerial levels in Libyan ports (See Eddrgash 2019).

#### 5.3.3.4 Measurement purification (Pilot study).

It is the third step of Churchill's (1979) process for developing measurement scales. A pilot study needs to be conducted to purify the developed measurement scales developed through the last two steps. It is also a step for testing the reliability and validity of the developed scale items (De Vaus 2001). The researcher first tries to gain experts' judgments by commencing a pre-test process among a group of them (Churchill 1979). Then it continued by conducting a pilot study to check whether the measurement scales and items measured the questionnaire constructs in a way that answered the research questions (see the details in the pilot study section).

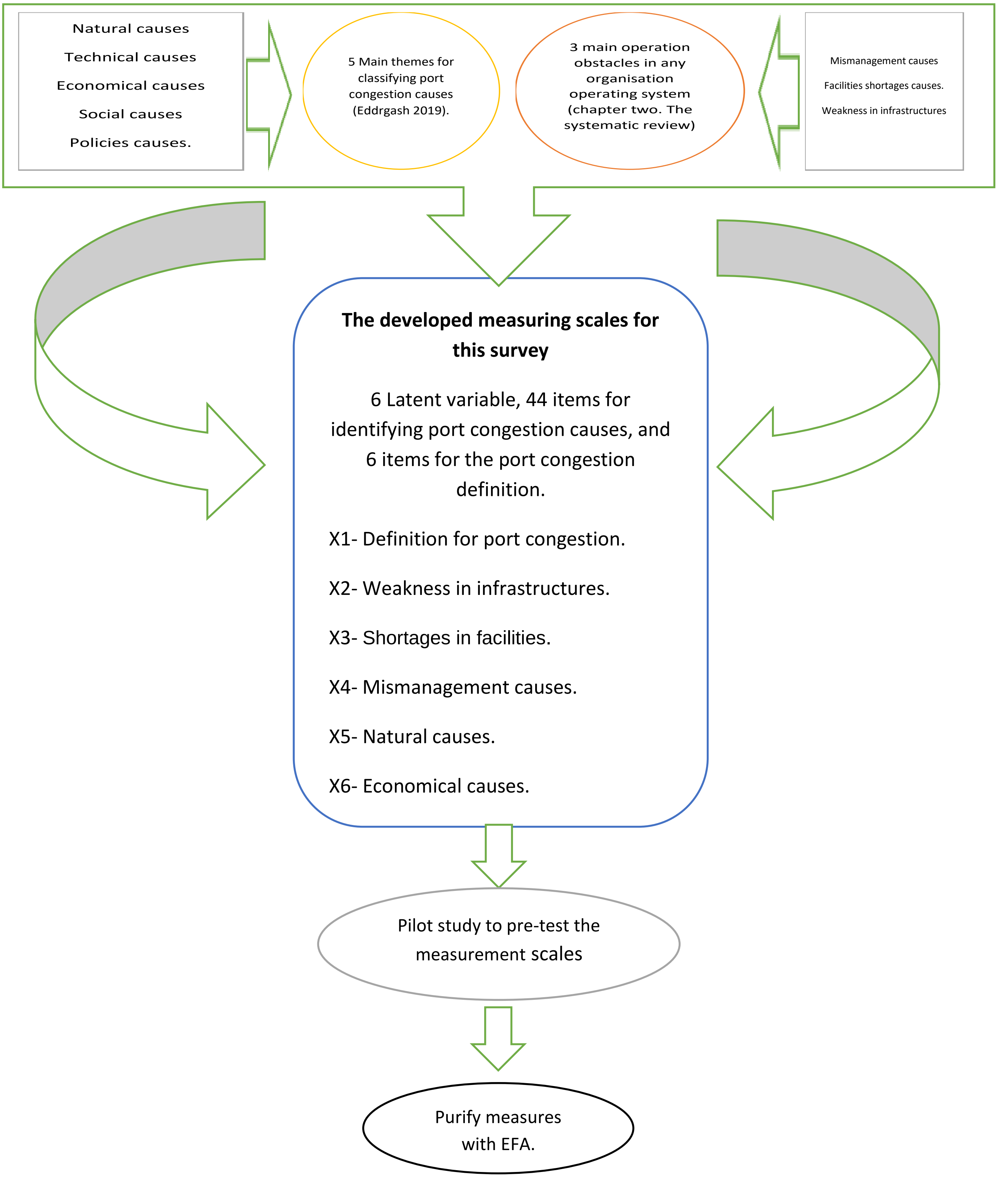
#### 5.3.3.5 Exploratory factor analysis.

In this final step, the researcher needs to commence an analysis technique to test the scales' factorial structure. During the early stage of measurement scale development, an EFA is commonly used as an analysis technique to refine and validate the developed scales. This is due to the EFA being a valuable analysis technique, and it enables the researcher to understand the correlations between the constructs and their relevant indicators (Churchill 1979; De Vaus 2001). Also, one of the EFA strengths is that it is beneficial as an analysis tool, especially when there is a lack of theory about the under-investigation constructs (Gerbing and Anderson 1988). This step usually starts with the pre-testing stage (pilot study), where the Coefficient Alpha for the pilot survey needs to be examined. Then the EFA has to be commenced to test each factor dimension, beginning with correlation coefficients and then extracting the common factors and rotating them (Hair et al. 1998).

#### 5.3.3.6 Development and validation process for the measurement scales of causes of the port congestion problem.

As discussed above, one of the key contributions in this study was the development of new measurement scale items according to the Churchill (1979) procedure to measure and identify the causes of the port congestion problem. These measurements were developed based on the theoretical, conceptual framework developed by (Eddrgash 2019) and chapter four of this PhD study See figure (5.3). Six latent variables (X1 to X6), six items' variables on defining port congestion problem, and 44 items on identifying the causes of port congestion problem see tables 5.3 to 5.8 (see appendix "H" for relating these measurement variables to the literature about port congestion). These items were measured by questions designed to gain better response outcomes using a seven-point Likert scale starting with "strongly agree" and ending with "strongly disagree". Then the respondents were asked to choose the three most important items from each variable (X1 to X6), which were put without ranking. This was for cross-checking whether the high score in Likert answers produced by each respondent matches its three prioritised items for the same variable.

Validating these measurement scales started with a pre-testing pilot survey study, where the Coefficient Alpha for the pilot survey was examined (Table 5.10). This is followed by the commencing of the EFA to test each factor dimension beginning with correlation coefficients and then extracting the common factors and rotating them. The EFA results are presented and discussed in this chapter in the results section.




Adapted from Churchill (1979).

Figure 5.3. Techniques for Developing measurement scales for this survey questionnaire.

## 5.4. Questionnaire pre-testing and the pilot study

Both questionnaire pre-testing and survey pilot study are essential stages in designing a survey questionnaire. In fact, to validate the questionnaire instrument of a survey and be sure that it is free of ambiguities and errors, the researcher needs to conduct a pre-testing and pilot study before finally distributing his/her survey (Sekaran 2003). Thus, to prevent any confusion that might cause the respondents to misunderstand or misinterpret the survey questions. This study conducts both pre-testing and pilot study processes to identify and eliminate any ambiguities and errors in this survey questionnaire design.

| Code | Item variables |
|---|---|
| X1 | **Definition of the port congestion problem** |
| **X1.1** | In general, the problem of port congestion can be defined as ‘the supply of port services and resources, for various reasons, cannot cope with the increasing demand for those services and resources.’ |
| **X1.2** | “Port congestion arises when port capacity is insufficient to cope with the traffic arriving at the port”. |
| **X1.3** | “It indicates the demand for the use of sea space exceeds the available capacity during that time period”. |
| **X1.4** | “a situation where a transport user, such as a ship, causes to delay another transport user (another ship), and this delay translated to extra cost upon the third party (usually the customer)”. |
| **X1.5** | “The congestion effect refers to the phenomenon that more customers choosing to use the same facility reduces the facility’s utility.” |
| **X1.6** | “Port congestion as a situation wherein a port; ships on arrival spend more time waiting to berth, in this context, more ships will queue at the channel and the outside of the port waiting to get space at the terminal for berth slot.” |

Source: The Author

Table 5.3. List of the constructed variable X1 and their items variable.

| **Code** | **Item variables** |
|---|---|
| **X2** | **Weakness in infrastructures** |
| **X2.1** | Insufficient port storage area capacities |
| **X2.2** | Insufficient port gates capacities |
| **X2.3** | Inadequate development in other port infrastructures such as port ways, yard lights, yard refrigerators sockets….etc. |
| **X2.4** | Insufficient port berths' capacities at a port |
| **X2.5** | Insufficient depths of the sea entrance, sea channels, and port berths for a port. |
| **X2.6** | Inadequate development in the infrastructures of the hinterland intermodal. |
| **X2.7** | Inadequate development in the port hinterland of other systems such as telecommunications, internet networks, and banks system. |

Source: The Author

Table 5.4. List of the constructed variable X2 and their items variable.

| **Code** | Item variable |
|---|---|
| X3 | **Shortages in facilities** |
| **X3.1** | An inadequate number of port gates. |
| **X3.2** | An inadequate number of port cranes. |
| **X3.3** | An inadequate number of other port equipment such as (straddles, trailers, port trucks, X-ray screening machines…etc). |
| **X3.4** | Shortages in supplying equipment's spare parts that might need for repairing these types of equipment frequently. |
| **X3.5** | The recent increase in ships' size (especially container ships) has caused putting more constraints on the existing equipment's capacities at the port that receive these types of ships. |
| **X3.6** | The increase in ships-sharing alliances between companies has caused putting more constraints on the existing equipment's capacities at the port that receive these types of ships. |
| **X3.7** | An inadequate number of tugboats at the port |
| **X3.8** | Insufficient capacities of port passages and port accesses (Roads, rail lines, and water channels) |

Source: The Author

Table 5.5. List of the constructed variable X3 and their items variable.

| Code | Item variables |
|---|---|
| **X4** | **Mismanagement issues** |
| **X4.1** | Inefficient management of port passages and port accesses |
| **X4.2** | Unproductive cargo handling operation |
| **X4.3** | Inefficient management of cargo handling equipment |
| **X4.4** | The increase in the complexity of port operations has been noticed lately due to the increase in ship size and the increasing in the ships sharing alliance between companies. |
| **X4.5** | Employing unqualified staff in ports |
| **X4.6** | Imposing cheaper prices for storing cargoes in ports (than outside ports) by port management |
| **X4.7** | Inefficient port yard template plans (especially in container terminals). |
| **X4.8** | Inefficient plans for allocating ships at port berths. |
| **X4.9** | Poor management for maintaining and repairing port facilities such as tugboats and the sea entrance's lights. |
| **X4.10** | Accidents at ports sea channels and berths. |
| **X4.11** | The lack of information exchange between port actors (Port operators, Customs, Shippers, and truck companies). |

Source: The Author

Table 5. 6. List of the constructed variable X4 and their items variable.

| Code | **Item variable** |
|---|---|
| **X4.12** | Inefficient management of the hinterland accesses (Roads, rail lines, and water channels) could lead to traffic congestion situations at ports and around them. |
| **X4.13** | Bureaucracy and severe customs regulations |
| **X4.14** | Centralism and monopolism in government public sectors |
| **X4.15** | Poor port regulation and policies |
| **X4.16** | A 100% cargo inspection policy at some ports |
| **X4.17** | Inadequate development government policies and regulations (especially in developing countries) |
| **X4.18** | The excessive number of port labours |
| **X4.19** | Labour inefficiency is a great cause for imposing time delays at cargo handling operations in ports. |
| **X4.20** | Insufficient working hours at ports is a direct cause for imposing delay times on both operations ship entering and cargo clearing process. |
| **X4.21** | Labour strikes at ports |
| **X4.22** | Corruption at ports and government systems |

Source: The Author

Table 5.6. (cont.) List of the constructed variable X4 and their items variable.

| Code | Item variables |
|---|---|
| **X5** | **Natural causes** |
| **X5.1** | Bad weather |
| **X5.2** | Tide issues |
| **X5.3** | Floods issues |

Source: The Author

Table 5.7. List of the constructed variable X5 and their items variable.

| Code | Item variables |
|---|---|
| X6 | **Economical causes** |
| **X6.1** | The sudden increase in international trade in a port |
| **X6.2** | The sudden increase in the trade local demand from a country or a region |
| **X6.3** | Concentrating the cargo traffic on a certain port while the other ports remain ineffective. |
| **X6.4** | Seasonality (increasing cargo traffic on a port at certain times of the year). |

Source: The Author

Table 5.8. List of the constructed variable X6 and their items variable.

### 5.4.1. The questionnaire pre-testing stage

It is a fundamental assessment stage that allows the researcher to secure the feedback around his/her questionnaire wording, contents, and design and eliminate any possible issues before extending the dispersing of the survey (Sekaran 2003). The pre-testing process is usually done in two steps (Saunders et al., 2009). Firstly, the researcher starts reviewing his/her survey questions and design with a group of experts or knowledgeable colleagues to acquire some suggestions on the questionnaire structure and detect any possible ambiguities or errors (Dillman 2007; Saunders et al. 2009). Secondly, after amending any ambiguities or errors that arise from stage one, the researcher might send a few copies of the survey questionnaire to a small group of the target population to be filled out. This indicates any possible misunderstanding or misinterpreting issues that might arise (Dillman 2007). In fact, this stage also helps the researcher test the validity of the questions and evaluate their reliability (Saunders et al., 2009).

In this survey study, the pre-testing process was carried out through three steps. In the first step, valuable feedback was acquired from three academic professors (the student supervisors) in operations and management who are experts in Seaports and the shipping industry on the questionnaire wording and structure. Some amendments were advised by them and have been taken into the researcher's consideration in issuing the final version of this survey questionnaire.

The pre-testing process in the second step was carried out by distributing a few copies of this survey questionnaire to some of the PhD research colleagues at Cardiff University from various academic backgrounds. This step aims to obtain feedback from PhD research students with diverse expertise and conduct surveys for their PhD study. The researcher received feedback from them suggesting the potential issues that might arise in designing and constructing the questionnaire. The researcher considered all highlighted potential problems, and the questionnaire has been revised based on the previous two pre-testing steps.

In the third step, the final version from the previous two steps was sent to some academic staff members with various academic knowledge and backgrounds. They form a committee review and improve members of ethical consideration at Cardiff University. Valuable and helpful feedback was received from them, such as adding “requesting response” flow logic for some questions and adding the statement “prefer not to say” to the demographic questions. The survey questionnaire was adjusted accordingly, and the final draft was programmed on the Qualtrics website.

### 5.4.2. The pilot study process.

It is a process for simulating the protocols and procedures already designed to collect the data from a small sample of the target population (Bolton 1993). In this stage, the researcher distributes a few survey questionnaires among a sample of the actual target population prior to the main survey process to detect any possible weaknesses in the constructed questions and the design of the survey. According to Jackson (1970), a pilot study process can be beneficial for testing: the wording of survey questions, questions flow, and order, obtaining familiarity with the survey participants, determining the accomplished time for the survey and testing the analysis technique that the researcher will use to analyse the main survey.

Regarding the sample size that the researcher needs to employ in the pilot study, Cooper and Schindler (2001) suggest a respondent rate between 25 to 100 as a reasonable response rate to gain a good result in the pilot study process. For the purpose of this survey research, a pilot study was conducted among seaport stakeholders in Libya and Malta, where about 42 online questionnaires were dispersed to seaport stockholders from various managerial levels. This process is followed by sending some reminders by email and text messages. Only (26) survey questionnaires were finished with complete answers, which produced a response rate of (62%). The time for accomplishing the pilot survey was between (8 to 15 min), and the online pilot survey itself remains open for eight weeks (from the first of August 2021 till the end of September 2021). Table 5.9 demonstrates the pilot study results for the demographical part using Excel software.

From the table, we can see that the majority of the pilot study respondents were male (96%), and most of them (62%) were aged between 50-59 years, and most of them qualified for a bachelor's degree for 42% and 38% for master's degree or equivalent. Also, port operators and ship agents are the most frequent job for the respondents with top and middle management level positions in their organizations. Furthermore, most of the respondents' business is globally distributed worldwide. Finally, 62% of the respondents have over 21 years of experience.

| Gender | Count of responses | Percentages |
|---|---|---|
| Female | 1 | 4% |
| Male | 25 | 96% |
| **Age** | | |
| 20-29 | 1 | 4% |
| 30-39 | 1 | 4% |
| 40-49 | 3 | 12% |
| 50-59 | 16 | 62% |
| 60 or over | 5 | 19% |
| **Level of your Education** | | |
| Bachelor’s degree | 11 | 42% |
| Master’s degree or equivalent | 10 | 38% |
| Technical college | 5 | 19% |
| **Type of Your Current organization** | | |
| Customer Services | 1 | 4% |
| Investor | 1 | 4% |
| Port Authority | 1 | 4% |
| Port Authority, Port operator | 1 | 4% |
| Port operator | 7 | 27% |
| Port operator, ships agent | 1 | 4% |
| Port operator, ships agent, Other, please specify | 1 | 4% |
| Port operator, Truck Company | 1 | 4% |
| Researcher | 1 | 4% |
| ships agent | 9 | 34% |
| ships agent, Cargo clearance agent, Customs agent | 1 | 4% |
| Trader | 1 | 4% |
| **The geographic working area for your current organization.** | | |
| Africa | 17 | 65% |
| Europe | 2 | 8% |
| Europe, Africa, Asia | 3 | 12% |
| Europe, Africa, Asia, North America, South America, Australia | 3 | 12% |
| North America | 1 | 4% |
| **Type of organization** | | |
| Admin. assistant | 1 | 4% |
| Consultant | 1 | 4% |
| Documentation coordinator | 1 | 4% |
| Lower-level manager | 1 | 4% |
| marine & humans resources consultant | 1 | 4% |
| Marine Adviser | 1 | 4% |
| Middle-Level manager | 10 | 38% |
| Top-level manager | 10 | 38% |
| **Years of experiences** | | |
| 11-15 | 2 | 8% |
| 1-5 | 1 | 4% |
| 16-20 | 6 | 23% |
| 21 and over | 16 | 62% |
| 6-10 | 1 | 4% |

Table 5.9. The demographical results for the pilot study.

## 5.5. Reliability and Validity

Reliability and validity are measurement tools for the quality of the survey and the data (Sekaran 2003). Both tools are significant tests to assess the generalizability of findings to the study population in quantitative models (Dunn et al. 1994). The following two sections discuss the reliability and validity of this PhD survey research.

### 5.5.1. Reliability

In positivist research studies, the reliability of responses obtained from a survey is an essential issue in designing the questionnaire questions (Collis and Hussey 2009). In other words, it concerns the credibility of the collected data and whether the type of data collection method led to yielding consistent findings (Saunders et al., 2009). This means that the findings for research can be considered reliable only if the same results could be obtained from repeating the same research procedure, which is referred to as the repeatability and consistency of research findings over time (Collis and Hussey 2009). Moreover, as reliability focuses on the ability to repeat a study over time using the same data collection method, any involved errors or biases in measures or with the instrument's structure can be observed over time (Robson 1993).

To enhance the reliability of this survey study, the researcher adopted positivist techniques which are efficient methods to gather data for the variables of this research interest (Collis and Hussey 2003). This survey questionnaire was designed to gain data from various levels of management in a range of global port stakeholders organisations. All respondents were enough qualified to meet this research's needed characteristics. Moreover, to eliminate the research bias, all these survey respondents were assured of a strictly confidential dealing with obtaining data and anonymous participation. Also, the scale items were constructed carefully, and ambiguous words, double-barrelled questions, and unfamiliar concepts were avoided. Also, prior to conducting the main survey, a pilot study was carried out to reduce and eliminate any possible errors and ambiguity. Finally, as this survey research was designed and conducted online, there were no observed errors or biases.

In positivist research, reliability can be examined by three types of tests (Burns and Burns 2008): Test-restart to examine the answers of the respondents are the same in one or more different time periods. The second is the Equivalence or split-half test to see if the respondents' answers have the same scores if they were given two halves or different forms of a set of items. The third one concerns internal consistency, which is used to see if the questionnaire questions have consistently measured the qualities, attitudes, or/and characteristics that they should have done.

In this PhD research, the first two reliability tests have not been conducted as their job has been done by the pilot study. However, for the third reliability test (internal consistency), a statistical method of Cronbach's coefficient alpha was employed and incorporated with the above-discussed procedural remedies for confirming that the common bias of the method used is under control. According to Hussey and Hussey (1997), the internal consistency method can be usefully used to measure the reliability of items in a questionnaire instrument. Cronbach's alpha test determines the consistency of the answers of all participants to all items in a scale measure. In other words, whether all items in a scale measure the same concept. Commonly, any determined value of Cronbach's alpha test between 0.7 to 0.8 is accepted as an indication of the reliability of the research data (Nunnally 1978). Also, any estimated value of Cronbach's alpha test below 0.6 indicates poor reliability and above 0.8 is a sign of a good one (Sekaran 2000). Table (5.10) shows the Cronbach's alpha coefficients that have been determined for all constructs in the survey. From this table, it can be clearly seen that all constructed measures used in this study related to Cronbach's alpha values have shown good reliability based on the argument of (Sekaran 2000).

**Reliability Statistics**

| Cronbach's Alpha | Cronbach's Alpha Based on Standardized Items | N of Items |
|---|---|---|
| .934 | .940 | 44 |

Table 5.10. Cronbach's alpha coefficients result for the survey study.

### 5.5.2. Validity

It rerefers to the soundness of the accuracy of the measurement tool to reflect the reality of the under-investigation phenomena accurately and precisely (Saunders et al. 2012). There are six types of validity measures usually used in social sciences (Content, Construct, Convergent, Discriminate, Criterion-related, and Nomological validity). The following paragraphs discuss them.

**Content validity** is also known as face validity. It tests whether the characteristics or attitudes that the item questions intend to measure are accurately represented by these survey item questions. Furthermore, this can be done in several ways through the pre-testing process of the survey, where the researcher can use feedback from related experts to be sure about the content validity (Fink and Kosecoff 1998). In this study, firstly, a careful and sensitive great search was done in the literature review, where most of the measuring items were gathered. Secondly, professionals and an expert panel who have perfect experience in port operation and management were asked to evaluate the measurement items in the questionnaire and whether they were useful for the research topic and answered the research questions. Thirdly, the measurement scales were also evaluated by maritime and port management researchers at Cardiff University (my supervisors' panel) at the beginning of the study (Hardesty and Bearden 2004). Finally, these measurement scales were evaluated and tested twice before and after conducting the pilot study process through PhD students at Cardiff University and by a group of managers from various levels in the target sample (Hair et al. 2006).

**Construct validity** is experimentally measured by surveying the participants and applying the Exploratory factor analysis (EFA) calculation to distinguish the constructs (Fink and Kosecoff 1998).

**Convergent validity** looks for any existence of a high degree of correlation between different sources that might be influenced by the same measure or construct (Sekaran 2003).

**Discriminant validity** tests that any two different items or concepts not in one construct should not be correlated to each other (Sekaran 2003).

**Criterion-related validity** examines whether any one of the respondents known to be different can be differentiated from the others by the power of the measure (Dunn et al. 1994; Sekaran 2003).

**Nomological validity** examines whether the relations between constructs are according to or aligned with the underlying theory (Dunn et al. 1994).

In this survey study, the last four validity types were examined through the commencing of the EFA analysis (see section 5.8.7).

## 5.6. Data analysis for this survey research

The main survey research has been commenced after the reliability and validity assessment process, which was done by finalising the questionnaire pre-testing and carrying out the pilot survey stage. The main survey was conducted globally in the port stakeholders' network. In this section, the analysis technique employed to analyse the survey data as presented.

### 5.6.1. Statistical package and data analysis technique for this PhD survey.

To avoid collecting an incorrect form of data and prevent errors and issues in the study findings, the right decision for selecting the data analysis technique should be taken before collecting data (Cooper and Schindler 2001). Also, in the purpose of selecting a correct and suitable data analysis method, the researcher should carefully consider these issues: the problem under investigation, the research objectives, and the data characteristics and their underlying properties (Zikmund 2003). As the target of this survey's study was to identify the common factors for the causes of port congestion problems at seaports, to meet this goal, an SPSS (Statistical Package for Social Sciences) version 26 was used to analyse the collected data.

SPSS is commonly used and widely accepted among researchers in different business and management fields of study (Zikmund 2003). Thus, it was selected to be the software package for applying all fundamental descriptive and statistical analyses to analyse and obtain results from the quantitative data that was gathered by this survey research. These statistical analyses include frequencies, percentages, mean, standard deviations, reliability measurements, and factor analysis. Those descriptive analyses were conducted separately on each measured item from the demographical part of the survey to gain the initial information and build up the participants' profiles (Sekaran 2000). Then, they were conducted to find out the best definition for port congestion and the causes of priorities according to each type of port stakeholder.

Furthermore, following the first step of descriptive analysis of data, the second step was to conduct the exploratory factor analysis (EFA) using SPSS to identify the common factors of the numerous variables in the proposed model of this research study (Hair et al. 2010).

#### 5.6.2. Exploratory Factor Analysis (EFA)

It is a common approach in social science studies to identify latent factors by lowering a great number of observed variables to a small manageable number (Tabachnick and Fidell 2007). It is also a technique for testing the relationships between variables with no prior hypotheses (Hair et al. 2010). In this PhD research, the EFA was commenced to examine each factor dimension as suggested by (Hair et al 2010).

To commence the EFA analysis, SPSS version 26 was used to extract the factors by conducting the principal component analysis, one of the common methods used in SPSS to identify the minimum number of variables that explain the maximum variance in the populations (Tabachnick and Fidell 2007). Many tests are available to test the adequacy of this reduction; however, the most frequent tests used in business research studies are Eigenvalues and Scree plot tests. It is important to know that prior to this reduction (Extracting factors), a calculation for the variance of any given measures must be done first (Field 2006). Moreover, a commonality that reveals the common variance proportion present in a variable (field 2009) can be estimated through the factors loads. Any model of multiple constructs with commonalities less than 0.5 needs to employ a large data sample size (Hair et al. 2010). Thus, a commonality above 0.5 was gained for all variables in this PhD research.

The next step in the EFA is to apply the factor rotation method to make the loadings pattern in a way that is interpreted quickly and correctly. The rotation technique is a method for discrimination between factors. It is usually used to maximise and obtain the high correlation among variables and factors and eliminate the lowest values (Field 2009; Hair et al. 2010). This rotation can be done in two ways orthogonal and oblique rotation (Ibid). The difference between those types of rotation is that while in orthogonal rotation, the extracted factors are uncorrelated (independent), they are correlated in the oblique rotation (Bryman and Cramer 2005; Field 2009). The orthogonal technique with Varimax rotation was used to conduct the factor analysis in this PhD study, where the Varimax was employed for maximising the loadings' dispersion within the factors (Field 2009). And the research attention behind using the orthogonal model of rotation was due to the uncorrelated relation. Maximising the loading variance on each factor will minimise the complexity of factors (Tabachnick and Fidell 2001).

## 5.7. Ethical Considerations

Ethical manners in social research studies are fundamental issues (Collis and Hussey 2003). A researcher is obligated to take his/her responsibility to protect the participants' rights, interests, and privacy (Burns 2000). Any research participants should be assured to give their consent for participating, securing the confidentiality of their responses, and being advised that they can withdraw from the survey at any time without giving any reasons for terminating their participation (Christians 2000; Payne and Payne 2004). Moreover, the study participants must be fully guaranteed anonymity and well informed about the study objectives and aims and the data gathering nature (Burns 2000).

In this PhD survey research, the researcher has followed the Cardiff Business school policies for research ethics. The researcher completed all concerned ethical forms required by these policies. Furthermore, these forms were signed by both the researcher and his supervisor. Then these forms were submitted to the CARBS Research Ethics Committee, and approval from the committee was gained before starting this research. In addition to all the above, a cover letter was attached to all emails that were used to spread this survey. This cover letter was included with the research title, the researcher's name, and the school to enhance the participants' confidence and increase the response rate (Cooper and Schindler 2001). Also, it was included with the research objectives and the way that the researcher will handle their information data. Moreover, and in conformity with the required ethical policies, the respondents were asked for voluntary participation and assured that they had the free will to withdraw from participating in the survey at any step. They can also ignore any question that they do not want to answer. Finally, all respondents were guaranteed that their responses would be dealt with anonymity and confidentiality that would not enable their identification in the study results. Furthermore, the researcher will only use the aggregate findings to report these survey results to maintain this confidentiality. In addition, the collected data will only be used for the purpose of these research objectives and to fulfil the requirements for the PhD thesis.

## 5.8. Survey research results and discussion

A detailed discussion of the applied statistical procedure, for analysing the collected data and presenting the final findings, is provided in this section.

### 5.8.1 Managing the data

The data collection procedure was undertaken from August 2021 until March 2022 using the appendix (G) questionnaire. As discussed in section (5.3.2), the non-probability sampling technique for collecting data type: convenience and snowball sampling techniques are considered the most appropriate technique to yield a satisfactory response in management and business studies (Bryman and Bell, 2007). Therefore, this study adopted those techniques to collect the survey responses, where the questionnaire was distributed by email to 1160 participants. These participants were selected by convenience sampling from the Linkedin website as managers at different levels in the Maritime and port industries. Also, those participants were gently asked to share the survey link with whom they may think is interested and might add a value to the research results. In addition, polite reminder emails were sent to non-respondents after three weeks from the first day of distribution. However, as it was not mandatory to complete the survey, out of the 1160 distributed emails, 467 started filling out the questionnaire, however, only 303 participants completed the survey. This represented about 26% of the total distributed samples.

Since this study used the SPSS version 26 to analyse the data, which should be quantitatively to run the objective, all responses were downloaded from the Qualtrics web page to an Excel spreadsheet and transformed all Likert scale responses to a numeric value. Furthermore, all variables which consisted of a set of question items were coded and grouped as independent or dependent variables to be used in the analysis process. Then this spreadsheet was used as input data for the SPSS program.

### 5.8.2 Missing data

In the data analysis process, missing data is one of the most concerning issues that are fairly common exist in survey studies and might cause some failures in research findings. Missing data usually happens due to one of these two common reasons. First, it might be due to a lengthy questionnaire which might cause the respondent to stop completing the survey and ignore the rest of the questionnaire. Second, it might happen accidentally where the respondent might miss one or more values during the whole survey accomplishes process. In this survey study, both cases have been neglected by using the Qualtrics features to ensure the respondent cannot proceed to the next questions without finishing the previous one. However, it was also ensured that the respondent freely has the right to withdraw at any time from completing the survey. Moreover, any unfinished survey responses were removed from the total survey samples.

### 5.8.3 Descriptive analysis of the Demographic data

In this section, a descriptive analysis of the demographic characteristics of 303 completed survey questionnaires was done. This sample size is consistent with the need to apply the descriptive analysis and factor analysis (EFA) according to Hair et al. (2010) and Pallant (2016, p.184), where the minimum sample size should be calculated as the number of variables multiply in 5 (role of thumb) (44 variable in this research X 5 = 220). Thus, a sample of 303 respondents is considered satisfactory. Also, the recorded data was cleaned and coded before being employed in the SPSS 26. However, missing data was neglected owing to the features gained by Qualtric's online survey website.

**The profile of the survey respondents.** The participants' characteristics such as Age, Gender, level of education, type of current organization, geographic working area, current job position and the years of experience were asked in the survey. Table 5.11 demonstrates the details of these characteristics where it can be seen that the majority of respondents were male 88.12% (N=267), while female was only represented in the sample with 10.84% (N=33). The finding also showed that the sample was nearly equally distributed over all age periods; however, it showed slight concentration in periods 40-49 with 26.40% and 30-39 with 24.75%. Almost half of the population sample has a bachelor's degree for their level of education 47.19% (N=143), and this level was followed by a master's degree with 30.30% (N=92). Most participants comprised port operators 26.25% (N=105) and port authority 14% (N=56), and the majority of these respondents worked at middle-level managers 36.96% (N=112) followed by top-level management with 33.66% (N=102), while their geographic worked area comprised Africa 28.89% followed by Europe 22.89%. Finally, nearly a quarter of the respondents had 11-15 years of work experience and the other quarter had 16-20 years of work experience.

#### 5.8.4 Descriptive analysis for the construct Items

This section provides the descriptive statistics of the questionnaire constructs. The researcher has transformed the gathered data into an easy and straightforward format for understanding and interpreting, as demonstrated in the following figures and tables. All constructed items were rated with a Likert scale of different scores of seven points. The means of the majority of all variables (50 measurement items) showed scores above 2,5 (neutral position); thus, a strong level of agreement among participants was indicated on every statement employed to measure the variables in this research questionnaire.

##### 5.8.4.1 Descriptive analysis for the Construct Items

Each item's mean value and standard deviation for all responses in variables from X1 to X6 were presented and discussed in the following paragraphs.

**X1- The best definition for the port congestion problem.** The mean value and the standard deviation of each item for all responses in variable X1 (port congestion definition) are demonstrated in table 5.12, where items (X1.1), (X1.6), and (X1.2) have the highest mean values. Moreover, the survey's participants are also asked to pick up only one definition from the six that best defines the port congestion problem to reach a consensus definition of the phenomena. Figure 5.4 shows that "In general, the problem of port congestion can be defined as the supply of port services and resources, for various reasons, cannot cope with the increasing demand for those services and resources" is the most prioritised definition for defining the port congestion problem.

| Demographic | Category | Frequencies | Percentage |
|---|---|---|---|
| Gender | Female | 33 | 10.89% |
| | Male | 267 | 88.12% |
| Age | 20-29 | 46 | 15.18% |
| | 30-39 | 75 | 24.75% |
| | 40-49 | 80 | 26.40% |
| | 50-59 | 74 | 24.42% |
| | 60 or over | 27 | 8.91% |
| | Prefer not to say | 1 | 0.33% |
| Level of Education | Technical college | 33 | 10.89% |
| | Bachelor's degree | 143 | 47.19% |
| | Master's degree or equivalent | 92 | 30.30% |
| | PhD or equivalent | 16 | 5.28% |
| | Other, please specify | 19 | 6.27% |
| Type of Current organization. | Port State | 18 | 4.50% |
| | Port Authority | 56 | 14.00% |
| | Port operator | 105 | 26.25% |
| | Truck Company | 16 | 4.00% |
| | Ships owner | 36 | 9.00% |
| | ships agent | 50 | 12.50% |
| | Cargo clearance agent | 20 | 5.00% |
| | Trader | 23 | 5.75% |
| | Customs agent | 18 | 4.50% |
| | Other, please specify | 58 | 14.50% |
| The geographic working area | Europe | 103 | 22.89% |
| | Africa | 130 | 28.89% |
| | Asia | 106 | 23.56% |
| | North America | 53 | 11.78% |
| | South America | 40 | 8.89% |
| | Australia | 18 | 4.00% |
| Current Job Position | Top-level manager | 102 | 33.66% |
| | Middle-Level manager | 112 | 36.96% |
| | Lower-level manager | 49 | 16.17% |
| | Other, please specify | 40 | 13.20% |
| Years of Experience | 1-5 | 62 | 20.46% |
| | 6-10 | 50 | 16.50% |
| | 11-15 | 75 | 24.75% |
| | 16-20 | 63 | 20.79% |
| | 21 and over | 53 | 17.49% |

Table 5.11. Profile of survey respondents.

**X2- The internal causes for port congestion problem: weakness in infrastructures.** Table 5.13 shows the mean and standard deviation value for each item of variable (X2) "the weakness in infrastructure" as one of the internal causes of port congestion. Items of X2.4 *"Insufficient port berths capacities at a port*", X2.1 *“Insufficient port storage area capacities”*, and X2.2 *“Insufficient port gates capacities”* have the highest value of the mean. Moreover, this also matches the three most prioritised choices for weakness in infrastructures causes of port congestion problems that the respondents chose see figure 5.5.

| | Item variable | Mean | Std. deviation |
|---|---|---|---|
| X1.1 | In general, the problem of port congestion can be defined as the supply of port services and resources, for various reasons, cannot cope with the increasing demand for those services and resources. | 6.20 | 1.360 |
| X1.2 | Port congestion arises when port capacity is insufficient to cope with the traffic arriving at the port. | 5.72 | 1.045 |
| X1.3 | It indicates the demand for the use of sea space exceeds the available capacity during that time period. | 5.31 | 1.254 |
| X1.4 | A situation where a transport user, such as a ship, causes to delay another transport user (another ship), and this delay translated to extra cost upon the third party (usually the customer). | 5.44 | 1.160 |
| X1.5 | The congestion effect refers to the phenomenon that more customers choosing to use the same facility reduces the facility’s utility. | 5.17 | 1.338 |
| X1.6 | Port congestion as a situation wherein a port; ships on arrival spend more time waiting to berth, in this context, more ships will queue at the channel and the outside of the port waiting to get space at the terminal for berth slot. | 5.76 | 0.962 |

Table 5.12. Descriptive statistics for port congestion definition

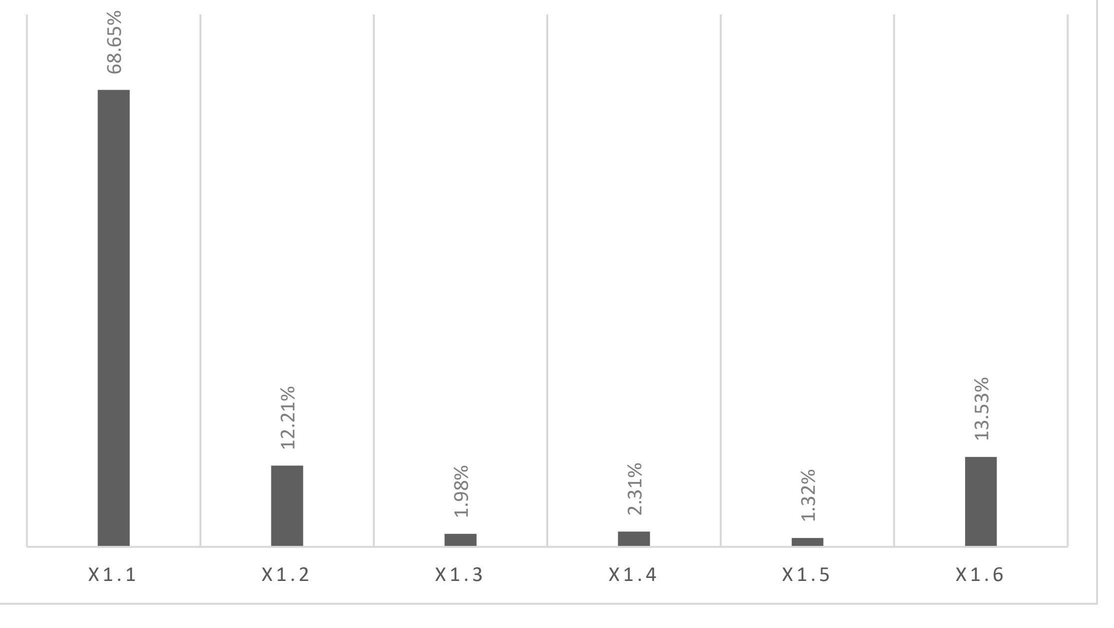



Figure 5.4. The prioritised item for the best choice for defining the port congestion problem

| | Item variable | Mean | Std. deviation |
|---|---|---|---|
| X2.1 | Insufficient port storage area capacities | 6.01 | 0.951 |
| X2.2 | Insufficient port gates capacities | 5.88 | 1.018 |
| X2.3 | Inadequate development in other port infrastructures such as port ways, yard lights, yard refrigerators sockets, etc., | 5.82 | 1.137 |
| X2.4 | Insufficient port berths capacities at a port | 6.08 | 0.968 |
| X2.5 | Insufficient depths of the sea entrance, sea channels, and port berths for a port | 5.56 | 1.372 |
| X2.6 | Inadequate development in the infrastructures of the hinterland intermodal | 5.74 | 1.139 |
| X2.7 | Inadequate development in the port hinterland other systems such as telecommunications, internet networks, and banks system | 5.72 | 1.244 |

Table 5.13. Descriptive statistics for internal causes (weakness in infrastructure) for port congestion

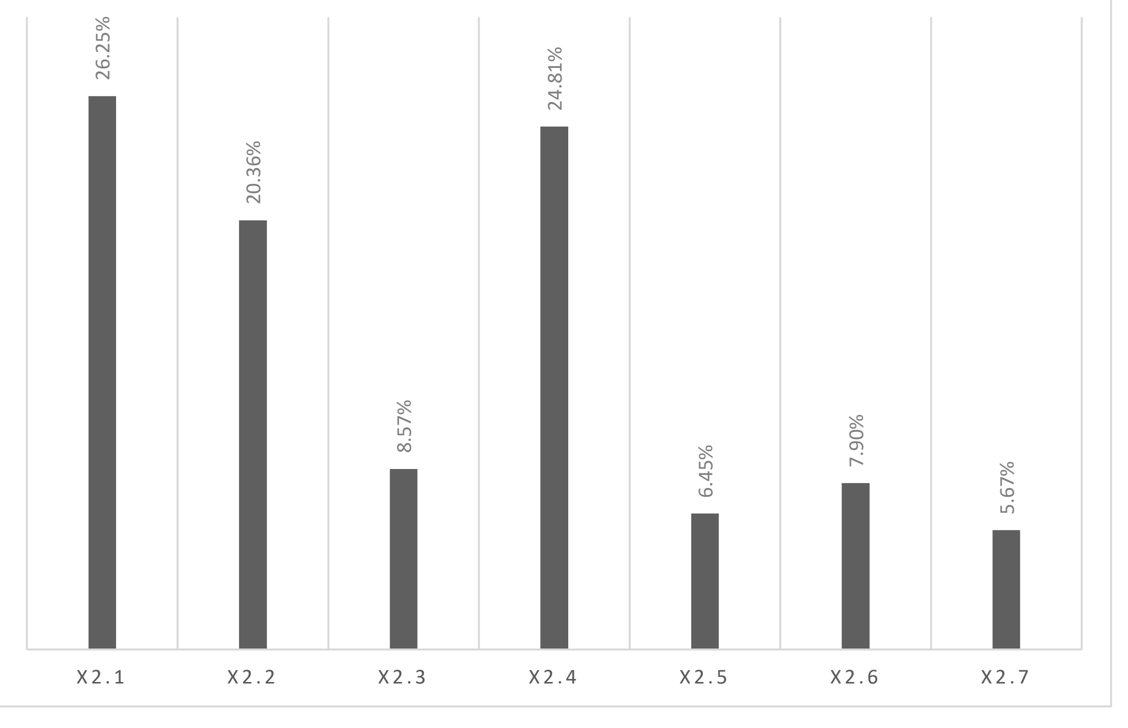



Figure 5.5. Three prioritised items for internal causes (weakness in infrastructure) for port congestion

**X3- The internal causes of the port congestion problem: Shortages in facilities.** The mean value and standard deviation for each item of all responses in the variable (X3) "the shortages in facilities" as one of the internal causes for port congestion are demonstrated in table 5.14. items (X3.1), (X3.2), and (X3.3) have the highest mean values. Moreover, survey participants are also asked to pick up their three prioritised from the eight shortages in facilities that cause the port congestion problem to arise. Figure 5.6 shows that *"An inadequate number of port gates"*, *"An inadequate number of port cranes"*, and *"An inadequate number of other port equipment such as (straddles, trailers, port trucks, X-ray screening machines.)"* are the most prioritised shortage in facilities causes for the port congestion problem and this is matching the mean results.

| | Item variable | Mean | Std. deviation |
|---|---|---|---|
| X3.1 | An inadequate number of port gates | 6.88 | 0.914 |
| X3.2 | An inadequate number of port cranes | 6.08 | 0.884 |
| X3.3 | An inadequate number of other port equipment such as (straddles, trailers, port trucks, and X-ray screening machines.) | 6.04 | 0.815 |
| X3.4 | Shortages in supplying equipment's spare parts that might need for repairing them frequently | 5.94 | 0.935 |
| X3.5 | The recent increase in ships' size (especially container ships) has caused putting more constraints on the existing equipment's capacities at the port that receive this type of ship. | 5.87 | 1.009 |
| X3.6 | The increase in ships sharing alliance between companies has caused putting more constraints on the existing equipment's capacities at the port that receive this type of ship. | 5.53 | 1.291 |
| X3.7 | An inadequate number of tugboats at the port | 5.73 | 1.136 |
| X3.8 | Insufficient capacities of port passages and port accesses (Roads, rail lines, and water channels) | 5.90 | 1.002 |

Table 5.14. Descriptive statistics for internal causes (shortages in facilities) for port congestion

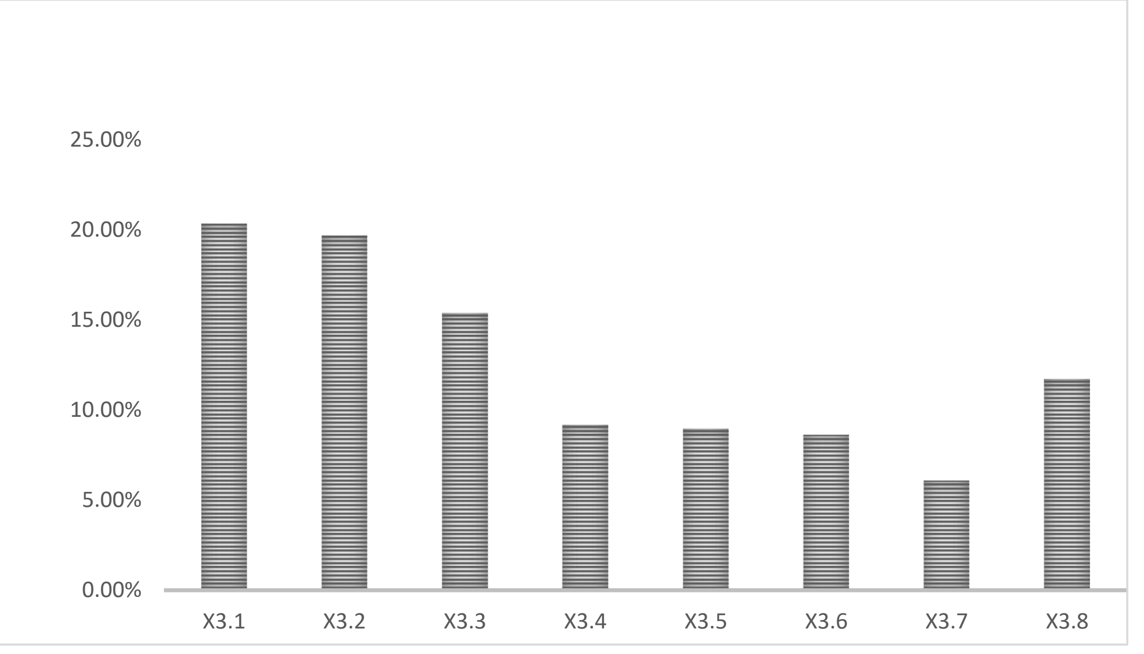



Figure 5.6. Three prioritised items for internal causes (shortages in facilities) for port congestion

**X4- The internal causes for port congestion problem: Mismanagement.** The Variable X4 (Mismanagement in the system) was divided into three categories Mis-management technical issues items from (X4.1 till X4.12), Mismanagement due to policy issues items from (X4.13 till X4.17), and Mis-management due to social issues items from (X4.18 till X4.22). All items for the variable X4 are described in the following tables and figures.

Mismanagement due to technical issues. Table 5.15 shows the mean value and the standard deviation for the Mis-management technical issues, where the highest values for the mean are X4.2 *"Unproductive cargo handling operation"*, X4.3 *"Inefficient management for cargo handling equipment"*, and X4.*1 "Inefficient management for port passages and port accesses"* respectively. When it comes to the respondents' prioritisation for the three causes of Mis-management due to technical issues, the frequency was found to be: X4.1 *"Inefficient management for port passages and port accesses"*, X4.8 *"Inefficient plans for allocating ships at port berths"*, and X4.3 *"Inefficient management for cargo handling equipment"* respectively (see figure 5.7). This is partially consistent with the mean values since the participants chose only the same two items they looked at as the top three priorities

(X4.1 and X4.3). In contrast, X4.8 *"Inefficient plans for allocating ships at port berths"* do not match the highest mean values.

Mis-management due to Policy issues. Table 5.16 shows the mean value and standard deviation for the Mismanagement policy issues. The highest values for the mean are X4.13 *"Bureaucracy and severe customs regulations"*, X4.14 *"Centralism and monopolism in government public sectors, especially in developing countries ports."*, and X4.17 *"Inadequate development government policies and regulations (especially in developing countries)"* respectively. Moreover, the survey's participants are also asked to pick up their three prioritised from the five policies and issues in Mismanagement causes that cause the port congestion problem to arise. Figure 5.8 shows that the same items

| | Item variable | Mean | Std. deviation |
|---|---|---|---|
| X4.1 | Inefficient management of port passages and port accesses | 6.05 | 0.874 |
| X4.2 | Unproductive cargo handling operation | 6.13 | 0.749 |
| X4.3 | Inefficient management of cargo handling equipment | 6.08 | 0.816 |
| X4.4 | The increase in the complexity of port operations that has been noticed lately due to the increase in ship size and the increasing in the ships sharing alliance between companies has resulted in reducing the efficiency of cargo handling operations. | 5.68 | 1.168 |
| X4.5 | Employing unqualified staff in ports | 6.03 | 0.868 |
| X4.6 | Imposing cheaper prices for storing cargoes in ports (than outside ports) by port management | 5.84 | 1.017 |
| X4.7 | Inefficient port yard template plans (especially in container terminals) | 5.94 | 0.888 |
| X4.8 | Inefficient plans for allocating ships at port berths | 6.01 | 0.867 |
| X4.9 | Accidents at ports sea channels and berths | 6.04 | 0.868 |
| X4.10 | Poor management for maintaining and repairing port facilities such as tugboats and the sea entrances lights | 5.95 | 0.975 |
| X4.11 | The lack of information exchange between port actors (Port operators, Customs, Shippers, and trucks companies) | 6.01 | 0.899 |
| X4.12 | Inefficient management of the hinterland accesses (Roads, rail lines, and water channels) | 5.99 | 0.859 |

Table 5.15. Descriptive statistics for internal causes (Mismanagement technical issues) for port congestion

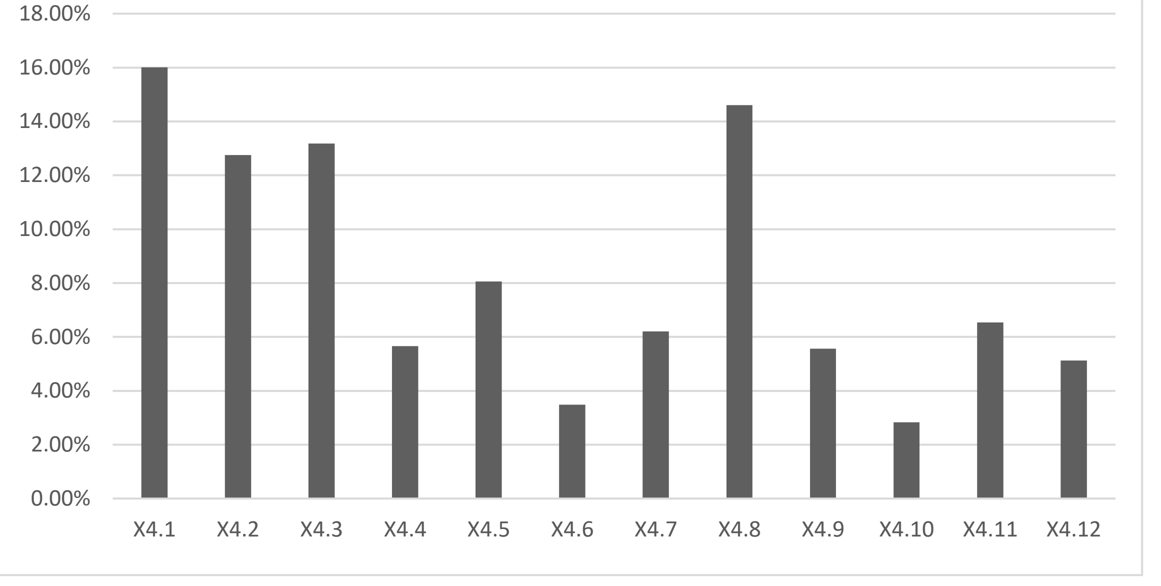



Figure 5.7. Three prioritised items for internal causes (Mismanagement technical issues) for port congestion

X4.13, X4.14, and X4.17 are chosen as the most prioritised "policy issues in mismanagement" that cause the port congestion problem; hence, their answers match and are consistent.

| | Item variable | Mean | Std. deviation |
|---|---|---|---|
| X4.13 | Bureaucracy and severe customs regulations | 6.08 | 0.820 |
| X4.14 | Centralism and monopolism in government public sectors, especially in developing countries ports. | 5.99 | 0.853 |
| X4.15 | Poor port regulation and policies | 5.89 | 0.933 |
| X4.16 | A 100% cargo inspection policy at some ports | 5.92 | 0.977 |
| X4.17 | Inadequate development government policies and regulations (especially in developing countries) | 5.93 | 0.851 |

Table 5.16. Descriptive statistics for internal causes (Mismanagement Policy issues) for port congestion

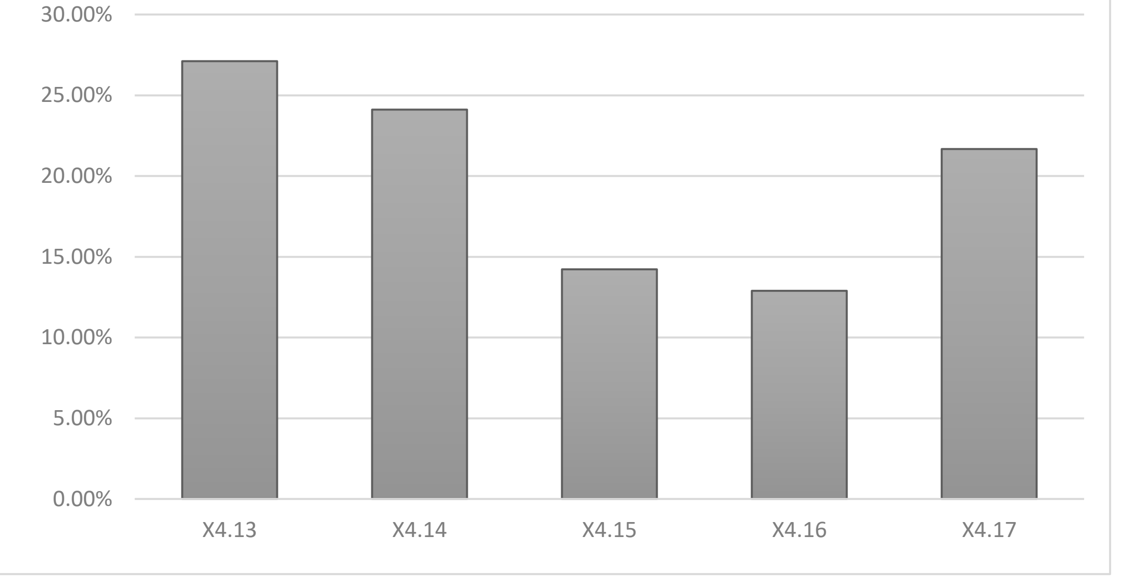



Figure 5.8. Three prioritised items for internal causes (Mismanagement Policy issues) for port congestion

Mismanagement Social issues. Table 5.17 shows the mean value and the standard deviation for the Mismanagement policy issues, where the highest values for the mean are X4.22 *"Corruption at ports and government systems"*, X4.19 *"Labour inefficiency"*, and X4.20 *"Insufficient working hours at ports"* respectively. In addition, survey participants are also asked to choose their three most prioritised choices from the five social issues in Mismanagement causes that cause the port congestion problem to arise. Figure 5.9 shows that the same items X4.22, X4.20, and X4.19 are chosen as the most prioritised "social issues in mismanagement" that cause the port congestion problem but in different consequences; hence, their answers match but are not consistent.

| | Item variable | Mean | Std. deviation |
|---|---|---|---|
| X4.18 | The excessive number of port labours | 5.80 | 1.010 |
| X4.19 | Labour inefficiency | 5.99 | 0.801 |
| X4.20 | Insufficient working hours at ports | 5.88 | 1.009 |
| X4.21 | Labour strikes at ports | 5.87 | 0.990 |
| X4.22 | Corruption at ports and government systems | 6.03 | 0.900 |

Table 5.17. Descriptive statistics for internal causes (Mismanagement Social issues) for port congestion

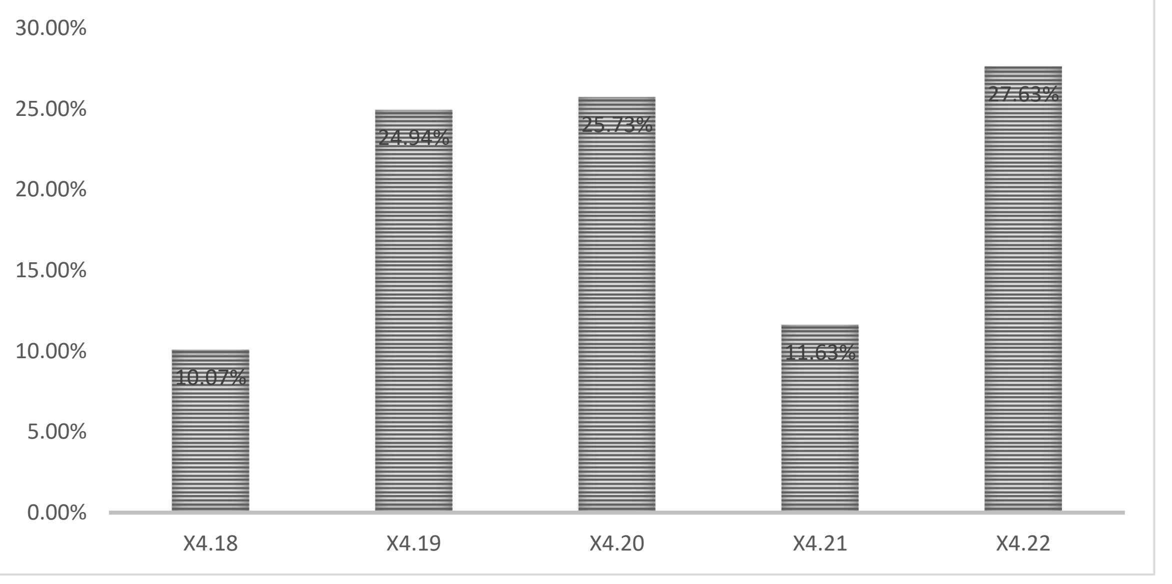



Figure 5.9. Three prioritised items for internal causes (Mismanagement and Social issues) for port congestion

**X5- The Natural issues for port congestion problem as External causes.** The mean value and the standard deviation for each item of all responses in the variable (X5) “the Natural issues” as one of the External causes of port congestion is demonstrated in table 5.18. item X5.1 *“Bad weather is an environmental uncertainty”* has the highest mean value, while item X5.3 *“Floods issues are an environmental uncertainty”,* has the lowest. No prioritised items are asked to be chosen from the respondents.

| | Item variable | Mean | Std. deviation |
|---|---|---|---|
| X5.1 | Bad weather is an environmental uncertainty that could lead to delayed ships and congested Seaports. | 6.11 | 0.868 |
| X5.2 | Tide issues are an environmental uncertainty that could lead to delayed ships and congested Seaports. | 5.95 | 0.992 |
| X5.3 | Floods issues are an environmental uncertainty that could lead to delayed ships and congested Seaports. | 5.89 | 1.036 |

Table 5.18. Descriptive statistics for External causes (Natural issues) for port congestion

**X6- The Economic issues for port congestion problem as External causes.** Table 5.19 demonstrates the mean value and the standard deviation for each item of all responses in the variable (X6) the economic issues as one of the External causes of port congestion. Items: X6.4 *"Seasonality (increasing cargo traffic on a port at certain times of the year)"*, X6.3 *"In a country or a region when the trade (the cargo traffic) is concentrating on a certain port, this could lead to congest this port while the other ports remain ineffective."*, and X6.1 *"The sudden increase in the international trade on a port"* have the highest mean values. In contrast, item X6.2, *"The sudden increase in the local trade demand from a country or a region",* has the lowest. When it comes to the respondents' prioritisation for the three causes of economic issues, the frequency found to be X6.1: *"The sudden increase in the international trade on a port"*, X6.3 *"In a country or a region when the trade (the cargo traffic) is concentrating on a certain port, this could lead to congest this port while the other ports remain ineffective."*, and X6.4 *"Seasonality (increasing cargo traffic on a port at certain times of the year)"* respectively. This is different from those yielded from the mean values (see figure 5.10). Hence, the participants' answers are matched but not consistent.

| | Item variable | Mean | Std. deviation |
|---|---|---|---|
| X6.1 | The sudden increase in international trade in a port | 6.02 | 0.828 |
| X6.2 | The sudden increase in the trade local demand from a country or a region | 5.94 | 0.850 |
| X6.3 | In a country or a region when the trade (the cargo traffic) is concentrated on a certain port, this could lead to congesting this port while the other ports remain ineffective. | 6.04 | 0.760 |
| X6.4 | Seasonality (increasing cargo traffic on a port at certain times of the year) | 6.09 | 0.703 |

Table 5.19. Descriptive statistics for External causes (Economic issues) for port congestion

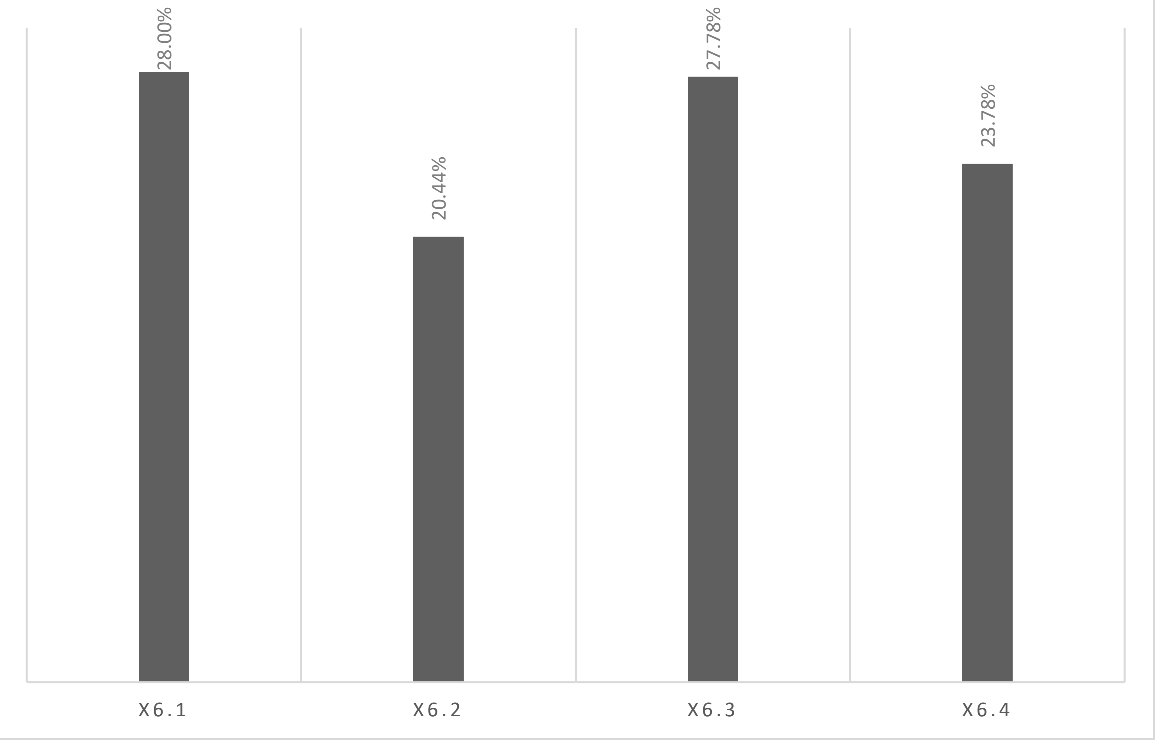



Figure 5.10. Three prioritised items for External causes (Economic issues) for port congestion

Finally, Items' variables X1 to X6 that were presented in the last section are compiled according to the highest values of their means in table 5.20. Also, the table shows the most priority items that were chosen by the survey's participants and marked with (*).

**5.8.4.2 Descriptive statistics by port stakeholders' type.**

The mean values of each variable item in this survey are presented in the tables (5.21 to 5.26) according to the type of current organization for survey respondents (as ports' stakeholders) to compare their answers. All the mean values were found to be above 5.00. The highest three mean values for each variable item were marked (some items have several equal values, so all were marked) to demonstrate the most effective causes for the port congestion problem as the port stakeholders saw them. (Other categories in the tables have represented these types of port stakeholders: Maritime researcher, Maritime Investor, Non-government Organization, Maritime Consultant, Port Consultant, Maritime field professional, Port and cargo surveyor, Ship chartering and forwarding, Tug Master, Ship Master, Pilot, and Maritime media agency.

The following paragraphs will discuss this point of view for all ports' stakeholders regarding port congestion definition and the causes behind the problem.

<u>Port congestion definition</u>. Most port stakeholders look to port congestion as an issue of coping between the supply of port resources and the demand for their services, which can happen for several reasons. Thus, they chose the first definition as the best one to describe and define the port congestion problem (see table 5.21). This indicates that it is critical for port industry practitioners and academic researchers when they try to study or solve this problem to start from this comprehensive definition as a foundation and baseline for future research studies. Also, using any of the other definitions (prevalent in the literature about port congestion) might cause misleading and less estimated potential solutions for the problem.

<u>Weakness in infrastructure as an issue that causes a port congestion problem</u>. According to table 5.22, all port stakeholders consider i*nsufficient port storage area capacities* (variable X2.1) as the most critical issue in the weakness of infrastructures. Also, the issue of *Insufficient port gate capacities* (variable 2.2) was seen as a problem by the port state, port authority, port operators, customs, cargo clearance, traders, and truck companies. In contrast, ship owners and ship agents did not consider it as they saw the Inadequate development in other port infrastructures such as port ways, yard lights, yard refrigerators sockets, Etc., could contribute highly to increasing the rate of congestion situations at the port. Another comparison can be clearly seen when it comes to the issue of Inadequate development infrastructures. Shipowners, ship agents, customs, cargo clearance agents, and truck companies related the problem to the *Inadequate development in other port infrastructures such as port ways, yard lights, and yard refrigerators sockets* (variable X2.3). In contrast, port authorities and port operators differently related the problem to the issue of *Inadequate development in the infrastructures of the hinterland intermodal,* which could lead to a rise in congestion situations at ports and/or around ports.

| Var | Code | Item variable | Mean | Std. deviation |
|---|---|---|---|---|
| X1 | X1.1* | In general, the problem of port congestion can be defined as the supply of port services and resources, for various reasons, cannot cope with the increasing demand for those services and resources. | 6.20 | 1.360 |
| | X1.6 | Port congestion as a situation wherein a port; ship on arrival spends more time waiting to berth, in this context, more ships will queue at the channel and the outside of the port waiting to get space at the terminal for berth slot. | 5.76 | 0.962 |
| | X1.2 | Port congestion arises when port capacity is insufficient to cope with the traffic arriving at the port. | 5.72 | 1.045 |
| X2 | X2.4* | Insufficient port berths capacities at a port | 6.08 | 0.968 |
| | X2.1* | Insufficient port storage area capacities | 6.01 | 0.951 |
| | X2.2* | Insufficient port gates capacities | 5.88 | 1.018 |
| X3 | X3.1* | An inadequate number of port gates | 6.88 | 0.914 |
| | X3.2* | An inadequate number of port cranes | 6.08 | 0.884 |
| | X3.3* | An inadequate number of other port equipment such as (straddles, trailers, port trucks, and X-ray screening machines.) | 6.04 | 0.815 |
| X4 | X4.2 | Unproductive cargo handling operation | 6.13 | 0.749 |
| | X4.3* | Inefficient management of cargo handling equipment | 6.08 | 0.816 |
| | X4.1* | Inefficient management of port passages and port accesses | 6.05 | 0.874 |
| | X4.8* | Inefficient plans for allocating ships at port berths | 6.01 | 0.867 |
| | X4.13* | Bureaucracy and severe customs regulations | 6.08 | 0.820 |
| | X4.14* | Centralism and monopolism in government public sectors, especially in developing countries ports. | 5.99 | 0.853 |
| | X4.17* | Inadequate development government policies and regulations (especially in developing countries) | 5.93 | 0.851 |
| | X4.22* | Corruption at ports and government systems | 6.03 | 0.900 |
| | X4.1*9 | Labour inefficiency | 5.99 | 0.801 |
| | X4.20* | Insufficient working hours at ports | 5.88 | 1.009 |
| X5 | X5.1 | Bad weather is an environmental uncertainty | 6.11 | 0.868 |
| | X5.2 | Tide issues are an environmental uncertainty | 5.95 | 0.992 |
| | X5.3 | Floods issues are an environmental uncertainty | 5.89 | 1.036 |
| X6 | X6.4* | Seasonality (increasing cargo traffic on a port at certain times of the year) | 6.09 | 0.703 |
| | X6.3* | In a country or a region when the trade (the cargo traffic) is concentrated on a certain port, this could lead to congesting this port while the other ports remain ineffective. | 6.04 | 0.760 |
| | X6.1* | The sudden increase in international trade in a port | 6.02 | 0.828 |

* Chosen as the most three priorities by the respondents

Table 5.20. The highest mean values in variables X1 to X6

| Organization type \ Variable Means | X1.1 | X1.2 | X1.3 | X1.4 | X1.5 | X1.6 |
|---|---|---|---|---|---|---|
| Port State | 6.71 | 6.24 | 5.71 | 5.59 | 5.59 | 5.35 |
| Port Authority | 6.71 | 6.71 | 5.87 | 5.63 | 5.73 | 5.40 |
| Port Operator | 6.71 | 6.20 | 5.59 | 5.20 | 5.50 | 5.16 |
| Ship Owner | 6.71 | 6.06 | 5.63 | 5.13 | 5.06 | 4.97 |
| Customs | 6.71 | 6.14 | 6.00 | 5.29 | 5.71 | 5.71 |
| Ship Agent | 6.71 | 6.22 | 5.85 | 5.44 | 5.17 | 5.12 |
| Cargo Clearance | 6.71 | 6.14 | 6.00 | 6.00 | 6.29 | 6.29 |
| Trader | 6.71 | 4.91 | 5.55 | 5.00 | 4.55 | 4.27 |
| Truck Companies | 6.71 | 6.07 | 5.79 | 5.07 | 5.71 | 5.36 |
| Others | 6.71 | 5.96 | 5.60 | 5.09 | 5.47 | 4.93 |

X1.1.In general, the problem of port congestion can be defined as the supply of port services and resources, for various reasons, cannot cope with the increasing demand for those services and resources.; X1.2.Port congestion arises when port capacity is insufficient to cope with the traffic arriving at the port.; X1.3.It indicates the demand for the use of sea space exceeds the available capacity during that time period; X1.4.A situation where a transport user, such as a ship, causes to delay another transport user (another ship), and this delay translated to extra cost upon the third party (usually the customer); X1.5.The congestion effect refers to the phenomenon that more customers choosing to use the same facility reduces the facility's utility; X1.6.Port congestion as a situation wherein a port; ship on arrival spends more time waiting to berth, in this context, more ships will queue at the channel and the outside of the port waiting to get space at the terminal for berth slot.

Table 5.21. The highest mean value in variables X1 (port congestion definition) according to port stakeholders' type

| Organization type \ Variable Mean | X2.1 | X2.2 | X2.3 | X2.4 | X2.5 | X2.6 | X2.7 |
|---|---|---|---|---|---|---|---|
| Port State | 6.00 | 6.06 | 5.94 | 6.12 | 5.88 | 5.88 | 5.65 |
| Port Authority | 6.25 | 6.17 | 5.96 | 6.10 | 5.83 | 6.33 | 6.00 |
| Port Operator | 5.71 | 5.79 | 5.53 | 5.84 | 5.46 | 5.72 | 5.66 |
| Ship Owner | 6.09 | 5.81 | 5.94 | 6.19 | 5.75 | 5.59 | 5.38 |
| Customs | 5.00 | 5.00 | 5.14 | 4.86 | 4.00 | 5.00 | 5.00 |
| Ship Agent | 6.02 | 5.76 | 6.05 | 6.07 | 5.27 | 5.80 | 5.80 |
| Cargo Clearance | 6.71 | 6.71 | 6.71 | 6.71 | 5.29 | 6.71 | 6.43 |
| Trader | 6.09 | 5.91 | 5.64 | 6.55 | 5.09 | 5.27 | 5.00 |
| Truck Companies | 6.50 | 6.07 | 6.29 | 6.00 | 6.00 | 6.07 | 5.86 |
| Others | 6.04 | 5.76 | 5.69 | 6.09 | 5.49 | 5.78 | 5.53 |

X2.1. Insufficient port storage area capacities; X2.2. Insufficient port gate capacities; X2.3. Inadequate development in other port infrastructures such as port ways, yard lights, yard refrigerators sockets, etc., X2.4. Insufficient port berths capacities at a port; X2.5. Insufficient depths of the sea entrance, sea channels, and port berths for a port; X2.6. Inadequate development in the infrastructures of the hinterland intermodal; X2.7. Inadequate development in the port hinterland other systems such as telecommunications, internet networks, and banks system

Table 5.22. The highest mean values in variable X2 (Weakness in infrastructures) according to port stakeholders' type

| Organization type \ Variable Means | X3.1 | X3.2 | X3.3 | X3.4 | X3.5 | X3.6 | X3.7 | X3.8 |
|---|---|---|---|---|---|---|---|---|
| Port State | 6.18 | 6.24 | 6.12 | 5.88 | 6.06 | 5.94 | 5.76 | 6.12 |
| Port Authority | 6.27 | 6.33 | 6.25 | 6.23 | 6.08 | 5.90 | 6.08 | 6.17 |
| Port Operator | 5.76 | 5.89 | 5.88 | 5.89 | 5.79 | 5.54 | 5.78 | 5.79 |
| Ship Owner | 5.50 | 6.06 | 6.03 | 5.75 | 5.81 | 5.38 | 5.38 | 5.78 |
| Customs | 5.57 | 5.86 | 5.86 | 5.57 | 5.57 | 5.00 | 5.71 | 5.14 |
| Ship Agent | 5.66 | 6.20 | 6.22 | 6.15 | 5.76 | 5.37 | 5.56 | 5.78 |
| Cargo clearance | 6.43 | 6.43 | 6.43 | 6.43 | 6.43 | 6.43 | 6.43 | 6.43 |
| Trader | 5.91 | 5.73 | 5.91 | 5.55 | 5.18 | 4.82 | 5.36 | 6.00 |
| Truck Companies | 6.29 | 6.21 | 6.14 | 6.07 | 5.93 | 5.50 | 5.86 | 6.21 |
| Others | 5.80 | 5.98 | 5.87 | 5.67 | 5.98 | 5.29 | 5.58 | 5.80 |

X3.1. An inadequate number of port gates; X3.2. An inadequate number of port cranes; X3.3. An inadequate number of other port equipment such as (straddles, trailers, port trucks, and X-ray screening machines.); X3.4. Shortages in supplying equipment's spare parts that might need for repairing these types of equipment frequently; X3.5. The recent increase in ships' size (especially container ships) has caused putting more constraints on the existing equipment's capacities at the port that receive this type of ship; X3.6. The increase in ships sharing alliance between companies has caused putting more constraints on the existing equipment's capacities at the port that receive this type of ship; X3.7. An inadequate number of tugboats at the port; X3.8. Insufficient capacities of port passages and port accesses (Roads, rail lines, and water channels)

Table 5.23. The highest mean values in variables X2 (Shortages in Facilities) according to port stakeholders' type

Shortages in facilities as issues cause a port congestion problem. Table 5.23 shows that all port stakeholders except trucks companies pointed out the variable item (X3.3), the issue of *"an inadequate number of other port equipment such as (straddles, trailers, port trucks, X-ray screening machines.)",* could result in rising congestion at port berths, yards, and gates. Also, all of them except Traders saw the issue of *an inadequate number of port cranes* variable (X3.2) could lead to increased time delays in handling cargo operations at any port. Moreover, stakeholders such as the port state, port authority, cargo clearance agents, traders and truck companies identify the issue of *an inadequate number of port gates* variable (X3.1) as the main cause of congestion problems at the port yards, gates, and accesses. In contrast, port operators, ship owners, and others have pointed out *that the increase in ships' size and the sharing alliance between companies have caused more constraints on the existing facilities' capacities at any port that receives* this type of ship.

Mismanagement as an issue causes port congestion problems. Looking to table 5.24, a kind of matching between the responses of (the port state, port authority, and port operators) as stakeholders concerning the mismanagement issues that cause a port congestion problem. These stakeholders all agree that congestion situations can exist due to: *Unproductive cargo handling operations, employing unqualified staff in ports, Inefficient plans for allocating ships at port berths, bureaucracy and severe customs regulations, and Inadequate development of government policies and regulations (especially in developing countries), Labour inefficiency, Labour strikes at ports* and *corruption at ports and government systems.* Also, customs, cargo clearance agents, traders and truck companies pointed out, more or less, the same mismanagement issues as causes of port congestion problems. These issues are *accidents at ports, sea channels and berths, poor management for maintaining and repairing port facilities such as tugboats and the sea entrances' lights, and the lack of information exchange between port actors (Port operators, Customs, Shippers, and trucks' companies, Centralism, and monopolism in government public sectors, Poor port regulation and policies, The excessive number of port labours,* and *Corruption at ports and government systems).*

Also, ship owners and ship agents have indicated the same mismanagement issues as the main causes of the port congestion problem. Their answers were *Unproductive cargo handling operations, Inefficient plans for allocating ships at port berths, Bureaucracy and severe customs regulations, Centralism and monopolism in government public sectors, Insufficient working hours at ports,* and *Corruption at ports and government systems.* Finally, all port stakeholders have agreed on both *Bureaucracy and severe customs regulations* and *Corruption at ports and government systems* as two main issues for mismanagement that cause congestion situations at ports.

Natural issues as a cause of port congestion problem. According to table 5.25, all port stakeholders find that bad weather, tide, and floods are the main natural issues that cause a port congestion problem.

| | Mis-management technical issues | | | | | | | | | | | | Mis-management policy issues | | | | | Mis-management social issues | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Variable Mean** / **Organization type** | X4.1 | X4.2 | X4.3 | X4.4 | X4.5 | X4.6 | X4.7 | X4.8 | X4.9 | X4.10 | X4.11 | X4.12 | X4.13 | X4.14 | X4.15 | X4.16 | X4.17 | X4.18 | X4.19 | X4.20 | X4.21 | X4.22 |
| Port State | 6.12 | 6.18 | 6.12 | 6.06 | 6.24 | 6.12 | 6.12 | 6.24 | 6.24 | 6.18 | 6.06 | 5.88 | 6.12 | 6.06 | 6.12 | 5.88 | 6.12 | 6.06 | 6.12 | 5.82 | 6.12 | 6.12 |
| Port Authority | 6.23 | 6.27 | 6.19 | 5.90 | 6.21 | 6.15 | 6.15 | 6.08 | 6.17 | 6.12 | 6.21 | 6.12 | 6.17 | 6.02 | 5.98 | 6.21 | 6.06 | 5.94 | 6.08 | 5.96 | 6.06 | 6.08 |
| Port Operator | 5.92 | 6.03 | 5.95 | 5.54 | 5.83 | 5.62 | 5.82 | 5.95 | 5.91 | 5.89 | 5.88 | 5.83 | 6.03 | 5.82 | 5.83 | 5.84 | 5.84 | 5.78 | 5.84 | 5.82 | 5.76 | 5.97 |
| Ship Owner | 6.13 | 6.19 | 6.16 | 5.72 | 6.13 | 5.72 | 5.91 | 5.94 | 6.19 | 6.03 | 5.97 | 5.97 | 6.00 | 5.97 | 5.81 | 5.66 | 5.75 | 5.56 | 5.88 | 5.94 | 5.88 | 6.03 |
| Customs | 5.71 | 5.71 | 5.86 | 5.57 | 5.43 | 5.71 | 5.86 | 5.57 | 6.00 | 6.00 | 6.14 | 6.00 | 5.86 | 5.14 | 5.71 | 5.71 | 5.71 | 5.57 | 5.71 | 5.29 | 5.43 | 5.71 |
| Ship Agent | 5.93 | 6.12 | 6.12 | 5.51 | 6.07 | 6.00 | 5.98 | 6.12 | 5.88 | 5.88 | 5.93 | 5.95 | 6.02 | 5.98 | 5.93 | 5.95 | 6.07 | 5.80 | 6.17 | 5.95 | 5.76 | 5.90 |
| Cargo clearance | 6.43 | 6.43 | 6.43 | 6.43 | 6.43 | 6.43 | 6.43 | 6.43 | 6.43 | 6.43 | 6.43 | 6.43 | 6.43 | 6.43 | 6.43 | 6.43 | 6.29 | 6.29 | 6.29 | 6.29 | 6.29 | 6.57 |
| Trader | 6.18 | 6.00 | 5.91 | 5.36 | 6.27 | 5.55 | 6.09 | 6.27 | 6.36 | 5.45 | 6.00 | 6.18 | 6.27 | 6.27 | 6.27 | 5.55 | 6.09 | 5.55 | 6.18 | 5.55 | 6.09 | 6.36 |
| Truck Companies | 6.14 | 6.43 | 6.21 | 5.86 | 6.36 | 6.14 | 6.07 | 6.00 | 6.07 | 6.14 | 6.21 | 6.50 | 6.64 | 6.50 | 6.43 | 6.21 | 6.36 | 6.57 | 6.21 | 6.00 | 6.07 | 6.50 |
| Others | 5.98 | 6.02 | 6.02 | 5.53 | 5.87 | 5.60 | 5.71 | 5.84 | 5.98 | 5.78 | 5.96 | 5.93 | 5.93 | 5.89 | 5.53 | 5.84 | 5.67 | 5.53 | 5.87 | 5.89 | 5.73 | 5.93 |

X4.1. Inefficient management for port passages and port accesses; X4.2. Unproductive cargo handling operation; X4.3. Inefficient management for cargo handling equipment; X4.4. The increase in the complexity of port operations that has been noticed lately due to the increase in ship size and the increasing in the ships' sharing alliance between companies has resulted in reducing the efficiency of cargo handling operations; X4.5. Employing unqualified staff in ports; X4.6. Imposing cheaper prices for storing cargoes in ports (than outside ports) by port management; X4.7. Inefficient port yard template plans (especially in container terminals); X4.8. Inefficient plans for allocating ships at port berths; X4.9. Accidents at ports sea channels and berths; X4.10. Poor management for maintaining and repairing port facilities such as tugboats and the sea entrance lights; X4.11. The lack of information exchange between port actors (Port operators, Customs, Shippers, and truck companies); X4.12. Inefficient management for the hinterland accesses (Roads, rail lines, and water channels); X4.13. Bureaucracy and severe customs regulations; X4.14. Centralism and monopolism in government public sectors, especially in developing countries' ports; X4.15. Poor port regulation and policies; X4.16. A 100% cargo inspection policy at some ports; X4.17. Inadequate development government policies and regulations (especially in developing countries); X4.18. The excessive number of port labours; X4.19. Labour inefficiency; X4.20. Insufficient working hours at ports; X4.21. Labour strikes at ports; X4.22. Corruption at ports and government systems.

Table 5.24. The highest mean values in variables X4(Mismanagement) according to port stakeholders' type

| Organization type \ Variable Means | X5.1 | X5.2 | X5.3 |
|---|---|---|---|
| Port State | 6.41 | 6.35 | 6.35 |
| Port Authority | 6.06 | 6.19 | 6.10 |
| Port Operator | 6.03 | 5.79 | 5.79 |
| Ship Owner | 6.25 | 6.13 | 6.00 |
| Customs | 5.57 | 5.71 | 5.43 |
| Ship Agent | 6.22 | 5.80 | 5.73 |
| Cargo clearance | 6.57 | 6.43 | 6.14 |
| Trader | 6.18 | 6.00 | 5.55 |
| Truck Companies | 6.00 | 5.86 | 5.71 |
| Others | 6.02 | 5.73 | 5.82 |

X5.1. Bad weather is an environmental uncertainty that could lead to delayed ships and congested Seaports; X5.2. Tide issues are an environmental uncertainty that could lead to delayed ships and congested Seaports; X5.3. Floods issues are an environmental uncertainty that could lead to delayed ships and congested Seaports.

Table 5.25. The highest mean values in variables X5 (Natural causes) according to port stakeholders' type

| Organization type \ Variable Means | X6.1 | X6.2 | X6.3 | X6.4 |
|---|---|---|---|---|
| Port State | 6.06 | 6.12 | 6.12 | 6.12 |
| Port Authority | 6.10 | 6.10 | 6.17 | 6.19 |
| Port Operator | 5.95 | 5.83 | 5.84 | 5.93 |
| Ship Owner | 6.16 | 6.19 | 6.09 | 6.16 |
| Customs | 5.86 | 5.43 | 5.71 | 5.86 |
| Ship Agent | 5.90 | 5.93 | 6.12 | 6.17 |
| Cargo Clearance | 6.14 | 6.29 | 6.29 | 6.12 |
| Trader | 6.00 | 5.73 | 6.27 | 6.27 |
| Truck Companies | 6.07 | 6.29 | 5.93 | 6.07 |
| Others | 6.02 | 5.73 | 6.04 | 6.09 |

X6.1. The sudden increase in the international trade in a port; X6.2. The sudden increase in the trade local demand from a country or a region; X6.3. In a country or a region when the trade (the cargo traffic) is concentrated on a certain port, this could lead to congesting this port while the other ports remain ineffective; X6.4. Seasonality (increasing cargo traffic on a port at certain times of the year)

Table 5.26. The highest mean values in variables X6 (Economic causes) according to port stakeholders' type

Economic issues as a cause for port congestion problem. Also, according to table 5.26, port stakeholders such as port authorities, port operators, customs, traders, and others have chosen the same economic reasons behind the port congestion problem. These reasons are *the sudden increase in international trade*, *in a country or a region when the trade (the cargo traffic) is concentrated on a certain port*, and *Seasonality (increasing cargo traffic on a port at certain times of the year)*. While ship owners do not see "*in a country or a region when the trade (the cargo traffic) is concentrating on a certain port"* as an issue causing congestion problems. Also, cargo clearance agents do not look to *Seasonality* as an economic issue that might lead to port congestion.

### 5.8.5 Reliability Assessment of the constructs' items

After examining the descriptive statistics of measuring instruments, it was very important to test how the participants responded to the questionnaire items in relation to constructs built from the conceptual framework. In other words, it is a test for the acceptable reliability of the measures' instruments (Hair et al. 2010). For testing this reliability, Cronbach's Alpha is the most significant and pervasive measure in the study that employs the reliability coefficient to determine and test the consistency of multiple measures constructs (Hussey and Hussey 1997).

Commonly, any determined value of Cronbach's alpha test between 0.7 to 0.8 is accepted as an indication of the reliability of the research data (Nunnally 1978). Also, any estimated value of Cronbach's alpha test below 0.6 indicates poor reliability and above 0.8 is a sign of a good one (Sekaran 2000). Table (5.27a) shows the Cronbach's alpha coefficients that have been determined for each observed variable, while table (5.27b) presents the Cronbach's alpha coefficients of constructs' measurement items in the survey. From these two tables, it can be clearly seen that all constructed measures used in this study related to Cronbach's alpha values have shown excellent reliability based on the argument of (Sekaran 2000).

| | Scale Mean if Item Deleted | Scale Variance if Item Deleted | Corrected Item-Total Correlation | Cronbach's Alpha if Item Deleted |
|---|---|---|---|---|
| X1.1 | 288.35 | 842.752 | .286 | .963 |
| X1.2 | 288.84 | 850.454 | .257 | .963 |
| X1.3 | 289.24 | 839.000 | .366 | .963 |
| X1.4 | 289.12 | 840.937 | .370 | .963 |
| X1.5 | 289.39 | 832.476 | .427 | .963 |
| X1.6 | 288.80 | 848.905 | .310 | .963 |
| X2.1 | 288.54 | 837.885 | .516 | .962 |
| X2.2 | 288.67 | 831.758 | .586 | .962 |
| X2.3 | 288.73 | 826.706 | .600 | .962 |
| X2.4 | 288.48 | 833.562 | .585 | .962 |
| X2.5 | 288.99 | 821.473 | .557 | .962 |
| X2.6 | 288.81 | 827.398 | .587 | .962 |
| X2.7 | 288.84 | 828.891 | .513 | .962 |
| X3.1 | 288.68 | 834.451 | .604 | .962 |
| X3.2 | 288.48 | 835.025 | .614 | .962 |
| X3.3 | 288.51 | 835.714 | .654 | .961 |
| X3.4 | 288.62 | 831.687 | .642 | .961 |
| X3.5 | 288.68 | 831.159 | .602 | .962 |
| X3.6 | 289.03 | 812.953 | .714 | .961 |
| X3.7 | 288.83 | 825.906 | .613 | .962 |
| X3.8 | 288.65 | 829.446 | .637 | .961 |
| X4.1 | 288.51 | 833.926 | .644 | .961 |
| X4.2 | 288.43 | 838.312 | .653 | .962 |
| X4.3 | 288.48 | 835.568 | .656 | .961 |
| X4.4 | 288.88 | 823.935 | .625 | .962 |
| X4.5 | 288.52 | 837.019 | .586 | .962 |
| X4.6 | 288.71 | 830.536 | .608 | .962 |
| X4.7 | 288.61 | 828.788 | .736 | .961 |

Table 5.27a. Cronbach's Alpha Coefficient of the survey variables' items

| | Scale Mean if Item Deleted | Scale Variance if Item Deleted | Corrected Item-Total Correlation | Cronbach's Alpha if Item Deleted |
|---|---|---|---|---|
| X4.8 | 288.54 | 831.010 | .709 | .961 |
| X4.9 | 288.51 | 834.151 | .644 | .961 |
| X4.10 | 288.60 | 828.592 | .670 | .961 |
| X4.11 | 288.54 | 833.196 | .640 | .961 |
| X4.12 | 288.56 | 834.359 | .647 | .961 |
| X4.13 | 288.47 | 840.270 | .552 | .962 |
| X4.14 | 288.57 | 834.081 | .657 | .961 |
| X4.15 | 288.66 | 828.954 | .696 | .961 |
| X4.16 | 288.63 | 837.200 | .514 | .962 |
| X4.17 | 288.62 | 833.236 | .677 | .961 |
| X4.18 | 288.75 | 829.008 | .639 | .961 |
| X4.19 | 288.57 | 834.882 | .684 | .961 |
| X4.20 | 288.67 | 828.095 | .655 | .961 |
| X4.21 | 288.68 | 828.999 | .653 | .961 |
| X4.22 | 288.52 | 834.171 | .620 | .962 |
| X5.1 | 288.45 | 840.003 | .526 | .962 |
| X5.2 | 288.61 | 834.253 | .558 | .962 |
| X5.3 | 288.67 | 830.389 | .598 | .962 |
| X6.1 | 288.54 | 835.203 | .654 | .961 |
| X6.2 | 288.61 | 836.907 | .601 | .962 |
| X6.3 | 288.52 | 839.105 | .625 | .962 |
| X6.4 | 288.46 | 841.918 | .607 | .962 |

Table 5.27a. (cont.) Cronbach’s Alpha Coefficient of the survey variables’ items

| Code | Construct | Number of items | Cronbach's Alpha Coefficient | Alpha for survey Data |
|---|---|---|---|---|
| X1 | Definition for port congestion | 6 | 0.787 | |
| X2 | Weakness in infrastructures | 7 | 0.859 | |
| X3 | Shortages in facilities. | 8 | 0.882 | 0.966 |
| X4 | Mismanagement causes | 22 | 0.951 | |
| X5 | Natural causes | 3 | 0.834 | |
| X6 | Economical causes | 4 | 0.888 | |

Table 5.27b. Cronbach's Alpha Coefficient of the survey constructs measurements

### 5.8.6 Correlation Analysis

This type of analysis is used to assess and describe the linear relationship between two variables and indicate any departure that can affect the correlation among the variables (Saunders et al., 2009). Thus, in this study, it was essential to see the level of relationship among the research variables by employing Pearson's correlation to assess these relationships (see Appendix K). All the study's variables have a significant value of correlation, and the correlation matrix table (appendix D) shows that these values represent good correlations between the variables. Also, most of them are greatly related to each other significantly at levels of 0.01 and 0.05.

### 5.8.7 Factor analysis

According to Byrne (2010), Exploratory factor analysis (EFA) is employed when there is a need for investigating the extent to which constructed measuring items in the questionnaire were linked to their latent variables. Thus, this research study has conducted the (EFA) to link observed and latent variables to find how and to what extent these observed variables are related to their underlying factors.

In EFA analysis, there are different ways to determine underline factors in a data set. One of these methods is the Principal Components Analysis (PCA). According to Tabachnick and Fidell (2007), PCA is the most common procedure for extracting the maximum variance from the data population regarding each component. The difference between EFA and PCA is that the PCA includes correlated variables with the purpose of reducing the numbers of variables and explaining the same amount of variance with fewer variables (principal components) whereas the EFA estimates factors, underlying constructs that cannot be measured directly (Suhr 2005; Alavi et al. 2020). The PCA deals with the linear combination of observed variables that are distinct and splits them into groups by maximising their component score variance (Tabachnick and Fidell 2007). Also, it is an analysis technique to identify patterns in the collected data by presenting this data by highlighting the similarities and differences of the data observed variables (Pallant 2007). Also, PCA is used to discover the relationship structures among the observed variables and categorise them according to the variability in the pattern of their correlations (Ibid). Finally, PCA is a suitable method for deconstructing the original data collection variables into smaller groups with the same linear combinations of variables variance.

The software package of SPSS 26 was used in this research to apply the PCA method for analysing the data collected, and the following data tests are conducted.

#### 5.8.7.1 KMO Test

The Kaiser-Meyer-Olkin measurement, or what is known as the KMO test, was conducted to know and test the sampling adequacy and suitability for using the factor analysis procedure (Hair et al. 2010). Table 5.28 demonstrates the results. The gained value of KMO is 0.908, which is above the recommended acceptable cut-off level value of 0.6 (Hair et al. 2010). This suggests that the KOM test confirms the adequateness of data sampling, and it is worthwhile to conduct factor analysis on this data. Moreover, the high value of the KOM test (0.908) indicated a high possibility of matching between the obtained factor components from the analysis and the ones assumed in the conceptual framework.

#### 5.8.7.2 Bartlett's Test of Sphericity

This test measures and confirms the relationship between observed variables in the data set. According to Hinton et al. (2004), the significant value of Bartlett's test of Sphericity of (< 0,05) is a sign of a good correlation between the observed variables, and it is worth continuing with the factor analysis procedure. From table 5.28, Bartlett's test of Sphericity was (< 0,000), which confirms the required statistical significance level.

Thus, the results from the tests mentioned above have confirmed the appropriateness of the collecting data for employing PCA factor analysis.

**KMO and Bartlett's Test**

| | | |
|---|---|---|
| Kaiser-Meyer-Olkin Measure of Sampling Adequacy. | | .908 |
| Bartlett's Test of Sphericity | Approx. Chi-Square | 10857.349 |
| | df | 946 |
| | Sig. | .000 |

Table 5.28. KMO Statistics and Bartlett's Test

#### 5.8.7.3 Communalities

It reveals the proportion of variance for each observed variable that shares with other analysed variables (Hair et al., 2007). Communalities values close to Zero indicate that these variables have nothing to share with other analysed variables. In contrast, values close to 1 mean that these variables have no random or specific variance (Field 2006). In a model containing multiple constructs, according to Hair et al. (2010), commonalities values can be extracted through factor loading where values less than 0.5 are considered appropriate commonality. Table 5.29 demonstrates that all observed variables maintained in the factor loading at the analysed data have commonality scores bigger than 0.5, a sign of high variance between observed variables.

**Communalities**

| | Initial | Extraction | | Initial | Extraction |
|---|---|---|---|---|---|
| **X2.1** | 1.000 | .722 | **X4.8** | 1.000 | .744 |
| **X2.2** | 1.000 | .712 | **X4.9** | 1.000 | .741 |
| **X2.3** | 1.000 | .704 | **X4.10** | 1.000 | .682 |
| **X2.4** | 1.000 | .631 | **X4.11** | 1.000 | .745 |
| **X2.5** | 1.000 | .650 | **X4.12** | 1.000 | .650 |
| **X2.6** | 1.000 | .578 | **X4.13** | 1.000 | .801 |
| **X2.7** | 1.000 | .645 | **X4.14** | 1.000 | .671 |
| **X3.1** | 1.000 | .571 | **X4.15** | 1.000 | .807 |
| **X3.2** | 1.000 | .765 | **X4.16** | 1.000 | .592 |
| **X3.3** | 1.000 | .764 | **X4.17** | 1.000 | .771 |
| **X3.4** | 1.000 | .721 | **X4.18** | 1.000 | .705 |
| **X3.5** | 1.000 | .616 | **X4.19** | 1.000 | .714 |
| **X3.6** | 1.000 | .829 | **X4.20** | 1.000 | .688 |
| **X3.7** | 1.000 | .698 | **X4.21** | 1.000 | .677 |
| **X3.8** | 1.000 | .676 | **X4.22** | 1.000 | .732 |
| **X4.1** | 1.000 | .798 | **X5.1** | 1.000 | .720 |
| **X4.2** | 1.000 | .768 | **X5.2** | 1.000 | .797 |
| **X4.3** | 1.000 | .659 | **X5.3** | 1.000 | .791 |
| **X4.4** | 1.000 | .793 | **X6.1** | 1.000 | .703 |
| **X4.5** | 1.000 | .724 | **X6.2** | 1.000 | .810 |
| **X4.6** | 1.000 | .509 | **X6.3** | 1.000 | .730 |
| **X4.7** | 1.000 | .678 | **X6.4** | 1.000 | .734 |

Extraction Method: Principal Component Analysis.

Table 5.29. Communalities.

### 5.8.7.4 Total variance explained

Based on Kaiser’s criterion, the factors are extracted in table 5.30 through their total variance explained for each component. From the initial run with principal component extraction, the quick estimation of the factors is calculated from the size of the reported eigenvalues (Tabachnich and Fidell 2007). Whereas factors with eigenvalues above one are considered significant, while factors with less than 1 eigenvalue are regarded as insignificant and ignored (Hair et al. 2010).

The results, as seen in table 5.30, indicate that from the collecting data of this research, only nine extracted factors were found to be with eigenvalues above one, and they explained a total variance of 70.94%, which is regarded as higher than was recommended by (Hair et al. 2910).

#### 5.8.7.5 Scree Plot

It is a graph commonly used to display and confirm the maximum extracted factors component with eigenvalues greater than “1”. According to Hair et al. (2010), this test is stemmed from plotting each factor by its total variance and according to extraction order and whereas the curve shape is used to determine the cut-off point.  Hence, the Scree Plot test was applied in this research study to confirm the results of factor components that were given by the eigenvalues criterion. The results gave the same number of 9 extraction factors (see figure 5.11).

#### 5.8.7.6 Factor Loadings

To better interpret these nine extracted factors, the researcher needs to apply rotational methods where the factors’ reference axes have to be turned from the origin. According to Hair et al. (2010), this rotation helps the researchers to have a simple model, enhance their interpretation and provide them with a theoretically meaningful pattern. There are two methods for rotation in the EFA analysis oblique and orthogonal. The differentiation between those methods implies that oblique rotation has more flexibility and gives more information regarding the correlation among factors (Hair et al., 2010). The other orthogonal method has three different techniques: quartimax, varimax, and equimax. Among these three techniques, varimax is mostly used due to its structural simplicity which helps the researcher to clearly distinguish the positive or negative relation between factors and their item variables (Hair et al. 2010).

The Varimax rotation technique was performed in this research study (see Appendix E). The table in the appendix shows the rotated component matrix where nine factors’ loadings were extracted for all constructs with loadings scores all above 0.3.

## Total Variance Explained

| Component | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | | Rotation Sums of Squared Loadings | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % |
| 1 | 18.774 | 42.668 | 42.668 | 18.774 | 42.668 | 42.668 | 4.858 | 11.041 | 11.041 |
| 2 | 2.554 | 5.806 | 48.473 | 2.554 | 5.806 | 48.473 | 4.248 | 9.655 | 20.697 |
| 3 | 1.900 | 4.318 | 52.791 | 1.900 | 4.318 | 52.791 | 3.895 | 8.852 | 29.548 |
| 4 | 1.654 | 3.760 | 56.551 | 1.654 | 3.760 | 56.551 | 3.773 | 8.574 | 38.123 |
| 5 | 1.557 | 3.538 | 60.089 | 1.557 | 3.538 | 60.089 | 3.410 | 7.750 | 45.873 |
| 6 | 1.451 | 3.298 | 63.387 | 1.451 | 3.298 | 63.387 | 3.144 | 7.146 | 53.019 |
| 7 | 1.196 | 2.718 | 66.105 | 1.196 | 2.718 | 66.105 | 2.945 | 6.693 | 59.712 |
| 8 | 1.116 | 2.535 | 68.640 | 1.116 | 2.535 | 68.640 | 2.776 | 6.309 | 66.021 |
| 9 | 1.012 | 2.301 | 70.941 | 1.012 | 2.301 | 70.941 | 2.165 | 4.920 | 70.941 |
| 10 | .912 | 2.074 | 73.015 | | | | | | |
| 11 | .858 | 1.950 | 74.964 | | | | | | |
| 12 | .833 | 1.893 | 76.858 | | | | | | |
| 13 | .756 | 1.719 | 78.577 | | | | | | |
| 14 | .737 | 1.674 | 80.250 | | | | | | |
| 15 | .683 | 1.553 | 81.803 | | | | | | |
| 16 | .648 | 1.472 | 83.275 | | | | | | |
| 17 | .592 | 1.345 | 84.620 | | | | | | |
| 18 | .540 | 1.228 | 85.848 | | | | | | |
| 19 | .479 | 1.089 | 86.937 | | | | | | |
| 20 | .454 | 1.031 | 87.968 | | | | | | |
| 21 | .430 | .976 | 88.944 | | | | | | |
| 22 | .410 | .931 | 89.876 | | | | | | |
| 23 | .366 | .832 | 90.708 | | | | | | |
| 24 | .359 | .816 | 91.524 | | | | | | |
| 25 | .337 | .765 | 92.289 | | | | | | |
| 26 | .330 | .749 | 93.038 | | | | | | |
| 27 | .310 | .705 | 93.743 | | | | | | |
| 28 | .277 | .629 | 94.371 | | | | | | |
| 29 | .268 | .609 | 94.980 | | | | | | |
| 30 | .239 | .544 | 95.524 | | | | | | |
| 31 | .230 | .523 | 96.047 | | | | | | |
| 32 | .204 | .463 | 96.510 | | | | | | |
| 33 | .197 | .447 | 96.957 | | | | | | |
| 34 | .180 | .410 | 97.367 | | | | | | |
| 35 | .166 | .378 | 97.744 | | | | | | |
| 36 | .162 | .368 | 98.113 | | | | | | |
| 37 | .143 | .325 | 98.438 | | | | | | |
| 38 | .136 | .310 | 98.747 | | | | | | |
| 39 | .119 | .271 | 99.019 | | | | | | |
| 40 | .100 | .226 | 99.245 | | | | | | |
| 41 | .097 | .219 | 99.464 | | | | | | |
| 42 | .086 | .195 | 99.659 | | | | | | |
| 43 | .080 | .182 | 99.841 | | | | | | |
| 44 | .070 | .159 | 100.000 | | | | | | |

Extraction Method: Principal Component Analysis.

Table 5.30. Total Variance Explained.

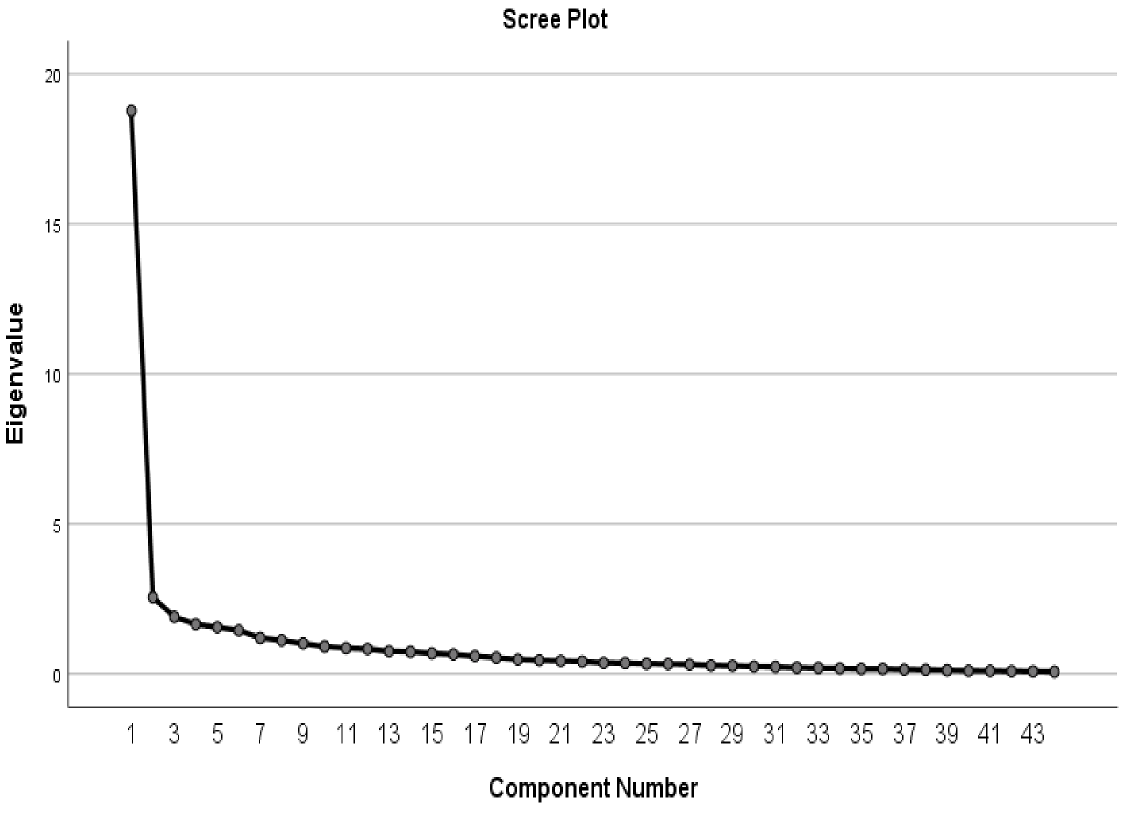



Figure 5.11. Scree Plot

Factor loadings show the degree of correspondence, and they explain the correlation between each observed variable and the factor component they were assigned to. According to Hair et al. (2010), high loading scores reveal that the component factor represents the observed variable well. Also, they argued that factor loadings scores between 0.3 – 0.7 are acceptable for an exploratory study since these loadings' values are enough for a minimal level for interpreting the measured structures. However, and looking back to the matrix table in appendix "L", a small number of items have cross-loading on more than one component factor. So, to overcome any potential overlapping that might occur between underlying constructs, there is a need for eliminating this problematic cross-loading issue by assigning the problematic item only once through considering it with the highest loading score factor (Byrne 2010). Thus, the rotated component matrix was reproduced with nine underlying factors and 43 variable items (Table 5.31).

**Rotated Component Matrix**

| | Component | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| X2.1 | | | | | .747 | | | | |
| X2.2 | | | | | .656 | | | | |
| X2.3 | | | | | .681 | | | | |
| X2.4 | | | | | .604 | | | | |
| X2.5 | | | | | .440 | | | | |
| X2.6 | | | | | .344 | | | | |
| X2.7 | | | | | .368 | | | | |
| X3.1 | | | | | | | | .493 | |
| X3.2 | | | | | | .698 | | | |
| X3.3 | | | | | | .689 | | | |
| X3.4 | | | | | | .611 | | | |
| X3.5 | | | .577 | | | | | | |
| X3.6 | | | .748 | | | | | | |
| X3.7 | | | | | | | | .661 | |
| X3.8 | | | | | | | | .534 | |
| X4.1 | .647 | | | | | | | | |
| X4.2 | .640 | | | | | | | | |
| X4.3 | .546 | | | | | | | | |
| X4.4 | | | | | | | | | |
| X4.5 | .628 | | | | | | | | |
| X4.6 | | | | .384 | | | | | |
| X4.7 | .480 | | | | | | | | |
| X4.8 | .485 | | | | | | | | |
| X4.9 | .606 | | | | | | | | |
| X4.10 | .611 | | | | | | | | |
| X4.11 | .633 | | | | | | | | |
| X4.12 | .445 | | | | | | | | |
| X4.13 | | | | | | | | | .753 |
| X4.14 | | | | | | | | | .351 |
| X4.15 | | .715 | | | | | | | |
| X4.16 | | | | | | | | | .554 |
| X4.17 | | | | | | | | | .360 |
| X4.18 | | .709 | | | | | | | |
| X4.19 | | .502 | | | | | | | |
| X4.20 | | .488 | | | | | | | |
| X4.21 | | .515 | | | | | | | |
| X4.22 | | .466 | | | | | | | |
| X5.1 | | | | | | | .612 | | |
| X5.2 | | | | | | | .816 | | |
| X5.3 | | | | | | | .748 | | |
| X6.1 | | | | .649 | | | | | |
| X6.2 | | | | .764 | | | | | |
| X6.3 | | | | .693 | | | | | |
| X6.4 | | | | .576 | | | | | |

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.[a]
a. Rotation converged in 32 iterations.

Table 5.31. Reproduced Rotated Component Matrix after eliminating the cross-loading items.

Also, table 5.32 demonstrates the eliminated variable item from the previous step, where the X4.4 was put off as it indicates the same construct measurement of X3.5 and X3.6 but with fewer loadings' values.

| Item Code | Item description |
|---|---|
| X4.4 | The increase in the complexity of port operations that has been noticed lately due to the increase in ship size and the increasing in the ships' sharing alliance between companies has resulted in reducing the efficiency of cargo handling operations. |

Table 5.32. The eliminated item from Rotated Component Matrix.

#### 5.8.7.7 The nine underline factors

From a total of 44 variables items that were yielded from the systematic literature review stage (chapter 4), an online survey method was conducted based on these variables to confirm and gain the port stakeholders' responses about the common factors for the port congestion problem. Only 43 items have come out from the EFA analysis, and these were simplified as nine common factors behind the arising of congestion situations at ports. These factors are presented in table 5.33, starting from the highest loading value to the lowest. Also, a comparison was made between the common causes for the port congestion problem that were yielded from the previous stage (systematic literature review) and the ones from the EFA analysis. This comparison is presented in table (5.34).

<u>Factor 1:  Mismanagement due to technical issues</u>. Factor one from the EFA analysis was matched entirely with the internal causes of the problem due to mismanagement of technical issues which were yielded from the systematic review with the same order of priority. However, the EFA analysis considered issue X4.6, “Imposing cheaper prices for storing cargoes in ports than outside ports”, as an external cause due to economic issues (table 5.35). This consideration might be related to behavioural uncertainty for this variable where the market usually controls the prices and is out of management control.

Table 5.33. Observed variables associated with their loadings extracted factors

| Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 | Factor 6 | Factor 7 | Factor 8 | Factor 9 |
|---|---|---|---|---|---|---|---|---|
| Inefficient management for port passages and port accesses could lead to impose time delays on both ships and trucks and result in congestion problems at ports. | Poor port regulations and policies have contributed greatly to arise the port congestion situations at ports. | The recent increase in ships' size (especially container ships) has caused putting more constraints on the existing equipment's capacities at the port that receive this type of ship. | The sudden increase in international trade in a port might lead to arise congestion problems at this port. | Insufficient port storage area capacities could cause to arise congestion issues at ports. | An inadequate number of port cranes could lead to increase time delays in the handle cargo operations at this port. | Bad weather is an environmental uncertainty that could lead to delayed ships and congested Seaports. | An inadequate number of tugboats at the port could lead to increasing the waiting times for ships that call this port. | Bureaucracy and severe customs regulations might lead to increasing the processing time and impose extra time delays on entering ships to the port and clearing cargoes from ports. |
| Unproductive cargo handling operations could create unwanted time delays and establish congestion nods at the other port operations. | The excessive number of port labours has contributed highly to unproductive operations in ports (especially at traditional public ports) and increasing strikes problems | The increase in ships sharing alliance between companies has caused putting more constraints on the existing equipment's capacities at the port that receive this type of ship. | The sudden increase in the trade local demand from a country or a region might lead to arise congestion situations at the ports of this country or the region. | Insufficient port gate capacities could result in congestion cargo traffic situations at port gates. | An inadequate number of other port equipment such as (straddles, trailers, port trucks, and X-ray screening machines.) could result in rising congestion situations at port berths, yards, and gates. | Tide issues are an environmental uncertainty that could lead to delayed ships and congested Seaports. | An inadequate number of port gates can result in congestion problems at the port yards, gates, and accesses. | Centralism and monopolism in government public sectors have contributed highly to causing congestion at ports, especially in developing countries ports. |
| Inefficient management of cargo handling equipment could lead to congestion problems at the cargo handling operation and might result in arising congestion at all port operations. | Labour inefficiency is a great cause for imposing time delays at cargo handling operations in ports. | | In a country or a region when the trade (the cargo traffic) is concentrated on a certain port, this could lead to congesting this port while the other ports remain ineffective. | Inadequate development in other port infrastructures such as port ways, yard lights, yard refrigerators sockets, etc., could contribute highly to increasing the rate of congestion | Shortages in supplying equipment spare parts that might need for repairing them frequently could result in increasing equipment stoppages and delay times in port operations. | Floods issues are an environmental uncertainty that could lead to delayed ships and congested Seaports. | Insufficient capacities of port passages and port accesses (Roads, rail lines, and water channels) might lead to arise congestion situations on port berths, port yards, and port gates. | A 100% cargo inspection policy at some ports has caused to increase in the cargo dwelling time at port yards and port gates. |
| Employing unqualified staff in ports will lead eventually to decreasing the productivity and efficiency of port operations. | Insufficient working hours at ports could be a direct cause for imposing delay times on both operations ship entering and cargo clearing. | | Imposing cheaper prices for storing cargoes in ports (than outside ports) by port management could lead to overstating time periods for cargoes and result in congesting port storing areas. | Insufficient port berths' capacities at a port could increase the ships waiting times at this port. | | | | Inadequate development government policies and regulations (especially in developing countries) have caused a decline in port operation efficiency and productivity of their ports. |

5.33. “Cont.” Observed variables associated with their loadings extracted factors

| Continued factor 1 | Continued factor 2 | Continued factor 3 | Continued factor 4 | Continued factor 5 | Continued factor 6 | Continued factor 7 | Continued factor 8 | Continued factor 9 |
|---|---|---|---|---|---|---|---|---|
| Inefficient port yard template plans (especially in container terminals) could generate congestion situations at these container terminals. | Labour strikes at ports are a significant issue that causes to arise congestion situations at ports. | | Seasonality (increasing cargo traffic on a port at certain times of the year) might lead to arise a congestion situation at this port during these times. | Insufficient depths of the sea entrance, sea channels, and port berths for a port could increase the possibility to congest this port. | | | | |
| Inefficient plans for allocating ships at port berths could cause to arise congestion situations at port berths. | Corruption at ports and government systems such as port operations, customs, and government institutions could lead to imposing time delays on processing ships' entrances and cargo clearing operations. | | | * Inadequate development in the infrastructures of the hinterland intermodal could lead to arise congestion situations at ports or/and around ports. | | | | |
| Accidents at ports sea channels and berths could lead to increase ship waiting times before entering these ports. | | | | * Inadequate development in the port hinterland other systems such as telecommunications, internet networks, and banks system could impose delay times for port users and result in congesting this port. | | | | |
| Poor management for maintaining and repairing port facilities such as tugboats and the sea entrance’s lights might result in delaying ships from entering the port. | | | | | | | | |
| The lack of information exchange between port actors (Port operators, Customs, Shippers, and truck companies) could result in inefficient port operations and as consequences increase delays times for ships and/or trucks at the port resources. | | | | | | | | |
| * Inefficient management of the hinterland accesses (Roads, rail lines, and water channels) could lead to traffic congestion situations at ports and around them. | | | | | | | | |

* Item variables with duple cross scores were assigned to the most appropriate factor instead of the high loadings’ values.

Table 5.34. Comparison between factors (causes for port congestion) generated from both systematic review and online survey

| | Common Factors "Causes" for port congestion from the Systematic review | | | Common Factors "Causes" for port congestion from the Online Survey | | |
|---|---|---|---|---|---|---|
| Internal causes | weakness in infrastructures | | **X2.1-** Inadequate development in other port infrastructures such as port ways, yard lights, yard refrigerators sockets, etc.,<br>**X2.2**- Insufficient port storage area capacities.<br>**X2.3**- Insufficient port gates capacities<br>**X2.4**- Insufficient berth capacity<br>**X2.5**- Low channel, entrances, and berths' depth.<br>**X2.6**- Weak intermodal infrastructures<br>**X2.7**- Weak in internet and banking system | **Factor 5** | **weakness in infrastructures** | **X2.2**- Insufficient port storage area capacities.<br>**X2.3**- Insufficient port gate capacities.<br>**X2.1**- Inadequate development in other port infrastructures such as port ways, yard lights, yard refrigerators sockets, etc.,<br>**X2.4**- Insufficient port berths' capacities.<br>**X2.5**- Low channel, entrances, and berths' depth.<br>**X2.6**- Weak intermodal infrastructures<br>**X2.7**- Weak in internet and banking system |
| | *Shortages in facilities | | **X3.1-** An inadequate number of port gates<br>**X3.2**- An inadequate number of port cranes<br>**X3.3**- An inadequate number of other port equipment such as (straddles, trailers, port trucks, and X-ray screening machines.)<br>**X3.4**- Shortages in equipment's spare parts<br>**X3.5**- Increase vessel size<br>**X3.6**- Vessel sharing alliance increased<br>**X3.7**- An inadequate number of tugboats.<br>**X3.8**- Insufficient capacities of port passages and port accesses (Roads, rail lines, etc..) | **Factor 6** | **Shortages in port equipment** | **X3.2**- An inadequate number of port cranes<br>**X3.3**- An inadequate number of other port equipment such as (straddles, trailers, port trucks, and X-ray screening machines.)<br>**X3.4**- Shortages in supplying equipment's spare parts. |
| | | | | **Factor 8** | **Shortages in port passages and entrances facilities** | **X3.7**- An inadequate number of tugboats.<br>**X3.1**- An inadequate number of port gates<br>**X3.8**- Insufficient capacities of port passages and port accesses (Roads, rail lines, etc.) |
| | Mismanagement | Technical | **X4.1**- Inefficient management for port passages and port accesses<br>**X4.2**- Inefficient port operation and productivity<br>**X4.3**- Inefficient management for cargo handling equipment<br>**X4.4**- Increasing operation complexity<br>**X4.5**- Employing unqualified staff<br>**X4.6**- Imposing cheaper prices for storing cargo in ports (than outside ports)<br>**X4.7**- Inefficient yard template planning<br>**X4.8**- Inefficient plans for allocating ships<br>**X4.9**- Accidents<br>**X4.10**- Poor maintenance for port facilities<br>**X4.11**- Lack of information exchange between port actors<br>**X4.12**- Inefficient hinterland access | **Factor 1** | **Mismanagement Technical** | **X4.1**- Inefficient management for port passages and port accesses<br>**X4.2**- Inefficient port operation and productivity<br>**X4.3**- Inefficient management for cargo handling equipment<br>**X4.5**- Employing unqualified staff<br>**X4.7**- Inefficient port yard template plans<br>**X4.8**- Inefficient plans for allocating ships<br>**X4.9**- Accidents<br>**X4.10**- Poor maintenance for port facilities<br>**X4.11-** Lack of information exchange between port actors<br>**X4.12**- Inefficient management for the hinterland access |
| | | Policy | **X4.13-** Bureaucracy and severe customs regulation<br>**X4.14**- Centralism and monopolism<br>**X4.15**- Poor port regulations and policies<br>**X4.16**- 100% cargo inspection at ports<br>**X4.17**- Un-developing government policies and regulations (especially in developing countries) | **Factor 9** | **Mismanagement Policy** | **X4.13**- Bureaucracy and severe customs<br>**X4.14**- Centralism and monopolism<br>**X4.16**- A 100% cargo inspection policy at some<br>**X4.17**- Inadequate development government policies and regulations (especially in developing countries) |
| | | Social | **X4.18**- Excessive number of port workers<br>**X4.19**- Labour inefficiency<br>**X4.20**- Less working hours<br>**X4.21**- Strikes<br>**X4.22**- Corruption at ports and government systems | **Factor 2** | **Mismanagement Social** | **X4.15**- Poor port regulations and policies<br>**X4.18**- Excessive number of port labours<br>**X4.19**- Labour inefficiency<br>**X4.20**- Insufficient working hours at ports<br>**X4.21**- Labour strikes<br>**X4.22**- Corruption at ports and government systems |

* The cause of Shortages in facilities has been divided into two factors by EFA: factor 6 (**Shortages in port equipment**) which included **X3.2, X3.3**, and **X3.4** and factor 8 (**Shortages in port passages and entrances facilities**) which included variables **X3.7, X3.1**, and **X3.8.**

Table 5.34. "Cont." Comparison between factors (causes for port congestion) generated from both systematic review and online survey

| | Common Factors "Causes" for port congestion from the Systematic review | | | Common Factors "Causes" for port congestion from the Online survey | |
|---|---|---|---|---|---|
| **External causes** | **Natural** | **X5.1**- Bad weather<br>**X5.2**- Tide<br>**X5.3**- Flood | **Factor 7** | **Natural** | **X5.1**- Bad weather<br>**X5.1**- Tide<br>**X5.1**- Flood |
| | **Economic** | **X6.1**- Increasing international trade<br>**X6.2**- Increasing local demand<br>**X6.3**- Concentration trade on a certain port<br>**X6.4**- Seasonality | **Factor 4** | **Economic** | **X6.1**- Sudden increase in the international trade<br>**X6.2**- Sudden increase in the trade local demand<br>**X6.3**- concentrating trade on a certain port,<br>***X4.6**- Imposing cheaper prices for storing cargo in ports (than outside ports)<br>**X6.4**- Seasonality |
| | | | **Factor 3** | **Constraints due to the growth of capacity** | ****X3.5** - The recent increase in ships' size (especially container ships) has caused putting more constraints on the existing equipment's capacities at the port that receive this type of ship.<br>****X3.6** - The increase in the ship-sharing alliance between companies has caused putting more constraints on the existing equipment's capacities at the port that receive this type of ship. |

***** X4.6. has been moved by EFA from Internal Mismanagement causes due to technical issues to external causes' Economic issues.

****** X3.5 and X3.6 Have been moved by EFA from the shortages in facilities to be in spilt factor 3 which is an External cause due to **Constraints due to the growth of capacity**

Factor 2: Mismanagement due to social issues. Also, this factor matched and represented the internal causes because of the mismanagement of social issues that were gained in the previous stage of the systematic review. Furthermore, all these issues remained with the same priority. However, the issue of ***X4.15,*** *“Poor port regulation and policies have contributed greatly to the port congestion situations at ports” was removed, by the EFA analysis, from mismanagement due to policy issues to be considered* mismanagement due to social issues. The consideration behind this might be that those poor regulations might result in social issues such as labour strikes, insufficient working hours, and corruption.

Factor 3: Constraints due to growth of capacity. This factor is new and was generated through the EFA analysis. The EFA factor analysis took the two dependent variables **X3.5** *“The recent increase in ships size (especially container ships) has caused putting more constraints on the existing equipment’s capacities at the port that receive this type of ships.”,* and **X3.6** *“The increase in ships sharing alliance between companies has caused for putting more constraints on the existing equipment's capacities at the port that receive this type of ships.”* from the internal causes due to the shortages in facilities that were yielded at systematic review stage and consider them under new independent variable that causes port congestion. This consideration might be related to the constraints and the pressure generated by the growth of ships' capacities (due to an increase in vessel size and ship-sharing alliance between companies) and put on the organizations’ systems (port and/or hinterland infrastructures, port and/or hinterland facilities, and port and/or hinterland management). This factor can be interpreted as an external cause for port congestion problems due to constraints of the growth of ship capacity.

Factor 4: Economic causes for port congestion. This factor matched and represented the external causes due to the economic issues that were gained in the previous stage of the systematic review. However, the EFA analysis added one more variable, ***X4.6,*** *“Imposing cheaper prices for storing cargoes in ports than outside ports” to* these economic causes. This issue was taken from the causes due to mismanagement technical issues. This consideration, as discussed previously, might be related to a behavioural uncertainty for this variable where the market usually controls the prices and is out of the management's control, and it is an external economic issue.

Factor 5**:** Weakness in infrastructures. Factor five from the EFA analysis was completely matched with the internal causes of the problem due to weakness in infrastructure issues which were yielded from the systematic review. However, the issue priority order for (variables) has been changed due to the ranking of highest to lowest loading values.

Factor 6**:** Shortages in port equipment. Factor six, as extracted by EFA analysis, is partially matched with the internal causes of the problem due to shortages in facilities issues yielded from the systematic review, where this factor only considers the shortages in port equipment which are represented by ***X3.2*** *"An inadequate number of port cranes"*, ***X3.3*** *"An inadequate number of other port equipment such as (straddles, trailers, port trucks, X-ray screening machines.)"*, and ***X3.4*** ***"****Shortages in supplying equipment's spare parts"* while other shortages in facilities concerning port entrances, accesses and hinterland passages were related to another factor (factor 8).

Factor 7**:** Natural causes. The comparison from table 5.34 shows no change for the dependent variables (issues) under the independent variable "natural causes". All these natural issues that represented the behaviour uncertainty in weather and natural disaster remained the same as were yielded from the systematic review and appeared under factor 7.

Factor 8**:** Shortages in port passages and entrance facilities. As discussed in factor six, this factor (factor 8) considers the remained items (Issues) of the internal causes due to shortages in facilities gained in the previous systematic review. These items are ***X3.7*** *"An inadequate number of tugboats"*, ***X3.1*** ***"****An inadequate number of port gates"*, and ***X3.8*** *"Insufficient capacities of port passages and port accesses (Roads, rail lines, etc.)"*. In fact, the only logic behind dividing the internal causes due to shortages in facilities (as it was yielded from systematic review) into two main common factors by the EFA analysis (factors 6 and 8) can be related to what respondents might perceive and consider that port equipment and facilities are different from port accesses facilities and hinterland intermodal.

Factor 9: Mismanagement policy issues. Factor nine from the EFA analysis completely matched the internal causes of the problem due to mismanagement policy issues which were yielded from the systematic review with the same order of priority. However, issue ***X4.15*** *"Poor port regulation and policies have contributed greatly to the port congestion situations at ports" was considered by the EFA analysis as an internal cause due to the Mismanagement of social issues (see* table 5.34). The reason behind this consideration was discussed previously in factor 2.

#### 5.8.7.8 Reliability and Validity of the EFA factors component.

The Reliability and validity tests were commenced after the EFA analysis had been done, as was explained in sections 5.5.1 and 5.5.2. The results of these tests are indicated in table 5.35. First, Alpha Cronbach's are above 0.7, which means that the factors have excellent internal consistency (reliability) (Hair et al. 2010). Also, for the convergent validity of the measurements, most values for both factor loadings and average variance extracted (AVE) are above 0.5, which means that these constructs have a valid convergent model (Hair et al., 2010).

| Factor no. | Extracted factor | Number of items | Cronbach's Alpha Coefficient > 0.5 | Convergent Validity | | Discriminant Validity | Nomological validity |
|---|---|---|---|---|---|---|---|
| | | | | Factor loadings > 0.5 | Average Variance Extracted AVE > 0.5 | | |
| **F1** | Mismanagement technical issues | 10 | 0.925 | Ranged from 0.445 to 0.647 | 0.70 | yes | yes |
| **F2** | Mismanagement social issues | 6 | 0.878 | Ranged from 0.466 to 0.715 | 0.68 | yes | yes |
| **F3** | Constraints due to growth of capacity. | 2 | 0.807 | Ranged from 0.577 to 0.748 | 0.66 | yes | yes |
| **F4** | Economic causes for port congestion | 5 | 0.874 | Ranged from 0.384 to 0.764 | 0.63 | yes | yes |
| **F5** | Weakness in infrastructures | 7 | 0.859 | Ranged from 0.344 to 0.747 | 0.60 | yes | yes |
| **F6** | Shortages in port equipment | 3 | 0.848 | Ranged from 0.611 to 0.698 | 0.56 | yes | yes |
| **F7** | Natural causes | 3 | 0.834 | Ranged from 0.612 to 0.816 | 0.52 | yes | yes |
| **F8** | Shortages in port passages and entrances facilities | 3 | 0.769 | Ranged from 0.493 to 0.661 | 0.48 | yes | yes |
| **F9** | Mismanagement policy issues | 4 | 0.801 | Ranged from 0.351 to 0.753 | 0.42 | yes | yes |

Table 5.35. Internal consistency (reliability) and the validity for the 9 extracted factors.

The discriminant validity was achieved by eliminating cross-loadings by assigning the duple cross item only to the factor with the highest loadings value (Hair et al., 2010). Furthermore, the nomological validity has been achieved and met by interpreting each component factor, which was done in previous sections. Finally, criterion-related validity has not been tested in this study as this validity concerned and predicted the differentiation among respondents (Sekaran 2003). This was not targeted by conducting the EFA since this research is not concerned with differentiation among port stakeholders.

## 5.9. Chapter summary and conclusion

In this chapter, an online survey was carried out to reach a consensus about defining the port congestion problem and to identify the common factors behind the congestion problem at seaports based on the theoretical, conceptual framework developed early by Eddrgash (2019) and the port congestion causes that were identified and yielded from the systematic literature review method (chapter 4).

An online questionnaire was built, distributed, and analysed to obtain and model the port congestion definition and to identify the common factors behind the problem. Dependent and independent latent variables were used to measure the port stakeholders' perceptions regarding port congestion definition and to identify the causes behind the congestion problems at ports. To acquire this identification, the researcher has developed measurement scales during the previous chapter (the systematic literature review research) based on the theoretical, conceptual framework developed early by Eddrgash (2019). Six latent constructs variables (X1 to X6), six items' variables on defining port congestion problem, and 44 items on identifying the causes for port congestion problem. These items were measured by questions designed to gain better responses and outcomes using a seven-point Likert scale starting with "strongly agree" and ending with "strongly disagree". Then the respondents were asked to choose the three most important items from each variable (X1 to X6), which were put without ranking. This was for cross-checking whether the high score in Likert answers produced by each respondent matches its three prioritised items for the same variable.

Validating these measurement scales started with a pre-testing pilot survey study, where the Coefficient Alpha for the pilot survey was examined. This was followed by applying descriptive statistics analysis for the respondents' demographical information and port congestion definition. Then was followed by commencing the EFA to test each factor dimension beginning with correlation coefficients and then extracting the common factors and rotating them. The EFA results were presented and discussed in this chapter in the results section.

Results from the first step of the descriptive statistics analysis showed that the respondents chose the definition produced by the researcher as the best definition that defines the port congestion problem. It accounts for all aspects of the phenomena. This will give a good foundation for any future research on the port congestion problem and help port operators and decision-makers better identify the problem and overcome its causes.

In the final step, the researcher commenced an analysis technique to test the scales' factorial structure. One of the famous types of EFA is the principal component analysis PCA, which is commonly used, during the early stage of measurement scale development, as an analysis technique to refine and validate the developed scales. This is due to the PCA being a valuable analysis technique for enabling the researcher to understand the correlations between the constructs and their relevant indicators. Also, one of the PCA strengths is that it is beneficial as an analysis tool, especially when there is a lack of theory about the under-investigation constructs. This step started with testing the reliability, where the Coefficient Alpha for all survey variables needs to be examined. Then the EFA has to be commenced to test each factor dimension beginning with correlation coefficients and then extracting the common factors and rotating them (Hair et al. 1998). The results from EFA indicated that only 43 items have come out from the EFA analysis, and these were simplified as nine common factors behind the arising of the congestion situations at ports. These factors are presented in table 5.34, starting from the highest loading value to the lowest. Also, a comparison was made between the common causes for the port congestion problem that were yielded from the previous stage (systematic literature review) and the ones from the EFA analysis. This comparison was presented in table (5.35).

# Chapter Six: Conclusions

This chapter aims to sum up, conclude, and reflect on the research findings. In this chapter, section 6.1 introduces the research topic again. Section 6.2 gives a brief summary of the whole thesis, and the revision of the study plan is in section 6.3. Then section 6.4 presents the research's key findings, while section 6.5 introduces the study limitation and recommendations for future research. Finally, the contribution of the base knowledge is discussed in section 6.6.

## 6.1. Introduction.

The importance of Ports has resulted from their significant role and contribution to developing nations' economies. They are the primary hubs and the main centres of services and cargo operations within a supply chain since their efficiency and productivity become significant issues for the supply chain as a whole. Also, the reliability of their services is an essential element to achieving the country's economic development via fast supplies that the industries, government, and people are required to accomplish this development. Since congestion at ports implies a loss of time and money, it decreases their competitive role with neighbouring ports to attract more vessel calls, and cargo traffics. Also, consequently, it undermines their competitive position in the maritime logistic chains.

Congestion situations at any port can be induced by the mutual relation between the demand for port resources' services and the supply of these services that the port resources can offer. This relationship between demand and supply can be impacted by many factors (internal and external) that need to be addressed by the government, port operators, and decision-makers to find proper solutions for lessening the congestion impacts on the whole maritime logistic chain. However, these factors remain complex and multidimensional, and there is uncertainty in time and space. To understand this diversity and complexity, dividing and categorising the source types of port congestion problems is, in fact, needed for both academic and port industry fields. Therefore, the researcher in this study identified these main categories of congestion based on his previous study (Eddrgash 2019), where he explored and understood the problem from a subjective view. Then the results from this stage have been adopted in this thesis to carry out two quantitative methodologies: a systematic literature review and an online survey to reach a more consensus definition for the problem and identify the common factors behind the arising of congestion situations at ports.

## 6.2. Thesis summary

**Chapter one:**

The chapter started by describing and introducing the congestion problem, then discussed the motivation for the study and its research background and aims. The chapter then states the research problem statement as "It is difficult for academic researchers, port managers and policymakers to identify common main causes and their solutions that caus*e congestion situations to arise at ports".* This chapter also discussed and explained the research objectives and set up the research questions as follows:

1. What is the best definition for the port congestion problem that can comprehensively express port congestion situations?

    1.1 What is the consensus among the port practitioners on a common or united definition of the port congestion problem?

2. What are the common reasons that lead for arising the congestion problems at ports?

    2.1. What are the internal causes that impact the port systems and cause port congestion situations to arise at any port?

    2.2. What are the external causes impacting the port systems and causing the port congestion situations to arise at any port?

3. What are the possible solutions to those common reasons for the port congestion problem?

    3.1. What is the role of the government in solving port congestion situations?

    3.2. What is the role of the port operators in solving port congestion situations?

    3.3. What is the role of the shipping lines or ship owners in solving the port congestion situations?

Finally, the chapter briefly introduced and demonstrated the researcher's philosophical stance and methodology for carrying out this study.

**Chapter two:**

In this chapter, the researcher has explored the rich literature about the port congestion phenomenon. It started with a background on the port congestion problem where the port congestion landscape seemed to be varied and diversified from one port to another. Also, while extreme port congestion situations rose at some ports and container terminals, others have not experienced congestion problems, and a few others are still in between.

Then the chapter extracted the definitions for the port congestion problem from the literature and elaborated on the consensus among scholars on defining the phenomenon. The diversity in defining the problem of port congestion in the literature has emerged from the fact that the reasons behind the port congestion problem in ports are complicated and multi-dimensional. They also differ from one country to another and even from port to port.

This chapter also presented the type of port congestion levels discussed in the literature. Congestion problems at seaports can be raised at one or more of these three different levels of port congestion:

***Seaside congestion level:*** The first type is the ship entry/exit route congestion, and the second type of seaside congestion is the ship to berth congestion.

***Landside congestion level:*** The first type of landside congestion is ship work congestion, and the second type of landside congestion is cargo storage and stack congestion. The third type of land congestion type is vehicle work congestion.

***Hinterland-side congestion level:*** The first type of hinterland-side congestion is vehicle gate congestion, and the second type of hinterland-side congestion is vehicle route congestion.

Finally, this chapter has identified, elaborated, and discussed all the reasons behind the port congestion problem in the previous literature. To provide a broad picture of the reasons behind the port congestion problem, the researcher has theoretically classified the causes of the port congestion problem and their proposed solutions prevalent in the previous literature into five categories. These five categories were built according to the type of classification that triggers and raises the situations of congestion at world ports:

***Natural Reasons:*** The port operations stoppages and delays due to bad weather, flooding, and tide conditions create waiting times and queue vessels before entering the port. These types of port congestion causes, except tide, are usually out of the hand of port operators and port users, and none of them can do anything other than just wait for those uncontrolled conditions to pass.

***Economic Reasons***. Since most of the world ports have been already developed to their maximum physical capacity; any sudden increase in the seaborne trade or local market demand for goods in their country or region will consequently lead to the cargo flow through them. This situation often results in congested ports and puts more strain on the international supply chain. To solve these congestion problems, the government needs to balance and equally distribute this increased traffic in trade flow to all its country ports. This can be done by investing in developing its smaller ports and establishing policies and regulations that encourage shippers to use them.

***Technical Reasons:*** Most scholars look to the port congestion phenomena as issues caused by technical problems in the literature. These technical problems sometimes are clear, such as the breakdowns and the shortages of port equipment or, in other cases, related to technical issues such as inefficient operation and management of port resources or poor port infrastructures. Most published studies in the previous literature have focused on improving port operation efficiency and managing the port gates' capacity to solve the problem of congestion situations at seaports.

***Policies Reasons:*** where congestion problems arise due to inefficient government or port policies and regulations, such as imposing the custom regulation of 100% cargo inspection. The pricing policies for storing cargoes at port yards where the scarcity of terminal storing spaces make the need for increasing the storage pricing policies to maintain the high port productivity and performance. Also, in developing countries, ineffective governing rules and policies that encourage monopoly, and bureaucracy in their public sectors, are important causes of existing port congestion situations. The government should ease the severe inspection cargo policies and establish new rules that prevent monopoly and bureaucracy in their institutions to solve policy issues.

***Social Reasons***. The increase of port workers number in traditional public ports with no correlation to production improvement and the increasing power of port labour unions have contributed to increasing port strikes and, consequently, declining port operation efficiencies and generating more congestion problems. For the aim of solving the problems mentioned above, most of the studies in the literature agreed on two solutions, establishing a labour deregulation process in ports and allowing the private sector to invest in developing and operating these ports.

**Chapter three:**

This chapter discussed and explained the philosophical stance and the methodology that the researcher adopted to carry out this research study. After reviewing the two main philosophic schools of thought (positivism and interpretivism) that are prevalent in operations and management studies, the researcher of this study accepts the positivist positions' assumptions on the ontological and epistemological levels. The researcher believes that positivism is appropriate for carrying out this research. It is linked with variables analysis and quantification and is suitable and widely used in studying operations and management problems. While on the Methodology level, the quantitative methodology has become the focus of this study. Quantitative methodologies enable the positivistic researcher to test and validate the existing and previously constructed theories that explain the happening of the phenomena. Moreover, the time consumption for collecting and analysing quantitative data is relatively less than qualitative methodologies. It also has samples with a much larger size than the qualitative methods' studies have, allowing the generalization of the study results when its data is based on random samples with sufficient size.

This chapter also discussed the research design used to design this PhD thesis, where the deductive cross-sectional research approach was used to tackle and answer the research questions. This is due to two reasons: firstly, the researcher has developed a conceptual framework in early-stage (Eddrgash 2019) about the port congestion phenomena. This conceptual framework needs to be tested accordingly. Secondly, the existence of significant rich literature about the port congestion phenomena can assist the researcher in developing a research model for the research problem. Also, the reason behind choosing the cross-sectional type in this PhD research is that both data (whether in systematic review method or online survey) are gathered at the same time from samples to investigate the relationships among the variables and determine the common factors for the port congestion problem.

In this chapter, the research also explained and discussed the two processes of the study data collection. The first data collection method was the systematic literature review. This research method sought to discover whether the eight Superordinate reasons and Subordinate reasons identified in the (Eddrgash 2019) cause and influence the problem of congestion at world ports. If so, what is the existing evidence in the previous literature that informs and exerts the strongest influence? The second data collection method was the online survey that was based on a close-structured questionnaire type. This method has been used in this PhD study to collect data to examine the relationships between port congestion variables (causes that make the problem happen) and attempt to identify the common factors among these variables and model the port congestion problem.

**Chapter four:**

This chapter sought to discover whether the eight Superordinate reasons and Subordinate reasons identified in Eddrgash (2019) cause and influence the problem of congestion at world ports. Furthermore, what is the existing evidence in the previous literature that informs and exerts the strongest influence? Thus, a systematic literature review method, where the evidence-based research framework developed by (Gough et al. 2012), was used to investigate the common theoretical classifications of the port congestion problem. These theoretical classifications triggered the port congestion problem and categorised the traits that can stimulate and cause port congestion in most ports. Then these causes were used as a list variable in the questioning of the online survey (chapter. 5) to find the common factors behind port congestion problems at ports.

In this chapter, a search process in the most famous search engines in the operations and management field was used to search for literature about the port congestion problem. Then inclusion and exclusion criteria followed by an appraisal technique were used to select only the papers that serve the aim of this research and could answer the four research questions established in the early stage of this systematic review research. The findings and results revealed that while the academic interest in the port congestion problem was established quite early (in 1961), the focus on the problem remained scarce until 2000. Moreover, the last two decades have witnessed an increase in academic interest in the port congestion problem leading to more paper publications about the subject. Furthermore, this increased interest was due to the increase in world port congestion problems, especially at the USA and China ports.

The results also indicated a clear variation in how scholars in the selected papers defined the port congestion problem where no consensus on a definition set has been established. This variation in defining the problem emerges from the fact that the causes of the port congestion problem in ports are complicated and multi-dimensional. They also differ from one country to another and even from port to port.

The results also revealed that most of the reviewed publications had used a quantitative methodology under both analytical and empirical types of research design. The finding also consented to the argument that most of the field researchers consider the field of operations and management as a discipline lacking of a theoretical foundation and it focus more on practices for addressing and solving problems. This can be clearly seen as about two-thirds of the selected papers for this review have not based their research on a theory base. However, they instead investigate the problem of port congestion from a practical perspective. The most applied theory that the other third used was the queuing theory which was used to find the balance between the cost of investing in a new asset and the cost of port congestion surcharges. Also, modelling and simulation techniques were the most analysed methods used in the reviewed literature. This could be due to their greater advantages in forecasting and simulating the relationships between the causes of port congestion problems as investigating variables.

The results also indicated the most prevalent causes of port congestion reported in the reviewed literature. These causes were divided into internal and external, and categorised under five classifications that triggered the problem and related to the three obstacles that caused the operating system to slow down. Furthermore, the suggested solutions for those causes, as indicated by the reviewed papers, have been categorised and related to the system slow-down categories. The revealed results suggested that the port congestion problem is highly related to management issues in parallel with weak infrastructures and shortages in facilities. Therefore, improving the infrastructure and investing in new facilities are needed. However, more concentration on enhancing and increasing the efficiency of port management, port policies and the government regulation system is highly suggested.

**Chapter five:**

In this chapter, an online survey was carried out to identify the common factors of port congestion situations at seaports. This identification was based on the theoretical, conceptual framework developed early in Eddrgash (2019) and the port congestion causes identified and yielded from the systematic literature review method (chapter 4). An online questionnaire was built, distributed, and analysed to obtain and model the common factors behind the problem. The questionnaire of this study came in ten pages (size A4) in the final version of its design. It included a front letter and a thank you page at the end. The front cover letter was dedicated to explaining the research target and for guaranteeing the security and confidentiality of the collected data. The questionnaire of this survey research included two parts. The first part covers the respondents' demographic information, such as gender, age, level of education, organization type that they work at, managerial level, working area, and years of experience. The second part was divided into two sections. In the first section, the respondents were asked to select a proper definition for the port congestion problem to measure and to reach a consensus amongst the industry experts on defining it. In the second section, the respondents had to respond to a list of statements describing the reasons behind port congestion problems at ports with a Likert scale of seven points. The questionnaire for this PhD research was generated, hosted, and distributed through Qualtrics online survey website at (www.qualtrics.com).

The seaport stakeholders from different managerial levels of a global seaports and container terminals network were targeted by this survey study to draw the survey sample based on three reasons. Firstly, managers are the most familiar element of port stakeholders with port issues and port problems. They are the ones that have enough knowledge and good experience about the port activities. Therefore, there is no need to explain the used terminology or any other commonly known port issues in the survey wording and language. The second reason is related to their decision-making authority, so it would be easier and faster for them to participate in this survey and freely give any relevant information that might add value to this study. The third reason is that, among others, they hold the position and share the responsibility for the inefficient performance of their organisations. Consequently, they will be the most affected by the port congestion situations.

Two non-probability sampling techniques: purposive and snowball sampling types have been used in this survey research. This choice was due to the difficulty of acquiring access to the global port sector organizations (port stakeholders worldwide). *In the purposive sampling technique*, respondents were chosen based on their experience and knowledge of the research topic. While *the snowball sampling technique* was used to increase the sample size by asking one or more respondents to nominate other participants willing to participate, they might be useful for adding value to the research.

In this stage, the researcher carried out a pilot study by distributing a few survey questionnaires among a sample of the actual target population prior to the main survey process to detect any possible weakness in the survey constructed questions and design.

To enhance the reliability of this survey study, the researcher adopted positivist techniques which are efficient methods to gather data for the variables of this research interest (Collis and Hussey 2003). Also, a statistical method of Cronbach’s coefficient alpha was employed to measure the study's reliability. All constructed measures used in this study related to Cronbach’s alpha values have shown good reliability based on (Sekaran 2000).

The descriptive statistics tests were the first step in analysing survey data. This step showed that the respondents chose the definition produced by the researcher as the best definition that defines the port congestion problem as it accounts for all aspects of the phenomena. This will give a good foundation for any future research on the port congestion problem and help port operators and decision-makers better identify the problem and overcome its causes.

The results from EFA as a second step indicated that only 43 items have come out from the EFA analysis. These were simplified as nine common factors behind the congestion situations at ports. These factors are presented in table 5.34, starting from the highest loading value to the lowest. Also, a comparison was made between the common causes for the port congestion problem that were yielded from the previous stage (systematic literature review) and the ones from the EFA analysis. This comparison is presented in table (5.35).

**Chapter six:**

In chapter six, a conclusion of the whole thesis was presented. This chapter was started by revising the thesis chapters and the plan. Then the chapter summarized the key findings from both research methods (the systematic literature review study and the online survey study). In this chapter, the researcher also indicated some limitations and suggested recommendations for future research. Finally, the researcher has explained the contribution of his thesis research to the base of knowledge about port operations and the management field.

## 6.3. Revised study plan

Since the main purpose of this research study was to make a contribution to both fields: academia and the port operations and management industry.  In the first one, this research will enrich the literature about the port congestion problem. While the second one will help port operators overcome the congestion problems at their ports and provide guidelines for decision-makers and investors in port development, especially in less developed and developing countries. Thus, to consider the limitation in previous literature and the problem statement for this study, the researcher has defined one main objective. This objective is to discover and distinguish the most common reasons that lead to arise in port congestion nodes and how to solve these congestion nodes. Also, the main objective has been divided into two associated sub-objectives to ensure a comprehensive and strong generalization of the research findings. These two sub-objectives are:

1- Conducting a systematic literature review and based-evidence research study as a quantitative method to investigate and explore the previous publications around port congestion to identify the reasons behind the port congestion problem and their solutions and used as a list of variables for the second objective.
2- Conducting factor analysis to reduce those variables (the main reasons) to common factors behind the congestion situations at ports.

## 6.4. Summary of the key findings of this research.

There was a clear difference in the reported causative reasons in the reviewed literature for global congestion problems at ports and container terminals (see chapter 2). However, most of these articles have implemented various theoretical ways to identify these causes and explain the solutions that should be taken to solve the port congestion problems. Most of them looked to the problem as an internal technical issue that caused it. Furthermore, they have based their identification of these causes, on three main technical obstacles that cause a slowdown of any organisation system (Weaknesses in infrastructures, Shortages in facilities, and Mismanagement). While only a few others have broadened their view of the congestion problem to include other external factors such as climate obstacles and economic issues. To ease the port congestion problem classification, this research, through a synthesising process, has categorised the causes of the port congestion problem reported in the literature into five analytical themes and three interpretative themes and 44 descriptive themes (see chapter 4). This categorised process was based on the Eddrgash 2019 research study results to build up a holistic picture and gain deep insights into the congestion problem at ports (see section 3 for the methodology of this chapter). However, for synthesising the findings from these selected papers, there was a need for a new kind of categorising where these causes for port congestion problems can be better identified and described. This new category divided the port congestion causes into internal and external causes and then looked at these causes from both perspectives: the classifications that triggered the port congestion and the three obstacles that slow down any organisation system. As a final step in this thesis, an online questionnaire was built based on measures scale items from chapter 4. The questionnaire was distributed and analysed to obtain and model the port congestion definition, and to identify the simplest common factors that explain the causes behind the congestion problem in ports and their suggested solutions (the three research questions of this thesis).

The first research question: **What is the best definition for the port congestion problem that can comprehensively express port congestion situations? And also, what is the consensus among the port practitioners on a common or united definition of the port congestion problem?**

Results from the first step of the descriptive statistics analysis showed that the majority of the survey respondents chose the definition produced by the researcher as the standard and best definition that defines the port congestion problem because it accounts for all aspects of the phenomena. The researcher defines the problem of port congestion as 'the supply of port services and resources, for various reasons, cannot cope with the increasing demand for those services and resources.' This standard definition will give a good foundation for future research on the port congestion problem and help port operators and decision-makers better identify the problem and overcome its causes.

Also, for the second research question: **What are the common reasons that lead to a rise in congestion problems at ports? And what are the internal causes that impact the port systems and cause port congestion situations to arise at any port? And what are the external causes impacting the port systems and causing the port congestion situations to arise at any port?**

Results from the EFA analysis show that the new nine factors more or less match the results from the systematic literature review. Both Natural causes and Economics still represent the external causes but add a new split cause: Constraints due to the growth of capacity. Natural causes are represented by the sub-causes: "*Bad weather", "tide", and" floods"*. Moreover, Economic causes are represented by sub-causes: "*Sudden increase in international trade", "Sudden increase in the trade local demand, concentrating trade on a certain port, imposing cheaper prices for storing cargoes in ports (than outside ports)", and "Seasonality"*. Furthermore, the new factor “constraints due to growth of capacity” is represented by: *“The recent increase in ships size (especially container ships) has caused putting more constraints on the existing equipment’s capacities at the port that receive this type of ships.”,* and *“The increase in ships sharing alliance between companies has caused for putting more constraints on the existing equipment's capacities at the port that receive this type of ships.”*. This new factor might be related to the: increase in vessel size, and the sharing alliance between ship companies might cause an external (shortage in supplying of Infrastructures and facilities) or high pressure on managing them (from increasing demand).

For the internal causes, although the three main obstacles to the organization system (Mismanagement, shortages in facilities, and Weakness in infrastructures) still represent them, there were some changes in causing these categories. The analysis suggests that the Mismanagement causes still can be related to three types: mismanagement technical issues, Mismanagement policies issues and Mismanagement social issues. Also, the analysis suggests that Shortages in facilities were divided into two categories: Shortages in port equipment and shortages in port accesses and hinterland facilities. In addition, the results reveal that weakness in the infrastructure remain the same as the ones yielded from the systematic review. Moreover, the analysis suggests that bureaucracy and severe regulation as a split internal cause for the port congestion problem.

Moreover, for the third research question: **What are the possible solutions to those common reasons for the port congestion problem? And what is the role of the government, the port operators, and the shipping lines or ship owners in solving port congestion situations?**

Results indicate that the solutions for those causes remain the same as were suggested by the reviewed papers. These solutions have been categorised and related to the system slow-down categories. The revealed results suggested that the port congestion problem is highly related to management issues parallel with weak infrastructures and shortages in facilities. Therefore, improving the infrastructure and investing in new facilities are needed. However, more concentration on enhancing and increasing the efficiency of port management, port policies and the government regulation system is highly suggested.

According to the analysis, most suggested solutions were proposed to solve the internal causes of the port congestion problem. It is also clear that most of these reviewed papers looked at the congestion problem as an issue in the management and operation of the ports. They suggested their solutions based on this issue, while there was less concentration on solutions for solving the issues arising from weak infrastructures and shortages in facilities. This might be related to the fact that most world ports that suffer from congestion are neither because of Inadequate development in their infrastructures nor shortages in their facilities, but due to inefficient management from the port operators and poor port policies and regulations issued by the country's government itself. Thus, to reduce and prevent port congestion problems, organisations such as port operators, shipping lines, and governments need to work together to efficiently solve the rising port congestion and issues.

Table 4.35 in chapter four shows the solutions that have been assigned according to the type of organisation's role. The majority are management solutions and should be done by the port operators, while few of these solutions remain in government roles. Of course, this depends on the type of port governing model where the percentages of government role will increase at the port public model type and consequently decrease at full private model ports. Also, the management solutions that have to be adopted by shipping lines are few compared to the total management solutions.

The above figures wholly changed when it comes to the solutions for improving the weak infrastructures, where a significant government share in these solutions has emphasised the role of the government against the port operators' responsibility for solving these issues. However, the solutions for shortages in facilities are 100% in the role of port operators, though it is still dependent on the port model type of governance and management.

In addition, solutions for solving the natural or/and economic classifications causes as external causes were suggested in the reviewed literature as follows: “Adopting policies and strategies that could encourage shippers to use all country's ports instead of concentrating the traffic on one port”. And this came as the responsibility of the government to establish and maintain those regulations. Also, the “freight volume-forecasting and detecting workload peaks and congestion in the inspection process of seaports and provides relevant information for decision-making and resource planning" for solving seasonality and the increase in international trade and the local market demand. This solution was to share responsibility between the government and port operators. In contrast, the natural causes as external reasons for the port congestion problem remain with no suggested solutions in the reviewed literature. This might be because these subjects need to target another area of the field, subject literature.

## 6.5. Limitations of this research and recommendations for future study.

Like most social science studies, this research study has some limitations:

**First limitation**:  Gough et al. (2012) argue that systematic reviewers might have achieved an exceptional level in synthesizing and analyzing the studies; however, their review reports might still be limited to academia unless they try harder to disseminate their results to the outside world. They suggested two models for simply linking academic research and practitioner decision-making where supporting evidence is either provided by reviewers or demanded by decision-making practitioners. They claimed that the first one represented a linear view and called it a classic knowledge-driven (push) model, where the research findings may be revealed to prompt action. The second one they claimed is called a problem-solving/practice-driven (pull) model, which is a reverse of the liner view, where the starting point is with the study end-users and the problem they have, before tracing back the problem in search of useful results. So, on the one hand, it is often that the researchers try their best to inform the practitioners and decision-makers, pushing their findings to impel actions and bridging the gaps (Gough et al., 2012). This might be done by publishing their studies in academic journals and in practice, such as conferences, workshops, and focus groups, to bridge the knowledge gaps in the practices. On the other hand, it is also common for some practitioners and decision-makers to make efforts to seek studies' products, pulling their findings into their own domain (Gough et al., 2012).

Based on the above discussion, this thesis has used both models for linking its research findings to the practitioners to ensure the best dissemination of the study results. First, it used the interviews of the port stakeholders as a starting point with the end-users for port congestion problems pulling their knowledge and experiences about the problem they face before tracking back in search of useful findings. However, for the second model for linking, and due to the Covid-19 circumstances, the researcher could not employ focus groups or workshops to present the research findings to inform the policymakers and decision-makers about the causes and the solutions for the port congestion problem based on evidence knowledge. For future research and hopefully after improving the situation from Covid 19, the researcher suggests carrying out some workshops to discuss these findings with the participants' seeking their reflecting points, comments, and suggestions to bridge the gaps and increase the reliability and the validity of future research studies on port congestion.

**Second limitation:** collecting quantitative data for participants in survey studies using the proportional sample size cannot ensure an equal distribution for each stakeholder's type. Results reveal that some geographical locations and some types of jobs dominate the participants' sample size, where most of them their business was located in Africa and Europe, and a few numbers represent the local government (port state and customs). This might be due to the closed nature of government systems, where they usually present less collaboration with research studies outside their network. Thus, the researcher hopes that the issues in large sample sizes related to the proportion of stakeholder types in survey studies could be improved in future studies to gain more valuable findings from statistical analysis results.

**Some suggestions for future research studies:**

Given the nature of the research, applying more different methodologies might be needed to gain better results in modelling the problem of port congestion. Therefore, applying other quantitative methods such as structural equation modelling or simulation modelling techniques might be visible for future research to model the problem and gain better generalisation for the common factors behind the rising of the port congestion problem at any port. Where in these methods the researcher can use artificial data to simulate different causes and circumstances for the problem and investigate the effect and the impact of these causes on rising or reducing the port congestion phenomena.

## 6.6. Contribution of this thesis to the base of knowledge about port operations and management.

Most scholars in previous literature have looked at the port congestion problem from various perspectives and dealt with it differently. And in fact, this is fine as the causes for port congestion are deferring from country to country and sometimes even from port to port in the same region or country. However, most of these scholars in the previous literature have focused on the technical side of the problem and defined the phenomena based on it. Moreover, they only focused on port operators and shipping lines as the main port stakeholders that were involved in and affected by the congestion problem. In reality, this is not completely true as firstly the causes of the port congestion problem might have other triggering and issue sides to be considered not only the technical issues. Such as economic triggers, social triggers, natural triggers, and political triggers. Secondly, focusing the investigation on only port operators and shipping lines as port stakeholders and neglecting the other port actors and the maritime supply chain players such as shippers, customs, customs agencies, governments institutions, and truck and train companies might lead to mes-investigation the problem and misestimation for the consequences of the port congestion situations.

As all know that ports are playing a very important role in the international maritime trading and supply chain, this thesis tries to overcome this gap by contributing to:

**First the body of literature (In academia):**

As it was known that successful, effective management for solving any operations and management problems should start with introducing an accurate and comprehensive definition of the problem. Thus, based on the above need, this thesis established a standard definition for port congestion problems that can be generalized to all congestion situations at ports and used as a baseline to identify the most common causes of the congestion problem at any seaport.

Moreover, to smoothly facilitate the maritime logistic chains and avoid congestion situations at ports, all controllable, relatively controllable, and uncontrollable causes of congestion must be identified. This can be done only by considering the role of all players (port stakeholders) in any investigation that tries to explore and mitigate the congestion problems at ports. This thesis has overcome this gap in the literature by extending the focus to include all players (port stockholders) in the maritime logistic chains for tackling the port congestion problem. Therefore, and based on that, this thesis has remapped and classified the causes of port congestion and their suggested solutions and also who is responsible for these solutions based on new types of triggering reasons for the phenomena. These triggering classifications were divided into external causes that were triggered by uncertain behaviour in the maritime industry or by internal causes that were triggered by the three obstacles of any internal organization system (Mismanagement, Shortages in facilities, and weakness in infrastructures).

Furthermore, this thesis will enrich the body of literature about the port congestion problem where it provides a systematic literature review about the port congestion phenomena that gives the following:

- Good knowledge about how the interest in investigating and solving the problem was distributed on the world map and how it evolved through time.
- Also provides the type of methodologies and research types that were used to gather and analyse the previous studies' data around the port congestion phenomena.
- Moreover, if any theory was applied to tackle the problem and why it was used. Also discussed this in the light of the lack of the operations and management research field for theory base.

All the above contributions will help researchers to understand the problem in a better way in any future studies about the port congestion phenomena.

**Secondly the port industry field (Beyond academia**):

This thesis also tries to contribute to the industry field of port operations and management, where establishing a consensus definition for port congestion will uncertainly help port operators and decision-makers to better know and understand the problem. Also identifying the common causes and their solutions and the role of solutions will undoubtedly give the port managers and government decision-makers a valuable set of decision-making for:

- Designing and allocating port resources and facilities and improving port systems, services, and supply chain networks.
- Improve plans (such as training plans, repairing and maintenance plans, and berthing and storing plans).
- When the finance and new budgets need to be implemented.
- Increased competition role for their ports, booming in international maritime trade and attracting new business.

## References


Abe, K. and Wilson, J.S., 2009. Weathering the storm: investing in port infrastructure to lower trade costs in East Asia. *World Bank Policy Research Working Paper Series, Vol*.

Abouarghoub, W., Pettit, S., Beresford, A. and Eddrgash, T., 2017. AN Investigation into port congestion: The Libyan Crisis. In *Symposium on Logistics (ISL 2017) Data Driven Supply Chains*.

AbuAlhaol, I., Falcon, R., Abielmona, R. and Petriu, E., 2018, July. Mining port congestion indicators from big AIS data. In *2018 International Joint Conference on Neural Networks (IJCNN)* (pp. 1-8). IEEE.

Adams, R.J., Smart, P. and Huff, A.S., 2017. Shades of grey: guidelines for working with the grey literature in systematic reviews for management and organizational studies. *International Journal of Management Reviews*, *19*(4), pp.432-454.

Agostini, C.A. and Saavedra, E.H., 2014. Chile: Port congestion and efficient rationing in cargo transfer operations. *CEPAL Review*, *2013*(111), pp.117-136.

Alattar, M.A., Karkare, B. and Rajhans, N., 2006, August. Simulation of container queues for port investment decisions. In *The Sixth International Symposium on Operations Research and Its Applications* (pp. 155-167).

Alavi, M., Visentin, D.C., Thapa, D.K., Hunt, G.E., Watson, R. and Cleary, M., 2020. Exploratory factor analysis and principal component analysis in clinical studies: Which one should you use. *Journal of Advanced Nursing*, *76*(8), pp.1886-1889.

Aldcroft, D.H., 1961. Port Congestion and the Shipping Boom of 1919–20. *Business History*, *3*(2), pp.97-106.

Alhameedi, M.E.A., Said, A.J. and Mudjiono, T.W., 2018. Performance evaluation and solutions for port congestion focused on the container terminal: a case study of Khalifa bin Salman Port (KBSP) Kingdom of Bahrain. Available at: https://commons.wmu.se/cgi/viewcontent.cgi?article=1687&context=all_dissertations [accessed on 6/7/2019].

Alreck, P.L. and Seattle, R.B. (1995) *The Survey Research Handbook*. Illinois, USA: Irwin.

Alvarez, J.F., Longva, T. and Engebrethsen, E.S., 2010. A methodology to assess vessel berthing and speed optimization policies. *Maritime economics & logistics*, *12*(4), pp.327-346.

Aken, J.E.V., 2004. Management research based on the paradigm of the design sciences: the quest for field-tested and grounded technological rules. *Journal of management studies*, *41*(2), pp.219-246.

Anagor, A. 2020,. *Congestion heightens in Lagos Ports as vessel waiting time hits 25 days.* Business day. Available at: Congestion heightens in Lagos Ports as vessel waiting time hits 25 days - Businessday NG. Accessed on:20/10/2022.

Arnaout, J.P., Hallab, S. and El Khoury, C., 2013, April. A throughput simulation of Port of Beirut. In *Proceedings of the Emerging M&S Applications in Industry & Academia/Modeling and Humanities Symposium* (pp. 1-8).

Baba, Y.N. and Abubakar, I.D., 2022. Assessment of Factors Causing Congestion and Nature of Cargo Clearance in Apapa Port, Lagos, Nigeria. *Assessment*, *14*(1).

Baker, M.J. and Foy, A. (2008) *Business and Management Research*. 2nd edn. Western: Publishers.

Bakshi, N., Flynn, S.E. and Gans, N., 2011. Estimating the operational impact of container inspections at international ports. *Management Science*, *57*(1), pp.1-20.

Bai, X., Jia, H. and Xu, M., 2021. Port congestion and the economics of LPG seaborne transportation. *Maritime Policy & Management*, pp.1-17.

Bailey, Kenneth D. (1994). *Methods of social research*. 4ed. The free Press New York.

Barnett-Page, E. and Thomas, J., 2009. Methods for the synthesis of qualitative research: a critical review. *BMC medical research methodology*, *9*(1), p.59.

Baruch, Y., and Holtom, B. (2008). Survey response rate levels and trends in organizational research. *Human Relations,* 61(8), 1139-1160.

Bentolila, D.J., Ziedenveber, R.K., Hayuth, Y. and Notteboom, T., 2016. Off-peak truck deliveries at container terminals: the “Good Night” program in Israel. *Maritime Business Review*.

Bernstein, M., 2006. The more trade grows, the worse US port congestion becomes. *WORLD TRADE*, *19*(8), p.46.

Beškovnik, B., 2008. Measuring and increasing the productivity model on maritime container terminals. *Pomorstvo*, *22*(2), pp.171-183.

Blaikie, N. (2003). *Designing social research*. Cambridge: Polity Press.

Blaikie, N., 2007. *Approaches to social enquiry: Advancing knowledge*. Polity.

Bolat, P., Kayişoğlu, G., Gunes, E., Kizilay, F. and Ozsogut, S., 2020. Weighting Key Factors for Port Congestion by AHP Method. *Journal of ETA Maritime Science*, *8*(4).

Bolton, R. N. (1993). Pretesting questionnaires: Content analyses of respondents' concurrent verbal protocols. *Marketing Science*, 12(3), 280-303.

Bragge, P., Clavisi, O., Turner, T., Tavender, E., Collie, A. and Gruen, R.L., 2011. The global evidence mapping initiative: scoping research in broad topic areas. *BMC medical research methodology*, *11*(1), p.92.

Briner, R.B., Denyer, D. and Rousseau, D.M., 2009. Evidence-based management: concept cleanup time?. *Academy of Management Perspectives*, *23*(4), pp.19-32.

Briner, R.B. and Walshe, N.D., 2014. From passively received wisdom to actively constructed knowledge: Teaching systematic review skills as a foundation of evidence-based management. *Academy of Management Learning & Education*, *13*(3), pp.415-432.

British Ports Association (2021) Global Container Congestion Affecting UK Ports, Available at: https://www.britishports.org.uk/global-congestion/ [Accessed November 2021]

Brooks, M.R., 2004. The governance structure of ports. *Review of network economics*, *3*(2).

Bryman, A. and Cramer, D. (2005) *Quantitative Data Analysis with SPSS 12 and 13: A Guide for Social Scientists.* East Sussex: Routledge.

Bryman, A., and Bell, E. (2007). *Business research methods* (2nd ed.). Oxford: Oxford University Press.

Bryman, A. (2008). *Social research methods* (3rd ed.). Oxford: Oxford University Press.

Bryman, A. and Bell, E. (2011) *Business Research Methods*. 3rd edn. Oxford University Press.

Burgess, K., Singh, P.J. and Koroglu, R. (2006), "Supply chain management: a structured literature review and implications for future research", *International Journal of Operations & Production Management*, Vol. 26 No. 7, pp. 703-729.

Burns, R. (2000) *Introduction to Research Methods*. London: Sage Publications.

Burns, R.P. and Burns, R., 2008. *Business research methods and statistics using SPSS*. Sage.

Carballo, J., Graziano, A., Schaur, G. and Martincus, C.V., 2016. Endogenous Border Times: Ports, Customs, Storage?. *Inter-American Development Bank Working Paper Series*. Available at: https://www.cesifo-group.de/dms/ifodoc/docs/Akad_Conf/CFP_CONF/CFP_CONF_2016/ge16_Whalley/Papers/ge16_Schaur.pdf. [accessed on 6/87/2019].

Carlan, V., Sys, C. and Vanelslander, T., 2016. How port community systems can contribute to port competitiveness: Developing a cost–benefit framework. *Research in transportation business & management*, *19*, pp.51-64.

Carr, C.M.J. and Crum, M.R., 1995. The US Customs Modernization and Informed Compliance Act: implications for the logistics pipeline. *The International Journal of Logistics Management*.

Carson, D., Gilmore, A., Perry, C. and Gronhaug, K. (2001) *Qualitative Marketing Research*. London: Sage.

Cetin, C.K. and Cerit, A.G., 2010. Organizational effectiveness at seaports: a systems approach. *Maritime Policy & Management*, *37*(3), pp.195-219.

Chang, Y.T., Lee, S.Y. and Tongzon, J.L., 2008. Port selection factors by shipping lines: Different perspectives between trunk liners and feeder service providers. *Marine Policy*, *32*(6), pp.877-885.

Chassiakos, A., Jula, H., VanderBeek, T., Shellhammer, M. and An, S.D., 2017. Analysis and Optimization Methods for Centralized Processing of Chassis. Available at: https://escholarship.org/content/qt1t75c3vw/qt1t75c3vw.pdf [accessed on 6/10/2019].

Chen, C.S., Lee, S.M. and Shen, Q.S., 1995. An analytical model for the container loading problem. *European Journal of operational research*, *80*(1), pp.68-76.

Chen, T., 1999. Yard operations in the container terminal-a study in the 'unproductive moves'. *Maritime Policy & Management*, *26*(1), pp.27-38.

Chen, G. and Yang, Z., 2010. Optimizing time windows for managing export container arrivals at Chinese container terminals. *Maritime Economics & Logistics*, *12*(1), pp.111-126.

Chen, Y., Meng, N. and Cao, B., 2010, August. A queuing network stochastic programming for berth planning. In *2010 International Conference on Management and Service Science* (pp. 1-4). IEEE.

Chen, G., Govindan, K. and Yang, Z., 2013. Managing truck arrivals with time windows to alleviate gate congestion at container terminals. *International Journal of Production Economics*, *141*(1), pp.179-188.

Chen, G. and Jiang, L., 2016. Managing customer arrivals with time windows: a case of truck arrivals at a congested container terminal. *Annals of Operations Research*, *244*(2), pp.349-365.

Cheung, R.K., Li, C.L. and Lin, W., 2002. Interblock crane deployment in container terminals. *Transportation Science*, *36*(1), pp.79-93.

Chinedum, O., 2018. Port congestion determinants and impacts on logistics and supply chain network of five African ports. *Journal of Sustainable Development of Transport and Logistics*, *3*(1 (4)).

Choo, S., Klabjan, D. and Simchi-Levi, D., 2010. Multiship crane sequencing with yard congestion constraints. *Transportation Science*, *44*(1), pp.98-115.

Choong, S.T., Cole, M.H. and Kutanoglu, E., 2002. Empty container management for intermodal transportation networks. *Transportation Research Part E: Logistics and Transportation Review*, *38*(6), pp.423-438.

Chou, C.C., Wen, C.C. and Huang, Y.J., 2021. Analysis of tugboat operation and towage fees in a Taiwanese port and alternatives for improving tugboat operation by the Delphi method. *Proceedings of the Institution of Mechanical Engineers, Part M: Journal of Engineering for the Maritime Environment*, *235*(1), pp.176-187.

Churchill, G.A. (1979) "A Paradigm for Developing Better Measures of Marketing Constructs", *Journal of Marketing Research*, Vol. 16, No. 1, pp. 64-73.

Churchill, G. A., and Iacobucci, D. (2002). *Marketing research: Methodological foundations* (8th ed.). Mason, Ohio: South-Western/Thomson Learning.

Clark, X., Dollar, D. and Micco, A., 2004. Port efficiency, maritime transport costs, and bilateral trade. *Journal of development economics*, *75*(2), pp.417-450.

Collier, P., Soludo, C.C. and Pattillo, C. eds., 2008. *Economic policy options for a prosperous Nigeria*. New York, NY: Palgrave Macmillan.

Collis, J. and Hussey, R., (2003) *Business Research: A Practical Guide for Undergraduate and Postgraduate Students.* 2nd edn. UK: Palgrave Macmillan.

Collis, J. and Hussey, R. (2009) *Business Research: A Practical Guide for Undergraduate and Postgraduate Students.* 3rd edn. Basingstoke: Palgrave Macmillan.

Collis, J. and Hussey, R. (2014) *Business Research: A Practical Guide for Undergraduate and Postgraduate Students.* 4th edn. Basingstoke: Palgrave Macmillan.

Comery, A.L. and Lee, H.B. (1992) *"A First Course in Factor Analysis",* in Tabachnick, B. G. and Fidell, L. S. (eds.) *Using Multivariate Statistics*. 4th edn. Needham Heights, MA: Allyn and Bacon.

Cong, L., Zhang, D., Wang, M., Xu, H., Li, L., 2020. The role of ports in the economic development of port cities: panel evidence from China. Transport Pol. 90, 13–21.

Cook, C. 2021. VesselsValue Insights and Analytics: 2021 Port Congestion Report. Maritim Africa. Available at: https://maritimafrica.com/en/vesselsvalue-insights-and-analytics-2021-port-congestion-report/ Accessed 14.10.2022.

Cooke-Davies, T.J., Crawford, L.H. and Lechler, T.G., 2009. Project management systems: Moving project management from an operational to a strategic discipline. *Project Management Journal*, *40*(1), pp.110-123.

Cooper, D.R. and Schindler, P.S. (2001) *Business Research Methods*. 7th edn. Singapore: Irwin/ McGraw-Hill.

Counsell, C., 1997. Formulating questions and locating primary studies for inclusion in systematic reviews. *Annals of internal medicine*, *127*(5), pp.380-387.

Couper, M.P., Traugott, M.W. and Lamias, M.J. (2001) "Web Survey Design and Administration", *The Public Opinion Quarterly*, Vol. 65, No. 2, pp. 230-253.

Covic, F., 2017. Re-marshalling in automated container yards with terminal appointment systems. *Flexible Services and Manufacturing Journal*, *29*(3), pp.433-503.

Cox, J., Mahoney, D. and Smart, M., 2009. Port Botany's Landside: Market Pricing to Address Congestion. *Economic Papers: A journal of applied economics and policy*, *28*(1), pp.49-55.

Creswell, J.W., J.D., 2003. *Research design: Qualitative, quantitative, and mixed methods approaches*. 2nd ed. Thousand Oaks, California. Sage publications.

Creswell, J.W. and Clark, V.L.P., 2017. *Designing and conducting mixed methods research*. Sage publications.

Cullinane, K. and Song, D.W., 1998. Container terminals in South Korea: Problems and panaceas. *Maritime Policy and Management*, *25*(1), pp.63-80.

Daganzo, C.F., 1989. Crane productivity and ship delay in ports.*Transportation Research Record*, (1251).

Davarzani, H., Fahimnia, B., Bell, M. and Sarkis, J., 2016. Greening ports and maritime logistics: A review. *Transportation Research Part D: Transport and Environment*, *48*, pp.473-487.

Davies, H.T. and Crombie, I.K., 1998. Getting to grips with systematic reviews and meta-analyses. *Hospital medicine (London, England: 1998)*, *59*(12), pp.955-958.

Davies, A.P. and Bischoff, E.E., 1999. Weight distribution considerations in container loading. *European Journal of Operational Research*, *114*(3), pp.509-527.

Davies, H., Nutley, S. and West, S.K.S., 2002. Discussion paper 2; Evidence-based policy and practice: Moving from rhetoric to reality. *University of St Andrews*.

Davies, P. and Kieran, M.E., 2015. Port Congestion and Drayage Efficiency. In *METRANS International Urban Freight Conference. In collab. with Metrans Transportation Center. Long Beach, USA*.

De Borger, B., Proost, S. and Van Dender, K., 2008. Private port pricing and public investment in port and hinterland capacity. *Journal of Transport Economics and Policy (JTEP)*, *42*(3), pp.527-561.

De Borger, B. and De Bruyne, D., 2011. Port activities, hinterland congestion, and optimal government policies the role of vertical integration in logistic operations. *Journal of Transport Economics and Policy (JTEP)*, *45*(2), pp.247-275.

Deeks, J.J., Higgins, J., Altman, D.G. and Green, S., 2011. Cochrane handbook for systematic reviews of interventions version 5.1. 0 (updated March 2011). *The Cochrane Collaboration*, p.2.

Dekker, R., van der Heide, S., van Asperen, E. and Ypsilantis, P., 2013. A chassis exchange terminal to reduce truck congestion at container terminals. *Flexible Services and Manufacturing Journal*, *25*(4), pp.528-542.

Denyer, D., & Tranfield, D. (2006). Using qualitative research synthesis to build an actionable knowledge base. *Management Decision, 44*(2), 213–227.

Denyer, D., Tranfield, D. and Van Aken, J.E., 2008. Developing design propositions through research synthesis. *Organization studies*, *29*(3), pp.393-413.

Denyer, D. and Tranfield, D., 2009. *Producing a systematic review*. The Sage handbook of organizational research methods.

Deo, M.C. and Chaudhari, G., 1998. Tide prediction using neural networks. *Computer‐Aided Civil and Infrastructure Engineering*, *13*(2), pp.113-120.

De Vaus, D. A. (2001). *Research design in social research*. London: Sage Publications.

Dillman, D.A. (2007) *Mail and Internet Surveys: The Tailored Design Method,* 2nd ed. Hoboken, NJ: Wiley.

Doll, C. and Schade, W., 2007, June. European Panorama of Congestion. In *11th World Conference on Transport Research (WCTR), Berkeley, USA*.

Dragović, B., Park, N.K. and Radmilović, Z., 2006. Ship-berth link performance evaluation: simulation and analytical approaches. *Maritime Policy & Management*, *33*(3), pp.281-299.

Dragović, B., Park, N.K., Radmilović, Z. and Maraš, V., 2005. Simulation modelling of ship-berth link with priority service. *Maritime Economics & Logistics*, *7*(4), pp.316-335.

Du, Y., Chen, Q., Lam, J.S.L., Xu, Y. and Cao, J.X., 2015. Modeling the impacts of tides and the virtual arrival policy in berth allocation. *Transportation Science*, *49*(4), pp.939-956.

Dunn, S. C. et al. 1994. Latent variables in business logistics research: Scale development and validation. *Journal of Business Logistics* 15(2), pp. 145-172.

Easa, S.M., 1987. Approximate queueing models for analyzing harbor terminal operations. *Transportation Research Part B: Methodological*, *21*(4), pp.269-286.

Easterby-Smith, M., Thorpe, R. and Jackson, P.R. (2008) *Management Research.* 3rd edn. London: Sage.

Easterby-Smith, M., Thorpe, R. and Jackson, P. (2012) *Management Research*. 4th edn. London: Sage.

Eddrgash, T. 2019. *The impact of port congestion on developing economics: the case of Libyan ports* (MSc Social Science Research Methods dissertation, Cardiff University).

Elentably, A., 2017. The New Suez Canal influencing to Enhancing Africa Inbound Maritime Logistics & Operations. *TransNav, the International Journal on Marine Navigation and Safety of Sea Transportation*, *11*(4).

Eliiyi, D.T., Özçam, B., Ada, E., Güldoğan, E., Sevil, B. and Yumurtacı, I.Ö., 2008. Simultaneous allocation of continuous berths and mobile cranes with variable handling times.

El-Naggar, M.E., 2010. Application of queuing theory to the container terminal at Alexandria seaport. *Journal of Soil Science and Environmental Management*, *1*(4), pp.77-85.

Evans, J.R. and Mathur, A. (2005) “The Value of Online Survey”, *Internet Research*, Vol. 15, No. 2, pp. 195-219.

Evidence for Policy and Practice Information and Co-ordinating Centre. (2010).

*EPPI-Centre methods for conducting systematic reviews.* Available at: https://www.betterevaluation.org/sites/default/files/Methods.pdf Accessed on: 05/02/2020.

Facchini, F., Digiesi, S. and Mossa, G., 2020. Optimal dry port configuration for container terminals: A non-linear model for sustainable decision making. *International Journal of Production Economics*, *219*, pp.164-178.

Fan, H.S. and Cao, J.M., 2000. Sea space capacity and operation strategy analysis system. *Transportation Planning and Technology*, *24*(1), pp.49-63.

Fan, L., Wilson, W.W. and Dahl, B., 2012. Congestion, port expansion and spatial competition for US container imports. *Transportation Research Part E: Logistics and Transportation Review*, *48*(6), pp.1121-1136.

Fan, L. and Wilson, W.W., 2012. Impacts of congestion and stochastic variables on the network for US container imports. *Journal of Transport Economics and Policy (JTEP)*, *46*(3), pp.381-398.

Fararoui, F. and Black, J.A., 1992. Priority berthing for congested ports: rationale and a model. *Transportation Planning and Technology*, *16*(4), pp.305-316.

Fereidoonian, F. and Mirzazadeh, A., 2012. A genetic algorithm for the integrated scheduling model of a container-handling system in a maritime terminal. *Proceedings of the Institution of Mechanical Engineers, Part M: Journal of Engineering for the Maritime Environment*, *226*(1), pp.62-77.

Field, A. (2006) *Discovering Statistics Using SPSS*. 2nd ed. London, UK: Sage Publications Ltd.

Field, A. (2009) *Discovering Statistics Using SPSS*. 3rd ed. London, UK: Sage Publications Ltd.

Field, A. 2018. *Discovering statistics using IBM SPSS Statisics*. 5 ed. London: SAGE Publications Ltd.

Finlay, H., O'Mahony, M. and O'Sullivan, D., 2003. Long transport chains: Exporting from a peripheral island. *Transportation research record*, *1854*(1), pp.144-151.

Fink, A. and Kosecoff, J. 1998. *How to conduct surveys: A step by step guide*. 2 ed. Thousand Oaks: SAGE Publications, Inc.

Fisher, C. (2007) *Researching and Writing a Dissertation for Business Students*. 2nd ed. Harlow, Financial: Times Prentice Hall.

Freeman, R.E. and McVea, J., 2001. A stakeholder approach to strategic management. *The Blackwell handbook of strategic management*, pp.189-207.

Garrison, D.R. and Vaughan, N.D., 2008. *Blended learning in higher education: Framework, principles, and guidelines*. John Wiley & Sons.

Gerbing, D.W. and Anderson, J.C. (1988) “An Updated Paradigm for Scale Development Incorporating Unidimensionality and Its Assessment”, *Journal of Marketing Research*, Vol. 25, No. 2, pp. 186-192.

Ghauri, P., and Grønhaug, K. (2002). *Research methods in business studies: A practical guide* (2nd ed.). Harlow: Prentice Hall.

Gidado, U., 2015. Consequences of port congestion on logistics and supply chain in African ports. *Developing Country Studies*, *5*(6), pp.160-167.

Giuliano, G. and O’Brien, T., 2007. Reducing port-related truck emissions: The terminal gate appointment system at the Ports of Los Angeles and Long Beach. *Transportation Research Part D: Transport and Environment*, *12*(7), pp.460-473.

Glujovsky, D., Boggino, C., Riestra, B., Coscia, A., Sueldo, C.E. and Ciapponi, A., 2015. Quality of reporting in infertility journals. *Fertility and sterility*, *103*(1), pp.236-241.

Goodchild, A.V. and Daganzo, C.F., 2006. Double-cycling strategies for container ships and their effect on ship loading and unloading operations. *Transportation Science*, *40*(4), pp.473-483.

Gough, D., Oliver, S., & Thomas, J. (2012). *An introduction to systematic reviews*. Thousand Oaks, CA: Sage Publishers.

Gracia, M.D., González-Ramírez, R.G. and Mar-Ortiz, J., 2017. The impact of lanes segmentation and booking levels on a container terminal gate congestion. *Flexible Services and Manufacturing Journal*, *29*(3), pp.403-432.

Greener, S. (2008) *Business Research Methods*. Bookboon.

Grix, J. (2002). Introducing students to the generic terminology of social research. *Politics,* 22(3), 175-185.

Grubisic, N., Krljan, T., Maglić, L. and Vilke, S., 2020. The microsimulation model for assessing the impact of inbound traffic flows for container terminals located near city centers. *Sustainability*, *12*(22), p.9478.

Gu, Q. and Lago, P., 2009. Exploring service-oriented system engineering challenges: a systematic literature review. *Service Oriented Computing and Applications*, *3*(3), pp.171-188.

Guadagnoli, E. and Velicer, W.F., 1988. Relation of sample size to the stability of component patterns. *Psychological bulletin*, *103*(2), p.265.

Guan, C.Q., 2009. *Analysis of marine container terminal gate congestion, truck waiting cost, and system optimization*. NEW JERSEY INSTITUTE OF TECHNOLOGY.

Guan, C. and Liu, R.R., 2009. Container terminal gate appointment system optimization. *Maritime Economics & Logistics*, *11*(4), pp.378-398.

Guba, E. G. (1990). The alternative paradigm dialogs. In E.G. Guba, (Ed.), *The paradigm dialog* (pp. 17-27). London: Sage Publications.

Guo, L., Ng, A.K., Jiang, C. and Long, J., 2021. Stepwise capacity integration in port cluster under uncertainty and congestion. *Transport Policy*, *112*, pp.94-113.

Hair, J.F., Anderson, R.E., Tatham, R.L. and Black, W.C. (1998) *Multivariate Data Analysis*. 5th edn. Upper Saddle River, NJ: Prentice Hall.

Hair, J.F., Babin, B., Money, A.H. and Samouel, P. (2003) *Essentials of Business Research Methods*. New Jersey: USA, John Wiley and Sons Inc.

Hair, J.F., Black, W.C., Babin, B. J. and Anderson, R.E., (2010) *Multivariate Data Analysis*. 7th edn. Upper Saddle River, New Jersey: Pearson.

Han, Y., Lee, L.H., Chew, E.P. and Tan, K.C., 2008. A yard storage strategy for minimizing traffic congestion in a marine container transshipment hub. *OR spectrum*, *30*(4), pp.697-720.

Han, Y., Lee, L.H., Chew, E.P. and Tan, K.C., 2008. A yard storage strategy for minimizing traffic congestion in a marine container transshipment hub. *OR spectrum*, *30*(4), pp.697-720.

Hanaoka, S. and Regmi, M.B., 2011. Promoting intermodal freight transport through the development of dry ports in Asia: An environmental perspective. *Iatss Research*, *35*(1), pp.16-23.

Hancock, T. (2020). Lack of port development a concern. Engineering news. Available at: Port infrastructure falters on unstable leadership (engineeringnews.co.za). Accessed on: 20/10/2022

Hannes, K., 2011. Chapter 4: Critical appraisal of qualitative research. *Supplementary guidance for inclusion of qualitative research in Cochrane systematic reviews of interventions. Version*, *1*, pp.1-14.

Harden, A. and Thomas, J., 2005. Methodological issues in combining diverse study types in systematic reviews. *International Journal of Social Research Methodology*, *8*(3), pp.257-271.

Heilig, L. and Voß, S., 2017. Information systems in seaports: a categorization and overview. *Information Technology and Management*, *18*(3), pp.179-201.

Heilig, L. and Voß, S., 2014, September. A cloud-based SOA for enhancing information exchange and decision support in ITT operations. In *International Conference on Computational Logistics* (pp. 112-131). Springer, Cham.

Hellenic Shipping News. 2020. *Nigerian ports: Where there's no ease of doing business*. Hellenic Shipping News. Available at: www.hellenicshippingnews.com/nigerian-ports-where-theres-no-ease-of-doing-business/. Accessed on: 21/10/2022.

Hervás-Peralta, M., Poveda-Reyes, S., Molero, G.D., Santarremigia, F.E. and Pastor-Ferrando, J.P., 2019. Improving the performance of dry and maritime ports by increasing knowledge about the most relevant functionalities of the Terminal Operating System (TOS). *Sustainability*, *11*(6), p.1648.

Hisaka, A., Yoshioka, H., Hatakeyama, H., 2020. Global comparison of changes in the number of test-positive cases and deaths by Coronavirus infection

(COVID-19) in the world. Geriatr. Gerontol. Int. 9 (6), 1904. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7356890/. Accessed on: 24/10/2022.

Hodgkinson, G.P., Herriot, P. and Anderson, N., 2001. Re-aligning the stakeholders in management research: lessons from industrial, work and organizational psychology. *British journal of Management*, *12*, pp.S41-S48.

Hogg, A., 2003. Web efforts energize customer research. *Electric Perspectives*, *28*(5), pp.81-81.

Homberg, F. and Bui, H.T., 2013. Top management team diversity: A systematic review. *Group & Organization Management*, *38*(4), pp.455-479.

Hopewell, S., McDonald, S., Clarke, M.J. and Egger, M., 2007. Grey literature in meta-analyses of randomized trials of health care interventions. *Cochrane Database of Systematic Reviews*, (2).

Hoque, A.S. and Biswas, S.K., 2007. Berthing problem of ships in Chittagong Port and proposal for its solution. *Journal of Mechanical Engineering*, *37*, pp.66-70.

Hu, Y.H., Zhu, Z.D. and Hsu, W.J., 2008. AS/RS based yard and yard planning. *Journal of Zhejiang University-Science A*, *9*(8), pp.1083-1089.

Huang, W.C., Kuo, T.C. and Wu, S.C., 2007. A comparison of analytical methods and simulation for container terminal planning. *Journal of the Chinese Institute of Industrial Engineers*, 24(3), pp.200-209

Hughes-Morley, A., Young, B., Waheed, W., Small, N. and Bower, P., 2015. Factors affecting recruitment into depression trials: systematic review, meta-synthesis and conceptual framework. *Journal of affective disorders*, *172*, pp.274-290.

Humphreys, M., Stokenberga, A., Dappe, M.H. and Hartmann, O., 2019. Port development and competition in East and Southern Africa: Prospects and challenges.

Hussey, J. and Hussey, R. (1997) *Business Research: A Practical Guide for Undergraduate and Postgraduate Student*. New York: Palgrave.

Huynh, N., Smith, D. and Harder, F., 2016. Truck appointment systems: where we are and where to go from here. *Transportation Research Record*, *2548*(1),pp.1-9.

Ilati, G., Sheikholeslami, A. and Hassannayebi, E., 2014. A simulation-based optimization approach for integrated port resource allocation problem. *PROMET-Traffic&Transportation*, *26*(3), pp.243-255.

Ilmer, M., 2006. Beating congestion by building capacity: An overview of new container terminal developments in Northern Europe. *Port Technology International*, *2*, p.2006.

Ilieva, J. Baron, S. and Healey, N. (2002) “Online Surveys in Marketing Research: Pros and Cons, *International Journal of Market Research*, Vol. 44, No. 3, pp. 361-376.

Imai, A., Nagaiwa, K.I. and Tat, C.W., 1997. Efficient planning of berth allocation for container terminals in Asia. *Journal of Advanced transportation*, *31*(1), pp.75-94.

Imai, A., Nishimura, E. and Papadimitriou, S., 2003. Berth allocation with service priority. *Transportation Research Part B: Methodological*, *37*(5), pp.437-457.

Imai, A., Chen, C., Nishimura, E., & Papadimitriou, S., (2007) ‘The simultaneous berth and quay crane allocation problem’, *Transportation Research* Part E, 44, pp.120-135.

Imai, A., Nishimura, E. and Papadimitriou, S., 2008. Berthing ships at a multi-user container terminal with a limited quay capacity. *Transportation Research Part E: Logistics and Transportation Review*, *44*(1), pp.136-151.

Inoue, K., 2000. Evaluation method of ship-handling difficulty for navigation in restricted and congested waterways. *The journal of navigation*, *53*(1), pp.167-180.

Islam, S. and Olsen, T.L., 2011. Factors affecting seaport capacity. In *19th International Congress on Modelling and Simulation, 2011, Perth, Western Australia* (pp. 412-418).

Islam, S., Olsen, T. and Ahmed, M.D., 2013. Reengineering the seaport container truck hauling process. *Business process management journal*. J. 19, 752–782.

Islam, S. and Olsen, T., 2014. Truck-sharing challenges for hinterland trucking companies. *Business Process Management Journal*. J. 20, 290–334.

Ismail, R.R., That, N.D. and Ha, Q.P., 2015. Modelling and robust trajectory following for offshore container crane systems. *Automation in Construction*, *59*, pp.179-187.

Jackson, D.N., 1970. A sequential system for personality scale development. In *Current topics in clinical and community psychology* (Vol. 2, pp. 61-96). Elsevier.

Jackson, N.B., 2003. Opinions to spare? Click here. *New York Times*, *3*.

Jacobsson, S., Arnäs, P.O. and Stefansson, G., 2018. Differentiation of access management services at seaport terminals: Facilitating potential improvements for road hauliers. *Journal of Transport Geography*, *70*, pp.256-264.

Jagerman, D. and Altiok, T., 2003. Vessel arrival process and queueing in marine ports handling bulk materials. *Queueing systems*, *45*(3), pp.223-243.

Jagerman, D.L., Balcıoglu, B., Altıok, T. and Melamed, B., 2004. Mean waiting time approximations in the G/G/1 queue. *Queueing Systems*, *46*(3-4), pp.481-506.

Jeevan, J. and Roso, V., 2019. Exploring seaport-dry ports dyadic integration to meet the increase in container vessels size. *Journal of Shipping and Trade*, *4*(1), pp.1-18.

Jiang, X., Lee, L.H., Chew, E.P., Han, Y. and Tan, K.C., 2012. A container yard storage strategy for improving land utilization and operation efficiency in a transshipment hub port. *European journal of operational research*, *221*(1), pp.64-73.

Jiang, C., Wan, Y. and Zhang, A., 2017. Internalization of port congestion: strategic effect behind shipping line delays and implications for terminal charges and investment. *Maritime Policy & Management*, *44*(1), pp.112-130.

Jin, J.G., Lee, D.H. and Hu, H., 2015. Tactical berth and yard template design at container transshipment terminals: A column generation based approach. *Transportation Research Part E: Logistics and Transportation Review*, *73*, pp.168-184.

Jin, J.G., Lee, D.H. and Cao, J.X., 2016. Storage yard management in maritime container terminals. *Transportation Science*, *50*(4), pp.1300-1313.

Jizba, M., Cheu, R.L., Horak, T. and Binova, H., 2015. Analysis of screening checkpoint operations for transatlantic container transportation. *Journal of Transportation Security*, *8*(3), pp.79-97.

Johnson, R. B., and Onwuegbuzie, A. J. (2004). Mixed methods research: A research paradigm whose time has come. *Educational Researcher*, 33(7), 14-26.

Jordan, M., Morris, C. and Dix, A., 2007. The Floaterm Concept: Reducing Terminal Congestion with Waterside Cranes. In *Ports 2007: 30 Years of Sharing Ideas: 1977-2007* (pp. 1-10).

Jula, H., Chassiakos, A. and Ioannou, P., 2006. Port dynamic empty container reuse. *Transportation Research Part E: Logistics and Transportation Review*, *42*(1), pp.43-60.

Kabak, I.W., 1970. Blocking and delays in M (x)/M/c bulk arrival queueing systems. *Management Science*, *17*(1), pp.112-115

Kabir, R.A. and Helal, K., 2021. Congestion at Chittagong seaport: Causes and consequences. A case study in Malaysia. *International Journal of Social Sciences and Economic Review*, *3*(3), pp.12-20.

Kannan, P.K., Chang, A.M. and Whinston, A.B. (1998) "Marketing Information on The I-Way: Data Junkyard or Information Gold Mine?", *Communications of the ACM*, Vol. 41, pp. 35-43.

Kaufmann, D. 2021. *Coronavirus pandemic triggers shipping container crisis*. DW. Available at: Coronavirus pandemic triggers shipping crisis – DW – 04/12/2021. Accessed on: 20/10/2022.

Ke, G.Y., Li, K.W. and Hipel, K.W., 2012. An integrated multiple criteria preference ranking approach to the Canadian west coast port congestion conflict. *Expert Systems with Applications*, *39*(10), pp.9181-9190.

Keceli, Y., 2016. A simulation model for gate operations in multi-purpose cargo terminals. *Maritime Policy & Management*, *43*(8), pp.945-958.

Kepes, S., Banks, G.C., McDaniel, M. and Whetzel, D.L., 2012. Publication bias in the organizational sciences. *Organizational Research Methods*, *15*(4), pp.624-662.

Kelareva, E. , Brand, S. , Kilby, P. , Thiébaux, S. , Wallace, M. , 2012. CP and MIP methods for ship scheduling with time-varying draft. In: Proceedings of the Twenty-Second International Conference on Automated Planning and Scheduling (Sao Paulo, Brazil), pp. 110–118

Kelareva, E., Tierney, K. and Kilby, P., 2014. CP methods for scheduling and routing with time-dependent task costs. *EURO Journal on Computational Optimization*, *2*(3), pp.147-194.

Kent, P.E. and Hochstein, A., 1998. Port reform and privatization in conditions of limited competition: the experience in Colombia, Costa Rica and Nicaragua. *Maritime Policy & Management*, *25*(4), pp.313-333.

Kepes, S., Bennett, A.A. and McDaniel, M.A., 2014. Evidence-based management and the trustworthiness of our cumulative scientific knowledge: Implications for teaching, research, and practice. *Academy of Management Learning & Education*, *13*(3), pp.446-466.

Khoshnevis, B. and Asef-Vaziri, A., 2000. *3D Virtual and physical simulation of automated container terminal and analysis of impact on in land transportation* (No. FHWA/CA/OR-2002/15). METRANS Transportation Center.

Klein, M.M., 1994. REENGINEERING METHODOLOGIES AND TOOLS A Prescription for Enhancing Success. *Information system management*, *11*(2), pp.30-35.

Kiani, M., Bonsall, S., Wang, J. and Wall, A., 2006. A break-even model for evaluating the cost of container ships waiting times and berth unproductive times in automated quayside operations. *WMU Journal of Maritime Affairs*, *5*(2), pp.153-179.

Kim, K.H. and Kim, K.Y., 1999. An optimal routing algorithm for a transfer crane in port container terminals. *Transportation science*, *33*(1), pp.17-33.

Kim, S. (2003). Research Paradigms in organizational learning and performance: Competing modes of inquiry. *Information Technology, Learning, and Performance Journal,* 21(1), 9-18.

Komaromi, A., Cerdeiro, D. and Liu, Y., 2022. Supply Chains and Port Congestion Around the World.

Kozan, E., 1994. Analysis of the economic effects of alternative investment decisions for seaport systems. *Transportation planning and Technology*, *18*(3), pp.239-248.

Ku, L.P., Chew, E.P., Lee, L.H. and Tan, K.C., 2012. A novel approach to yard planning under vessel arrival uncertainty. *Flexible Services and Manufacturing Journal*, *24*(3), pp.274-293.

Kun, Y., 2015. Research on the Comparison of a Port Traffic Organization Scheme Based on VISSIM Simulation. In *CICTP 2015* (pp. 116-126).

Kura, B. and Sulaiman, Y., 2012. Qualitative and quantitative approaches to the study of poverty: Taming the tensions and appreciating the complementarities. *The Qualitative Report*, *17*(20), pp.1-19.

Kwateng, K.O., Donkoh, A. and Muntaka, A.S., 2017. Evaluation of dry port implementation in Ghana. *Maritime Business Review*.

Laih, C.H. and Hung, K.C., 2004. The optimal step toll scheme for heavily congested ports. *Journal of Marine Science and Technology*, *12*(1), pp.16-24.

Lalla-Ruiz, E., Shi, X. and Voß, S., 2018. The waterway ship scheduling problem. *Transportation Research Part D: Transport and Environment*, *60*, pp.191-209.

Lane, T.E., 2009. Assessing sustainability and energy efficiency improvement measures in freight transportation. *SATC 2009*. ] Available at:

https://repository.up.ac.za/bitstream/handle/2263/11956/Lane_Assessing(2009).pdf?sequence=1 Accessed on 1/7/2019

Lange, A.K., Schwientek, A.K. and Jahn, C., 2017. Reducing truck congestion at ports-classification and trends. In *Digitalization in Maritime and Sustainable Logistics: City Logistics, Port Logistics and Sustainable Supply Chain Management in the Digital Age. Proceedings of the Hamburg International Conference of Logistics (HICL), Vol. 24* (pp. 37-58). Berlin: epubli GmbH.

Lawrence, A., Houghton, J., Thomas, J. and Weldon, P.R.(2014). *Where is the Evidence? Realising the Value of Grey Literature for Public Policy and Practice: A Discussion Paper*. Melbourne, Australia: Swinburne Institute for Social Research.

Lee, L.H., Chew, E.P., Tan, K.C. and Han, Y.B., 2006. A yard storage strategy for minimizing traffic management in transshipment hubs. *OR Spectrum*, *28*, pp.539-561.

Lee, L.H., Chew, E.P., Tan, K.C. and Han, Y., 2007. An optimization model for storage yard management in transshipment hubs. In *Container Terminals and Cargo Systems* (pp. 107-129). Springer, Berlin, Heidelberg.

Legato, P. and Mazza, R.M., 2001. Berth planning and resources optimization at a container terminal via discrete event simulation. *European Journal of Operational Research*, *133*(3), pp.537-547.

Levin, K. A. (2006). Study design III: Cross-sectional studies. *Evidence-Based Dentistry*, 7(1), 24-25.

Li, Q. and Lam, J.S.L., 2017. Conflict resolution for enhancing shipping safety and improving navigational traffic within a seaport: vessel arrival scheduling. *Transportmetrica A: Transport Science*, *13*(8), pp.727-741.

Li, S. and Jia, S., 2019. The seaport traffic scheduling problem: Formulations and a column-row generation algorithm. *Transportation Research Part B: Methodological*, *128*, pp.158-184.

Lloyd’s List, D.C.N., 2009. West Side Story: A Tale of Boom and Bust. *Lloyd's List DCN, ed*, *763*(2).

Liberati, A., Altman, D.G., Tetzlaff, J., Mulrow, C., Gøtzsche, P.C., Ioannidis, J.P., Clarke, M., Devereaux, P.J., Kleijnen, J. and Moher, D., 2009. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. *Annals of internal medicine*, *151*(4), pp.W-65.

Liu, Z.X. and Wang, S.M., 2004. The computer simulation study of port tugboat operation. *Acta Simulata Systematica Sinica*, *1*, p.014.

Liu, J. and Wang, J., 2019. Carrier alliance incentive analysis and coordination in a maritime transport chain based on service competition. *Transportation Research Part E: Logistics and Transportation Review*, *128*, pp.333-355.

Lubulwa, G., Malarz, A. and Wang, S.P., 2011, September. An investigation of best practice landside efficiency at Australian container ports. In *Australasian transport research forum* (pp. 1-14).

Luck, J.D. and Rubin, S.R. (1987) *Marketing Research*. 7th edn. Prentice Hall International.

Ma, H. and Zhu, J., 2021, November. Port Congestion Evaluation Model Based on Ship Automatic Identification System. In *ISCTT 2021; 6th International Conference on Information Science, Computer Technology and Transportation* (pp. 1-4). VDE.

Macpherson, A. and Holt, R., 2007. Knowledge, learning and small firm growth: a systematic review of the evidence. *Research policy*, *36*(2), pp.172-192.

Maduka, (2004). Port shipping, safety and Environmental Management Concept Publication Ltd, Lagos.

Magibho, M., 2017. *Analysis on the Effect of Port Congestion on Port Performance: Case Study of Dar es Salaam Port* (Doctoral dissertation, The Open University of Tanzania).

Maguire, A., Ivey, S., Golias, M.M. and Lipinski, M.E., 2010. Relieving congestion at intermodal marine container terminals: review of tactical/operational strategies.

Malhorta, N. K., and Birks, D. F. (2007). *Marketing research: An applied approach* (3rd ed.). Harlow: Prentice Hall Inc.

Maloni, M. and Jackson, E.C., 2005. North American container port capacity: a literature review. *Transportation journal*, pp.16-36.

Manaadiar, H. 2020. Port Congestion – causes, consequences and impact on global trade. Shipping and Frieght Resources. Available at: Port Congestion - causes, consequences and impact on global trade (shippingandfreightresource.com). Accessed on: 19/10/2022.

Maneno, F.H., 2019. Assessment of factors causing port congestion: a case of the port Dar es Salaam.

Market Watch 2022. Global port congestion is getting worse, dashing hopes for easing supply chain snags, report says. Available at:

https://www.marketwatch.com/story/global-port-congestion-is-getting-worse-dashing-hopes-for-easing-supply-chain-snags-report-says-11651599485. [Accessed on 03/04/2022].

Maritime-executive, 2014. Port Congestion: Look Long Term Available at:

https://www.maritime-executive.com/article/Port-Congestion-Look-Long-Term-2014-09-29. Accessed on: 17/12/2019

Martínez Moya, J. and Feo Valero, M., 2017. Port choice in container market: a literature review. *Transport Reviews*, *37*(3), pp.300-321.

Marvasti, A. B. (2004). *Qualitative research in sociology: An introduction*. London: Sage Publications.

Mason, M., 2010, August. Sample size and saturation in PhD studies using qualitative interviews. In *Forum qualitative Sozialforschung/Forum: qualitative social research* (Vol. 11, No. 3).

Mbonambi, N.N., 2018. *An assessment of weather patterns on property-related crimes in Newlands East policing area, Durban* (Doctoral dissertation). Available at: Mbonambi_Nokukhanya_Neptune_2018.pdf (ukzn.ac.za). accessed on: 17/10/2022.

Meersman, H., Van de Voorde, E. and Vanelslander, T., 2012. Port congestion and implications to maritime logistics. In *Maritime Logistics*. Emerald Group Publishing Limited.

Meng, N., Chen, Y. and He, L., 2009, October. Dynamic decision-making for port berth allocation. In *Intelligent Computation Technology and Automation, 2009. ICICTA'09. Second International Conference on* (Vol. 4, pp. 188-191). IEEE.

Meng, W., Li, G. and Hua, L., 2022. A goal-programming based optimal port docking scheme under COVID-19. *Ocean & Coastal Management*, p.106222.

Meredith, J.R., Raturi, A., Amoako-Gyampah, K. and Kaplan, B., 1989. Alternative research paradigms in operations. *Journal of operations management*, *8*(4), pp.297-326.

Meisel, F. and Bierwirth, C., 2009. Heuristics for the integration of crane productivity in the berth allocation problem. *Transportation Research Part E: Logistics and Transportation Review*, *45*(1), pp.196-209.

Miles, M. B., & Huberman, A. M. (1994). *An expanded sourcebook qualitative data analysis.* Thousand Oaks, CA: Sage Publishers.

Minh, C.C. and Huynh, N., 2017. Optimal design of container terminal gate layout. *International Journal of Shipping and Transport Logistics*, *9*(5), pp.640-650.

Misra, T., 2021. *Addressing the innovation lag of port congestion in Durban, South Africa* (Doctoral dissertation, University of Pretoria).

Moghadam, M.K., Jahromi, A.R.M. and Nooramin, A.S., 2011. A fuzzy AHP decision support system for selecting yard cranes in marine container terminals. *WMU Journal of Maritime Affairs*, *10*(2), pp.227-240.

Monem, A.m., 2015. Study the problem of congestion in Emkaser port by using queuing theory. *International Journal of Applied Research*, *1*(9), pp.417-423.

Motono, I., Furuichi, M., Kimoto, H. and Suzuki, S., 2014, July. A new concept of off-dock container traffic control for heavily congested ports. In *The Fifth International Conference on Transportation and Logistics (T-LOG)*.

Motono, I., Furuichi, M., Ninomiya, T., Suzuki, S. and Fuse, M., 2016. Insightful observations on trailer queues at landside container terminal gates: What generates congestion at the gates?. *Research in transportation business & management*, *19*, pp.118-131.

Moorthy, K.S., 1993. Theoretical modeling in marketing. *Journal of Marketing*, *57*(2), pp.92-106.

Muchunu, V. 2021. Mixed reaction to Durban hub port plans. IOL. Available at: Mixed reaction to Durban hub port plans (iol.co.za) accessed on: 19/10/2022

Mullarkey, G.W. (2004) "Internet Measurement Data-Practical and Technical Issues", *Marketing Intelligence and Planning,* Vol. 22, No. 1, pp. 42-58.

Munshi, N. 2020. *Nigeria's port crisis: the $4,000 charge to carry goods across Lagos*. Financial Times. Available at: Subscribe to read | Financial Times (ft.com). Accessed on: 23/10/2022.

Murty, K.G., Liu, J., Wan, Y.W. and Linn, R., 2005. A decision support system for operations in a container terminal. *Decision support systems*, *39*(3), pp.309-332.

Myers, M. (1997) "Qualitative Research in Information Systems", *MIS Quarterly*, Vol. 21, No. 2, pp. 241-242.

Namboothiri, R. and Erera, A.L., 2008. Planning local container drayage operations given a port access appointment system. *Transportation Research Part E: Logistics and Transportation Review*, *44*(2), pp.185-202.

Naudé, J., 2016. *A multi-phase model to forecast congestion at Brazilian grain ports: a case study at the port of Paranagua* (Doctoral dissertation, Stellenbosch: Stellenbosch University).

Navarro, M.M., Bano, R.M.L.P., Cheng, M.D.C., Torres, M.B., Kurata, Y.B. and Gutierrez, M.T.E., 2015. Queuing Theory Application using Model Simulation: Solution to address Manila Port congestion.

NDIPMUN, N.E., 2010. *AN ASSESSMENT OF REFORMS TO REDUCE CONGESTION AT TEMA PORT* (Doctoral dissertation, REGIONAL MARITIME UNIVERSITY).

Neagoe, M., Turner, P., Nguyen, H.O. and Taskhiri, M.S., 2017. Port terminal congestion management. *An integrated information systems approach for improving supply chain value*. In Proceedings from the Australasian Conference on Information Systems (pp. 1-9).

Neagoe, M., Hvolby, H.H., Taskhiri, M.S. and Turner, P., 2021. Using discrete-event simulation to compare congestion management initiatives at a port terminal. *Simulation Modelling Practice and Theory*, *112*, p.102362.

Ngo, Q.H., Nguyen, N.P., Nguyen, C.N., Tran, T.H. and Ha, Q.P., 2017. Fuzzy sliding mode control of an offshore container crane. *Ocean Engineering*, *140*, pp.125-134.

Noritake, M., (1978). “A study on optimum number of berths in public wharf”, *Proceedings of the Japanese Society of Civil Engineers*, **278**, 113-122.

Noritake, M., 1985. Congestion cost and pricing of seaports. *Journal of waterway, port, coastal, and ocean engineering*, *111*(2), pp.354-370.

Notteboom, T., 2007, July. The changing face of the terminal operator business: lessons for the regulator. In *ACCC Regulatory Conference. Gold Coast, Australia*.

Nunnally, J.C. (1978) *Psychometric Theory*. 3rd ed. New York: McGraw-Hill.

Nutley, S., Walter, I. and Davies, H.T., 2003. From knowing to doing: a framework for understanding the evidence-into-practice agenda. *Evaluation*, *9*(2), pp.125-148.

Nze, I. C. & Onyemechi, C. 2018. Port congestion determinants and impacts on logistics and supply chain network of five African ports. Journal of Sustainable De-velopment of Transport and Logistics. Available at: View of Port congestion determinants and impacts on logistics and supply chain network of five African ports (sciview.net). Accessed on:30/10/2022.

Odukwe, E., & Ikeh, C. (2017). The efficiency and effectiveness of security agents in Nigeria seaports. *International Journal of Social Sciences and Humanities Review, 6*. Retrieved from http://www.ijhssnet.com/

Oghojafor,B.E.A., Kuye, O.L. and Alaneme, G.C., 2012. Concession as a Strategic Tool for Ports Efficiency: An Assessment of the Nigerian Ports. Available at: https://ir.unilag.edu.ng/jspui/bitstream/123456789/2468/1/Concession%20as%20a%20strategic%20tool%20for%20ports%20efficiency-%20An%20assessment%20of%20the%20Nigerian%20ports.pdf. Accessed on 18/7/2019

Ojadi, F.I. and Walters, J., 2015. Critical factors that impact on the efficiency of the Lagos seaports. *Journal of Transport and Supply Chain Management*, *9*(1), pp.1-13.

Okpomo, E. 2021. *Port Congestion and its Cost Implication in Nigeria*. Bord Bia. Available at: Port Congestion and its Cost Implication in Nigeria (bordbia.ie). Accessed on:23/10/2022.

Onyema, H., Obinna, P., Emenyonu, U., & Emeghara, G. (2015). The Impact of Port Congestion on The Nigerian Economy. *International Journal of Scientific Research and Management , 3*(7), 3431-3437.

Onwumere, (2008). Handout on Maritime Transport, Operations and Management, Certified Institute of Shipping, Lagos.

Onyemejor, V.I., 2015. Relationship between maritime logistics performance and international trade competitiveness: A case study of Nigeria in Central West African cluster of countries. Available at: https://commons.wmu.se/cgi/viewcontent.cgi?referer=https://scholar.google.com/&httpsredir=1&article=1502&context=all_dissertations. Accessed on 15/7/2019.

Oxford English dictionary, 2004. Oxford English dictionary online. *Mount Royal College Lib., Calgary*, *14*.

Oruwari, A.M., 2021. An assessment of factors causing port congestion in Nigeria: a case of Lagos-Apapa Port.

Oyatoye, E.O., Adebiyi, S.O., Okoyee, J.C. and Amole, B.B., 2011. Application of Queueing theory to port congestion problem in Nigeria. *European Journal of Business and Management*, 3(8), p.2011.

Pace, R., Pluye, P., Bartlett, G., Macaulay, A.C., Salsberg, J., Jagosh, J. and Seller, R., 2012. Testing the reliability and efficiency of the pilot Mixed Methods Appraisal Tool (MMAT) for systematic mixed studies review. *International journal of nursing studies*, *49*(1), pp.47-53.

Paggi, M. and Fuller, S., 1979. *Congestion In The Agricultural Marketing/Transportation System: A Case Study* (No. 2135-2018-5891).

Pallant, J. 2016. *SPSS survival manual*. 6 ed. Berkshire: Open University Press.

Parker, L. (1992) “Collecting Data the Email Way”, *Training and Development*, Vol. 46, No. 7, pp. 52-54.

Patalinghug, E.E., Llanto, G.M., Fillone, A.M., Tiglao, N.C., Salazar, C.R., Madriaga, C.A. and Arbo, M.D.G., 2015. *A system-wide study of the logistics industry in the greater capital region* (No. 2015-24). PIDS discussion paper series.

Pawson, R., Greenhalgh, T., Harvey, G. and Walshe, K., 2005. Realist review-a new method of systematic review designed for complex policy interventions. *Journal of health services research & policy*, *10*(1_suppl), pp.21-34.

Peng, Y., Wang, W., Xu, X., Chen, M., Song, X. and Li, X., 2018. A simulation-based dynamic programming method for interchange scheduling of port collecting and distributing network. *Journal of Advanced Transportation*, *2018*.

Peng, W., Bai, X., Yang, D., Yuen, K.F. and Wu, J., 2022. A deep learning approach for port congestion estimation and prediction. *Maritime Policy & Management*, pp.1-26.

Persson, M., 2008. Trade facilitation and the EU-ACP economic partnership agreements. *Journal of Economic Integration*, pp.518-546.

Perrar, K.M., Schmidt, H., Eisenmann, Y., Cremer, B. and Voltz, R., 2015. Needs of people with severe dementia at the end-of-life: a systematic review. *Journal of Alzheimer's Disease*, *43*(2), pp.397-413.

Petticrew, M., & Roberts, H. (2006). *Systematic reviews in the social science: A practical guide.* Malden, MA: Blackwell Publishing.

Petticrew, M. and Roberts, H., 2008. *Systematic reviews in the social sciences: A practical guide*. John Wiley & Sons.

Phan, M.H. and Kim, K.H., 2015. Negotiating truck arrival times among trucking companies and a container terminal. *Transportation Research Part E: Logistics and Transportation Review*, *75*, pp.132-144.

Phan, M.H. and Kim, K.H., 2016. Collaborative truck scheduling and appointments for trucking companies and container terminals. *Transportation Research Part B: Methodological*, *86*, pp.37-50.

Potgieter, L., 2016. *Risk profile of port congestion: Cape Town Container Terminal case study* (Doctoral dissertation, Stellenbosch: Stellenbosch University).

Potgieter, L., Goedhals-Gerber, L.L. and Havenga, J., 2020. Risk profile of weather and system-related port congestion for the Cape Town container terminal.

Powles, M.J., 2004. *Improved operational efficiency as a measure for alleviating port congestion at the Cape Town container terminal* (Doctoral dissertation, Cape Technikon).

Pruyn, J.F.J., Kana, A.A. and Groeneveld, W.M., 2020. Analysis of port waiting time due to congestion by applying Markov chain analysis. In *Maritime Supply Chains* (pp. 69-94). Elsevier.

Render B, Stair R & Hanna M, 2006, *Quantitative Analysis for Management*, Edition,Pearson, London, UK.

Radmilovic, Z., Colic, V. and Hrle, Z., 1996. Some aspects of storage and bulk queueing systems in transport operations. *Transportation planning and technology*, *20*(1), pp.67-81.

Rahmanto, W.P., 2016. Kandangan dry port project: an option of solution for congestion: case of Lamong Bay Terminal (Surabaya, Indonesia).

Rajamanickam, G.D. and Ramadurai, G., 2015, December. Simulation of truck congestion in Chennai port. In *2015 Winter Simulation Conference (WSC)* (pp. 1904-1915). IEEE.

Rajasekar, D. and Rengamani, J., 2017. A study on the port conge stion of the seaports in Chennai cluster. *International Jou rnal of Research in Management, Economics and Commer ce*, *7*(12), pp.13-19.

Ramírez-Nafarrate, A., González-Ramírez, R.G., Smith, N.R., Guerra-Olivares, R. and Voß, S., 2017. Impact on yard efficiency of a truck appointment system for a port terminal. *Annals of Operations Research*, *258*(2), pp.195-216.

Regan, A.C. and Golob, T.F., 2000. Trucking industry perceptions of congestion problems and potential solutions in maritime intermodal operations in California. *Transportation Research Part A: Policy and Practice*, *34*(8), pp.587-605.

Richards, L. and Morse, J.M., 2007. *Readme first for a user's guide to qualitative methods*. Thousand Oaks: SAGE.

Ritchie, J. and Spencer, L., 2002. Qualitative data analysis for applied policy research. In *Analyzing qualitative data* (pp. 187-208). Routledge.

Robson, C. (1993) *Real World Research*. Oxford: Blackwell.

Robson, C. (2002). *Real Word Research*. Oxford: Blackwell.

Rosario, I. (2020). congestion at Durban - a technical evaluation. (S.A. news, compiler) southern Africa's freight news. Available at: Congestion at Durban – A technical evaluation | Freight News. Accessed on: 17/10/2022

Roso, V., 2007. Evaluation of the dry port concept from an environmental perspective: A note. *Transportation Research Part D: Transport and Environment*, *12*(7), pp.523-527.

Roso, V., 2008. Factors influencing implementation of a dry port. *International Journal of Physical Distribution & Logistics Management,* 38(10), pp.782-798.

Roso, V., Woxenius, J. and Lumsden, K., 2009. The dry port concept: connecting container seaports with the hinterland. *Journal of Transport Geography*, *17*(5), pp.338-345.

Rothstein, H.R., Sutton, A.J. and Borenstein, M., 2005. Publication bias in meta-analysis. *Publication bias in meta-analysis: Prevention, assessment and adjustments*, pp.1-7.

Rousseau, D.M., 2006. Is there such a thing as "evidence-based management"?. *Academy of management review*, *31*(2), pp.256-269.

Rousseau, D.M., Manning, J. and Denyer, D., 2008. 11 Evidence in management and organizational science: assembling the field's full weight of scientific knowledge through syntheses. *The academy of management annals*, *2*(1), pp.475-515.

Roy, D., Gupta, A. and De Koster, R.B., 2016. A non-linear traffic flow-based queuing model to estimate container terminal throughput with AGVs. *International Journal of Production Research*, *54*(2), pp.472-493.

Ruiz-Aguilar, J.J., Turias, I.J. and Jiménez-Come, M.J., 2015. A two-stage procedure for forecasting freight inspections at Border Inspection Posts using SOMs and support vector regression. *International Journal of Production Research*, *53*(7), pp.2119-2130.

Ruiz-Aguilar, J.J., Turias, I., Moscoso-López, J.A., Jiménez-Come, M.J. and Cerbán, M., 2016. Forecasting of short-term flow freight congestion: A study case of Algeciras Bay Port (Spain). *Dyna*, *83*(195), pp.163-172.

Ruiz-Aguilar, J.J., Turias, I., Moscoso-López, J.A., Jiménez-Come, M.J. and Cerbán-Jiménez, M., 2019. Efficient goods inspection demand at ports: a comparative forecasting approach. *International Transactions in Operational Research*, *26*(5), pp.1906-1934.

Saeed, N. and Larsen, O.I., 2016. Application of queuing methodology to analyze congestion: A case study of the Manila International Container Terminal, Philippines. *Case Studies on Transport Policy*, *4*(2), pp.143-149.

Saeed, N., Song, D.W. and Andersen, O., 2018. Governance mode for port congestion mitigation: A transaction cost perspective. *NETNOMICS: Economic Research and Electronic Networking*, *19*(3), pp.159-178.

Sale, J. E., Lohfeld, L. H., and Brazil, K. (2002). Revisiting the quantitative-qualitative debate: Implications for mixed-methods research. *Quality & Quantity,* 36(1), 43-53.

Salipante, P, Notz, B. & Bigelow, J. 1982. A matrix approach to literature reviews. Research on Organizational Behavior, B.M. Staw and L.L.Cummings (eds.) pp. 321-348. JAI Press.

Saunders, MN, Lewis, P, & Thornhill, A., 2009. *Research Methods for Business Students*, 5th. ed. Harlow: Financial Times Prentice Hall, United Kingdom.

Saunders, M., Lewis, P. and Thornhill, A. (2012) *Research Methods for Business Students*. 6th edn. London: Prentice Hall.

Saurí, S., Serra, J. and Martín, E., 2011. Evaluating pricing strategies for storage in import container terminals. *Transportation research record*, *2238*(1), pp.1-7.

Schaefer, R. and Dillman, D.A. (1998) “Development of A Standard Email Methodology: Results of an Experiment”, *Public Opinion Quarterly*, Vol. 62, No. 3, pp. 378-397.

Scheithauer, G., 1999. LP-based bounds for the container and multi-container loading problem. *International Transactions in Operational Research*, *6*(2), pp.199-213.

Schonlau, M., Ronald Jr, D. and Elliott, M.N., 2002. *Conducting research surveys via e-mail and the web*. Rand Corporation.

Sekaran, U. (2000) *Research Methods for Business: A Skill Building Approach*. New York: John Wiley and Sons.

Sekaran, U. (2003) Research Methods for Business: A Skilled Building Approach. 3rd edn. New York: Wiley.

Seuring, S. and Müller, M., 2008. From a literature review to a conceptual framework for sustainable supply chain management. *Journal of cleaner production*, *16*(15), pp.1699-1710.

Sequeira, S. and Djankov, S., 2010. An empirical study of corruption in ports. Available at: mpra.ub.uni-muenchen.de/21791/1/MPRA_paper_21791.pdf [Acceded on 1/7/2019].

Shabayek, A.A. and Yeung, W.W., 2000. A queuing model analysis of the performance of the Hong Kong container terminals. *Transportation Planning and Technology*, *23*(4), pp.323-351.

Shabayek, A.A. and Yeung, W.W., 2001. Effect of seasonal factors on performance of container terminals. *Journal of waterway, port, coastal, and ocean engineering*, 127(3), pp.135-140.

Shabayek, A.A. and Yeung, W.W., 2002. A simulation model for the Kwai Chung container terminals in Hong Kong. *European Journal of Operational Research*, *140*(1), pp.1-11.

Shahpanah, A., Shariatmadari, S., Chegeni, A., Gholamkhasi, A. and Shahpanah, M., 2014. Improvement in queuing network model to reduce waiting time at berthing area of port container terminal via discrete event simulation. In *Applied Mechanics and Materials* (Vol. 621, pp. 253-258). Trans Tech Publications Ltd.

Sheehan, K.B. and McMillan, S.J. (1999) “Response Variation in E-Mail Surveys: an Exploration”, *Journal of Advertising Research*, Vol. 39, pp. 45-54.

Sheikholeslami, A., Ilati, G. and Yeganeh, Y.E., 2013. Practical solutions for reducing container ships’ waiting times at ports using simulation model. *Journal of Marine Science and Application,* 12(4), pp.434-444.

Sheikholeslami, A., Ilati, G. and Kobari, M., 2014. The continuous dynamic berth allocation problem at a marine container terminal with tidal constraints in the access channel. *International Journal of Civil Engineering*, *12*(3), pp.344-353.

Sheikholeslami, A. and Ilati, R., 2018. A sample average approximation approach to the berth allocation problem with uncertain tides. *Engineering Optimization*, *50*(10), pp.1772-1788.

Sierles, F. S. (2003). How to do research with self-administered surveys. *Academic Psychiatry,* 27(2), 104-113.

Simões, P. and Marques, R.C., 2010. Influence of congestion efficiency on the European seaports performance: does it matter?. *Transport Reviews*, *30*(4), pp.517-539.

Slack, B. and Frémont, A., 2005. Transformation of port terminal operations: from the local to the global. *Transport Reviews*, *25*(1), pp.117-130.

Smart, P., Bessant, J. and Gupta, A. (2007). Towards technological rules for designing innovation networks: a dynamic capabilities view. *International Journal of Operations & Production Management*, **27**, pp. 1069–1092.

Smith, J.A. ed., 2015. *Qualitative psychology: A practical guide to research methods*. Sage.

Smith, D., Bingham, P., Hackett, D. and Smith, J., 2022. Multiperspective Analysis of Pandemic Impacts on US Import Trade: What Happened, and Why?. *Transportation Research Record*, p.03611981221098663.

Song, S.C., hoon Park, S. and Yeo, G.T., 2019. Network Structure Analysis of a Sub-Hub-Oriented Port. *The Asian Journal of Shipping and Logistics*, *35*(2), pp.118-125.

Soriguera, F., Robuste, F., Juanola, R. and Lopez-Pita, A., 2006. Optimization of handling equipment in the container terminal of the Port of Barcelona, Spain. *Transportation research record*, *1963*(1), pp.44-51.

Souf-Aljen, A.S., Maimun, A., Rahimuddin, R. and Zairie, N., 2016. Port capacity forecasting and the impact of the dredging works on port sea operations using discrete event simulation. *Jurnal Teknologi*, *78*(9-4).

Stephens, M.S. and Ukpere, W.I., 2011. Port performance: The importance of land transport in a developing economy. *African Journal of Business Management*, *5*(21), pp.8545-8551.

Strike K, and Posner G. (1983). Types of synthesis and their criteria. In kmowledge structure and use: *implications for synthesis and interpretation*. Edited by: Ward S, Reed L. Philadelphia: Temple university press.

Suhr, D.D., 2005. Principal component analysis vs. exploratory factor analysis. *SUGI 30 proceedings*, *203*, p.230.

Sun, Y.G., Qiang, H.Y., Xu, J. and Dong, D.S., 2017. The nonlinear dynamics and anti-sway tracking control for offshore container crane on a mobile harbor. *Journal of Marine Science and Technology*, *25*(6), p.5.

Svendsen, A.S., 1967. *Does the traditional set-up of port charges favour old and unmodern ships?*. Institute for Shipping Research. The Norwegian School of Economics and Business Administration.

Swamidass, P.M., 1986. Manufacturing strategy: its assessment and practice. *Journal of operations management*, *6*(3-4), pp.471-484.

Tabachnick, B. and Fidell, L. (2001) *Using Multivariate Statistics*. Boston: Ally and Bacon.

Tabachnick, B.G. and Fidell, L.S. (2007) *Using Multivariate Statistics.* 5th edn. Boston: Pearson Education.

Taleb-Ibrahimi, M., de Castilho, B. and Daganzo, C.F., 1993. Storage space vs handling work in container terminals. *Transportation Research Part B: Methodological*, *27*(1), pp.13-32.

Talley,W.K. (2006). An economic theory of the port. In Cullinane, K., & Talley,W.K. (Eds.) *Research in transportation economics: Port economics* (pp. 43–65). Amsterdam: Elsevier.

Talley, W.K. and Ng, M., 2016. Port multi-service congestion. *Transportation Research Part E: Logistics and Transportation Review*, *94*, pp.66-70.

Talley, W.K., 2017. *Port economics*. Routledge. Available at:

http://www.khuisf.ac.ir/dorsapax/Data/Sub_118/File/Port%20Economics%20.pdf [Acceded on 1/7/2019].

Teye, C., Bell, M.G. and Bliemer, M.C., 2016, November. Optimal location of open access urban container terminals under elastic cargo demand. In *Australasian Transport Research Forum (ATRF), 38th, 2016, Melbourne, Victoria, Australia*.

The World Bank (2007). World Bank Port reform Toolkit, 2nd Eds. Available at: https://ppiaf.org/sites/ppiaf.org/files/documents/toolkits/Portoolkit/Toolkit/pdf/modules/03 TOOLKIT Module3.pdf. Accessed on: 09/02/2020.

Thomas, A. B. (2004). *Research skills for management studies*. London: Routledge.

Thomas, J. and Harden, A., 2008. Methods for the thematic synthesis of qualitative research in systematic reviews. *BMC medical research methodology*, *8*(1), p.45.

Tong, A., Flemming, K., McInnes, E., Oliver, S. and Craig, J., 2012. Enhancing transparency in reporting the synthesis of qualitative research: ENTREQ. *BMC medical research methodology*, *12*(1), p.181.

Tranfield, D., Denyer, D. and Smart, P., 2003. Towards a methodology for developing evidence-informed management knowledge by means of systematic review. *British journal of management*, *14*(3), pp.207-222.

Trujillo, L. and Nombela, G., 1999. *Privatization and regulation of the seaport industry*. The World Bank. Available at: http://documents.worldbank.org/curated/en/973281468740398501/104504322_20041117155008/additional/multi-page.pdf . Acceded on 1/8/2019

Tsao, Y.C. and Linh, V.T., 2018. Seaport-dry port network design considering multimodal transport and carbon emissions. *Journal of Cleaner Production*, *199*, pp.481-492.

Turner, N., Swart, J. and Maylor, H., 2013. Mechanisms for managing ambidexterity: A review and research agenda. *International Journal of Management Reviews*, *15*(3), pp.317-332.

Van Asperen, E., Dekker, R., Polman, M. and De Swaan Arons, H., 2003, December. Waterway, shipping, and ports: modeling ship arrivals in ports*. In Proceedings of the 35th conference on Winter simulation: driving innovation(pp. 1737-1744). Winter Simulation Conference.*

Vandenbosch, B., Saatcioglu, A. and Fay, S., 2006. Idea management: a systemic view. *Journal of Management Studies*, *43*(2), pp.259-288.

Veloqui, M., Turias, I., Cerbán, M.M., González, M.J., Buiza, G. and Beltrán, J., 2014. Simulating the landside congestion in a container terminal. The experience of the port of Naples (Italy). *Procedia-Social and Behavioral Sciences*, *160*, pp.615-624.

Vessels Value trade data 2021. Global port congestion bulk and container vessels waiting time 25 October 2021. Available at: https://maritimafrica.com/en/wp-content/uploads/2021/11/Global-port-congestion-scaled.jpg. Acceded on 13/10/2022.

Vu, N.B.N., 2022. Port Congestion and an Operational Guideline to Settle It. Available at: https://www.theseus.fi/bitstream/handle/10024/756197/thesis_Ngoc%20Vu_e1900700.pdf?sequence=2 Acceded on 15/10/2022

Wacker, J.G., 1998. A definition of theory: research guidelines for different theory-building research methods in operations management. *Journal of operations management*, *16*(4), pp.361-385.

Wagner, N. (2017). Identification of the most important sustainability topics in seaports. Logistics and Transport, 34, 79-88.

Walker, H., Chicksand, D., Radnor, Z. and Watson, G. 2015. Theoretical perspectives in operations management: an analysis of the literature. *International Journal of Operations & Production Management*, *35*(8), pp.1182-1206.

Wan, Y., Zhang, A. and Yuen, A.C., 2017. Urban road congestion, capacity expansion and port competition: empirical analysis of US container ports. In *Ports and the Environment* (pp. 27-28). Routledge.

Wang, Z.X., Chan, F.T., Chung, S.H. and Niu, B., 2014, April. Yard truck configurations for efficient operation of container terminals in Hong Kong. In *2014 International Conference on Information Science, Electronics and Electrical Engineering* (Vol. 3, pp. 1435-1439). IEEE.

Wang, X. and Meng, Q., 2019. Optimal price decisions for joint ventures between port operators and shipping lines under the congestion effect. *European Journal of Operational Research*, *273*(2), pp.695-707.

Wang, Y. and Wang, N., 2019. The role of the port industry in China's national economy: An input–output analysis. *Transport Policy*, *78*, pp.1-7.

Wanke, P., 2011. Ship-berth link and demurrage costs: evaluating different allocation policies and queue priorities via simulation. *Pesquisa Operacional*, *31*(1), pp.113-134.

Wein, L.M., Wilkins, A.H., Baveja, M. and Flynn, S.E., 2006. Preventing the importation of illicit nuclear materials in shipping containers. *Risk Analysis*, *26*(5), pp.1377-1393.

Welman, C., Kruger, F. and Mitchell, B., 2005. Research Methodology (Third Edit). *Cape Town: Oxford University Press Southern Africa (Pty) Ltd*, pp.165-167.

Wenhui, Y., 2011, September. Heuristic Algorithm for Simulation and Optimization System of Port Tugboats Allocation. In *2011 International Conference on Internet Computing and Information Services* (pp. 306-309). IEEE.

Whitley, R., 1984a. The fragmented state of management studies: reasons and consequences. *Journal of management studies*, *21*(3), pp.331-348.

World shipping council 2015. world shipping organization. Available at: http://www.worldshipping.org/industry-issues/transportation-infrastructure/Observations_on_Port_Congestion_Vessel_Size_and_VSA_May_28_2015.pdf accessed on 22/3/2020

Wilson, A. and Laskey, N. (2003) “Internet-Based Marketing Research: A Serious Alternative to Traditional Research Methods?”, *Marketing Intelligence and Planning*, Vol. 21, No. 2, pp. 79-84.

Woo, S.H., Pettit, S.J., Kwak, D.W. and Beresford, A.K., 2011. Seaport research: A structured literature review on methodological issues since the 1980s. *Transportation Research Part A: Policy and Practice*, *45*(7), pp.667-685.

Xchange. (2020). *Port Congestion – An Industry threat*. Available at: [Port congestion: What are common causes? [+how to avoid them] (container-xchange.com)](). Accessed on: 20/10/2022.

Xu, Q., Mao, J. and Jin, Z., 2012. Simulated annealing-based ant colony algorithm for tugboat scheduling optimization. *Mathematical Problems in Engineering*, *2012*.

Xu, B., Liu, X., Yang, Y., Li, J. and Postolache, O., 2021. Optimization for a Multi-Constraint Truck Appointment System Considering Morning and Evening Peak Congestion. Sustainability 2021, 13, 1181.

Yang, D., 2008. Integrity for hire: an analysis of a widespread customs reform. *The Journal of Law and Economics*, *51*(1), pp.25-57.

Yang, Z.Z., Chen, G. and Song, D.P., 2013. Integrating truck arrival management into tactical operation planning at container terminals. *Polish Maritime Research*, 20(Special Issue), pp.32-46.

Yeo, G.T., Roe, M. and Soak, S.M., 2007. Evaluation of the marine traffic congestion of north harbor in busan port. *Journal of waterway, port, coastal, and ocean engineering*, *133*(2), pp.87-93.

Yin, R. (2009) *Case Study Research: Design and Methods.* London: Sage Publications

Yin, R.K., 2013. *Case Study Research*: Design and Methods, Fifth ed. Sage, Thousand Oaks, CA.

Yi, S., Scholz-Reiter, B., Kim, T. and Kim, K.H., 2019. Scheduling appointments for container truck arrivals considering their effects on congestion. *Flexible Services and Manufacturing Journal*, *31*(3), pp.730-762.

Yu, H., Ge, Y.E., Fu, X., Huang, Y., Zhang, Y. and Tan, C., 2018, March. Capturing effects of container location dispersion on quay crane performance. In *Proceedings of the Institution of Civil Engineers-Maritime Engineering* (Vol. 171, No. 1, pp. 25-39). Thomas Telford Ltd.

Zain, R.M., Ab Rahman, M.N., Ramli, A., Nopiah, Z.M. and Saibani, N., 2016. Using Measures of Agreement to Evaluate a Chronic Problem of Congestion in the Empty Container Depots. *International Review of Management and Marketing*, *6*(4).

Zhang, C., Wan, Y.W., Liu, J. and Linn, R.J., 2002. Dynamic crane deployment in container storage yards. *Transportation Research Part B: Methodological*, *36*(6), pp.537-555.

Zhang, C., Liu, J., Wan, Y.W., Murty, K.G., and Linn, R.J. 2008. Storage Space Allocation in ContaineTerminals: *Transportation Research Part B*: 883-903.

Zhang, M., Batta, R. and Nagi, R., 2009. Modeling of workflow congestion and optimization of flow routing in a manufacturing/warehouse facility. *Management Science*, *55*(2), pp.267-280.

Zhang, X., Zeng, Q. and Chen, W., 2013. Optimization model for truck appointment in container terminals. *Procedia-Social and Behavioral Sciences*, *96*, pp.1938-1947.

Zhang, A., Zheng, Z. and Teo, C.P., 2022. Schedule reliability in liner shipping timetable design: A convex programming approach. *Transportation Research Part B: Methodological*, *155*, pp.499-525.

Zhen, L., 2013. Yard template planning in transshipment hubs under uncertain berthing time and position. *Journal of the Operational Research Society*, *64*(9), pp.1418-1428.

Zhen, L., 2016. Modeling of yard congestion and optimization of yard template in container ports. *Transportation Research Part B: Methodological*, *90*, pp.83-104.

Zhen, L., Xu, Z., Wang, K. and Ding, Y., 2016. Multi-period yard template planning in container terminals. *Transportation Research Part B: Methodological*, *93*, pp.700-719.

Zheng, S., Luo, M., 2021. Competition for cooperation? ports' strategies and welfare analysis facing shipping alliances. Transportation Research Part E: Logistics and Transportation Review, Volume 153,2021,102429, available at: Competition or cooperation? Portsâ€™ strategies and welfare analysis facing shipping alliances | Elsevier Enhanced Reader. Accessed on: 12/10/2022.

ISSN 1366-5545, Zikmund, W.G. (2003) *Business Research Method*. 8th ed. Cincinnati, Ohio: Thomson/South-Western

Zrnić, D.N., Dragović, B.M. and Radmilović, Z.R., 1999. Anchorage-ship-berth link as multiple server queuing system. *Journal of waterway, port, coastal, and ocean engineering*, *125*(5), pp.232-240.

# Appendixes:

## Appendix (A).

Experiences and background of the stakeholders (Eddrgash 2019).

| Participant | Experience and background | Total experience | Current working place | sector |
|---|---|---|---|---|
| **P1** | An officer on board of ships for 10 years +port Harbor Master for 15 years + Director Manager for shipping company for 5 years | 30 years | Director Manager for shipping company | Private |
| **P2** | Port Stevedoring operator for 10 years + Silos head department at one of Libyan ports for 8 years. | 18 years | Silos head department at one of Libyan ports | Public |
| **P3** | 5 years as ship officer + 20 years at management level in LPC | 25 years | Upper management level in LPC | Public |
| **P4** | 2 years as engineer on board ships + 10 years as a manager in middle level at PC + 7 years as a manager in upper management level + 7 years as general manager for shipping company. | 26 years | General manager for shipping company. | Private |
| **P5** | 5 years as customs officer + 10 years as A customs releasing agent + 5 years as general manager for customs releasing agency. | 20 years | General manager for customs releasing agency | Private |
| **P6** | 5 years as a Lawyer + 10 years at middle Legal management at LPC + 8 years at upper Legal management at MFZ company | 23 years | Upper Legal management at MFZ company | Public |
| **P7** | 5 years as a Radio operator in port + 8 years as Harbor Master | 13 years | Harbor Master | Public |
| **P8** | 10 years as customs officer + 10 years as A customs releasing agent + 2 years as general manager for customs releasing agency. | 22 years | The manager of customs releasing agency. | Private |
| **P9** | 15 as customs officer + 10 years at middle customs management + 5 years at upper customs management | 30 years | Upper customs management | Public |
| **P10** | 10 years as ship captain + 10 years at middle management in port authorities + 4 years as a manager at upper management in port authorities. | 24 years | Manager at upper management in port authorities. | Public |
| **P11** | 10 years employment at Economic Ministry + 5 years as a head department in Marketing management at MFZ + 10 years as a manager in upper management for MFZ. | 25 years | Manager in upper management for MFZ. | Public |
| **P12** | 10 years as employee in food control and release authorities in ports + 5 years at middle and then 10 years as a manager at upper management in food control and release authorities in ports | 25 years | A manager at upper management in food control and release authorities in ports | Public |
| **P13** | 5 years as ship engineer + 10 years as Harbor master in LPC + 8 years as a manager at upper management in LPC | 23 years | A manager at upper management in LPC | Public |

Continued with experiences and the background of the stakeholders (Eddrgash 2019).

| Participant | Experience and background | Total experience | Current working place | sector |
|---|---|---|---|---|
| **P15** | 20 years as car importer and trader + 8 years as manager and shareholder at car importing company. | 28 years | A manager and shareholder at car importing company. | Private |
| **P16** | 10 years as chief officer on board ships + 5 years as ship agent + 7 years as Manager and shareholder in shipping and freight forward company | 22 years | Manager and shareholder in shipping and freight forwarding company | Private |
| **P17** | 15 years as ship agent + 7 years as Manager and shareholder in shipping and freight forwarding company | 22 years | Manager and shareholder in shipping and freight forwarding company | Private |
| **P18** | 7 years as ship agent + 10 years as operation manager in shipping and freight forwarding company | 17 years | Operation manager in shipping and freight forwarding company | Private |
| **P19** | 5 years as ship agent + 12years as a Manager and shareholder in shipping and freight forwarding company | 17 years | Manager and shareholder in shipping and freight forwarding company | Private |
| **P20** | 20 years as ship agent + 7 years as operation manager in shipping company | 27 years | Operation manager in shipping company | Private |
| **P21** | 12 years as Chief engineer on board ships + 10 years as Manager at middle management in LPC + 8 years as manager at upper management in LPC. | 30 years | Manager at upper management in LPC. | Public |
| **P22** | 10 years employee at USA + 10 years as a manager at upper investment management in MFZ company | 20 years | A manager at upper investment management in MFZ company | Public |
| **P23** | 15 years as repairing engineer in ports + 5 years at middle maintenance management at LPC + 7 years as a manager at upper Maintenance management in MFZ | 27 years | A manager at upper Maintenance management in MFZ | Public |
| **P24** | 15 years as employee in food control and release authorities in ports + 2years at middle and then 5 years as a manager at upper management in radiation test and release authorities in ports | 22 years | A manager at upper management in radiation test and release authorities in ports | Public |
| **P25** | 17 years as Chief engineer on board ships + 10 years as employee in LPC + 5 years as manager at upper management in LPC | 32 years | A manager at upper management in LPC | Public |

Continued with Experiences and the background of the stakeholders (Eddrgash 2019).

| Participant | Experience and background | Total experience | Current working place | sector |
|---|---|---|---|---|
| **P26** | 5 years as ship officer on board ships + 5 years as a Harbor Master in LPC ports + 3 years as manager at Stevedoring middle management in LPC port. | 13 years | A manager at Stevedoring middle management at LPC port. | Public |
| **P27** | 10 years as an engineer in Port sector administration + 5 years as a manager in upper management at LPC + 7 years as manager in upper management at LMA + 5 years as Manager in high level at the Transportation Ministry responsible for port sector. | 27 years | A manager in high level in Transportation Ministry responsible for port sector. | Public |
| **P28** | 5 years as employee in Stevedoring management in LPC port + 10 years as manager in middle Stevedoring management in LPC port + 10 as a manager at upper Stevedoring management in MFZ port. | 25 years | A manager in upper Stevedoring management of MFZ port. | Public |
| **P29** | 3 years as employee in Stevedoring management in LPC port + 8 years as manager in middle Stevedoring management in LPC port + 2 as a manager at upper Stevedoring management in MFZ port + 5 years as a manager in upper management in MFZ | 18 years | A manager in upper management in MFZ | Public |
| **P30** | 5 years as an engineer on board of ships + 12 years as a manager in middle management in LMA + 5 years as a manager in upper management in LMA. | 22 years | A manager in upper management in LMA. | Public |
| **P31** | 8 years as ship captain on board ships + 5 years as manager in middle Stevedoring management in LPC port + 2 as a Harbor Master in LPC port + 5 years as a manager in upper management in LPC port. | 20 years | A manager in upper management in LPC port. | Public |

Appendix B: Journals' ranks and types for the review selected articles according to the Academic Journal Guide 2018.

| Journal title | Ranking | Count of selected journals |
|---|---|---|
| A case study | No rank | 1 |
| Academic journal of humanities & social sciences | No rank | 1 |
| African journal of business management | * | 1 |
| Annals of operations research | *** | 2 |
| Automation in construction | No rank | 1 |
| Business history | *** | 1 |
| Business process management journal | ** | 1 |
| Case studies on transportation policy | No rank | 1 |
| Decision support systems | *** | 1 |
| Developing country studies | No rank | 1 |
| Dyna. universidad nacional de colombia | No rank | 1 |
| Engineering optimization | ** | 1 |
| European journal of operational research | **** | 2 |
| Expert systems with applications | *** | 1 |
| Flexible services and manufacturing journal | * | 5 |
| In advanced materials research | No rank | 1 |
| In proceedings of the institution of civil engineers-maritime engineering | No rank | 1 |
| International journal of applied research | No rank | 1 |
| International journal of physical distribution & logistics management | ** | 1 |
| International journal of production economics | *** | 2 |
| International journal of production research | *** | 2 |
| International journal of research in management, economics and commerce | No rank | 1 |
| International review of management and marketing | No rank | 1 |
| International transactions in operational research | * | 1 |
| Journal of advanced transportation | No rank | 1 |
| Journal of applied economics and policy | *** | 1 |
| Journal of business and management | ** | 1 |

Journals' ranks and types for the review selected articles according to the Academic Journal Guide 2018.

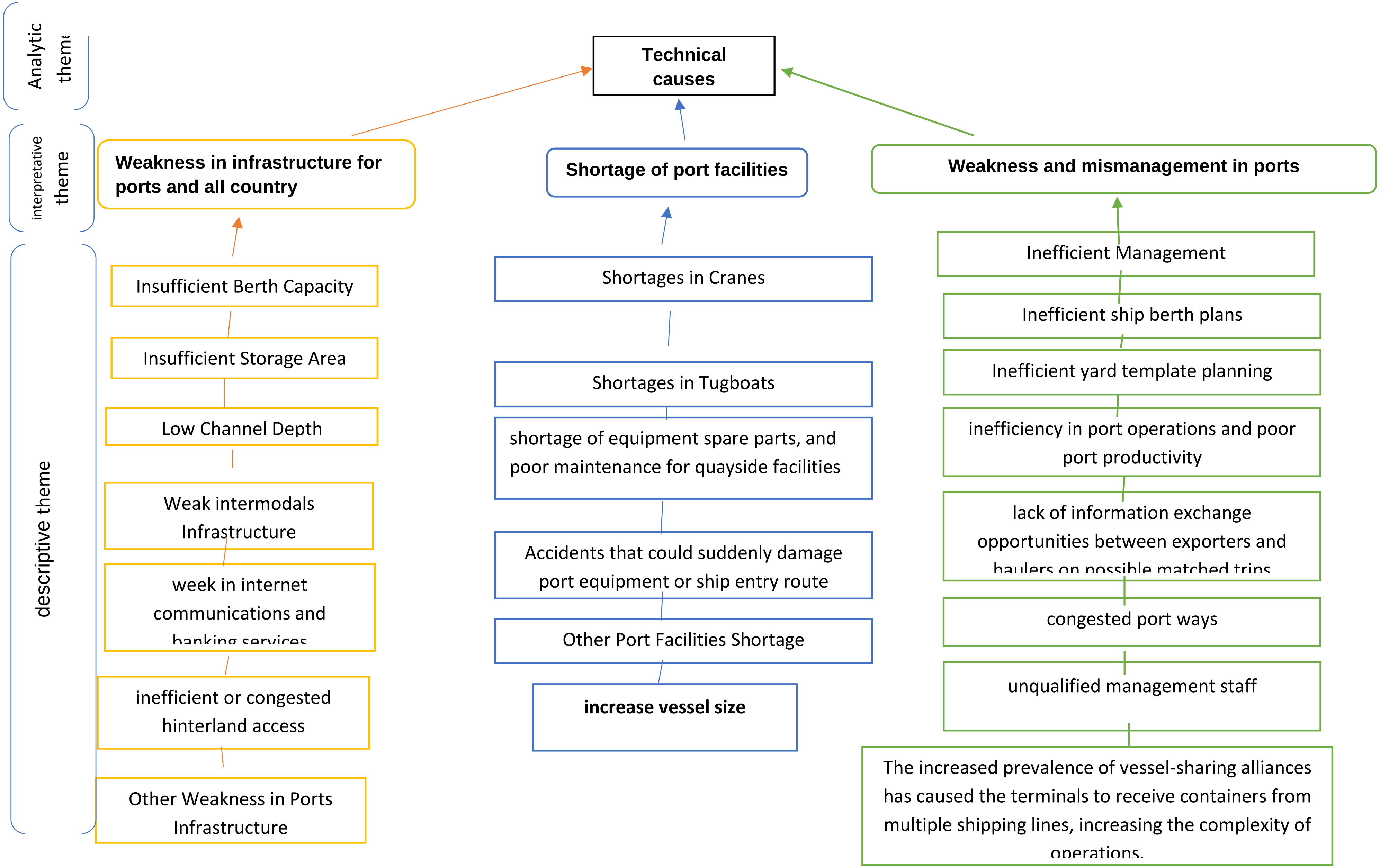
| Journal title | Ranking | Count of selected journals |
|---|---|---|
| Journal of engineering for the maritime environment | No rank | 1 |
| Journal of marine science and application | No rank | 1 |
| Journal of marine science and technology | No rank | 2 |
| Journal of mechanical engineering | No rank | 2 |
| Journal of policy modelling | ** | 1 |
| Journal of shipping and trade | No rank | 1 |
| Journal of shipping and transport logistics | * | 1 |
| Journal of soil science and environmental management | No rank | 1 |
| Journal of sustainable development of transport and logistics | No rank | 1 |
| Journal of transport and supply chain management | No rank | 1 |
| Journal of transport economics and policy | ** | 3 |
| Journal of transport geography | ** | 1 |
| Journal of transportation security | No rank | 1 |
| Journal of waterway, port, coastal, and ocean engineering | No rank | 3 |
| Journal of zhejiang university-science | No rank | 1 |
| Journal teknologi | No rank | 1 |
| Management science | **** | 1 |
| Maritime business review | No rank | 2 |
| Maritime economics & logistics | * | 4 |
| Maritime policy & management | ** | 5 |
| Netnomics: economic research and electronic networking | No rank | 1 |
| Ocean engineering | No rank | 1 |
| Or spectrum | *** | 1 |
| Pesquisa operational | * | 1 |
| Polish maritime research | No rank | 1 |
| Port, coastal, and ocean engineering | No rank | 1 |
| Procedia-social and behavioural sciences | No rank | 2 |
| Promet-traffic & transportation | No rank | 1 |

Continued with the Journals' ranks and types for the review selected articles according to the Academic Journal Guide 2018.

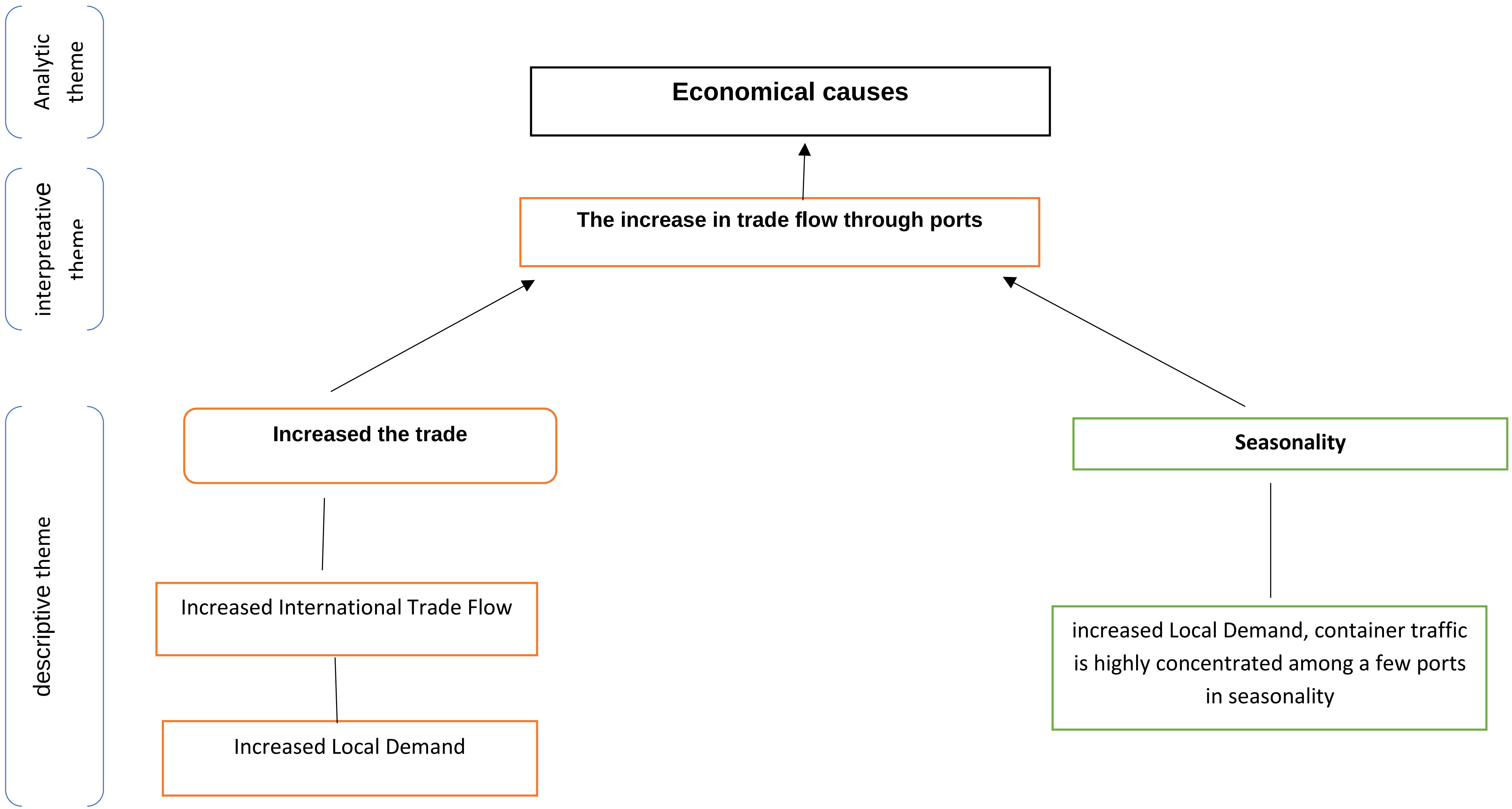
Continued with the Journals' ranks and types for the review selected articles according to the Academic Journal Guide 2018.

| Journal title | Ranking | Count of selected journals |
|---|---|---|
| Research in transportation business & management | No rank | 1 |
| Research in transportation economics | * | 1 |
| Risk analysis | **** | 1 |
| Stainability | ** | 1 |
| The Asian journal of shipping and logistics | No rank | 1 |
| The international journal of logistics management | No rank | 1 |
| The international journal on marine navigation and safety of sea transportation | No rank | 1 |
| The journal of navigation | No rank | 1 |
| Transport reviews | ** | 1 |
| Transportation planning and technology | No rank | 3 |
| Transportation research part a | *** | 2 |
| Transportation research part b | **** | 5 |
| Transportation research part d | *** | 2 |
| Transportation research part e | *** | 6 |
| Transportation research record | No rank | 2 |
| Transportation science | *** | 3 |
| Wmu journal of maritime affairs | No rank | 2 |
| **Grand Total** | | **112** |

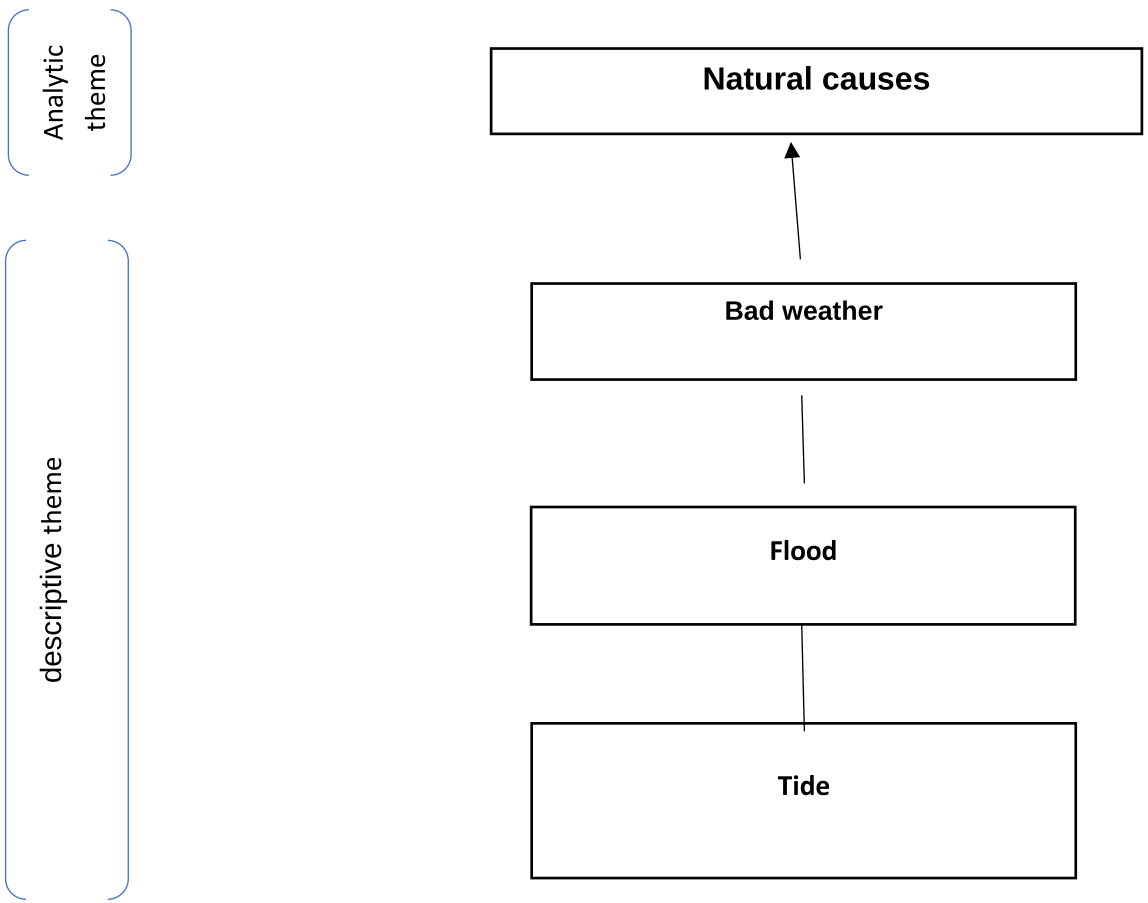
Appendix C: The descriptive, the interpretative and the systematic analytical themes for technical causes of port congestion problem.



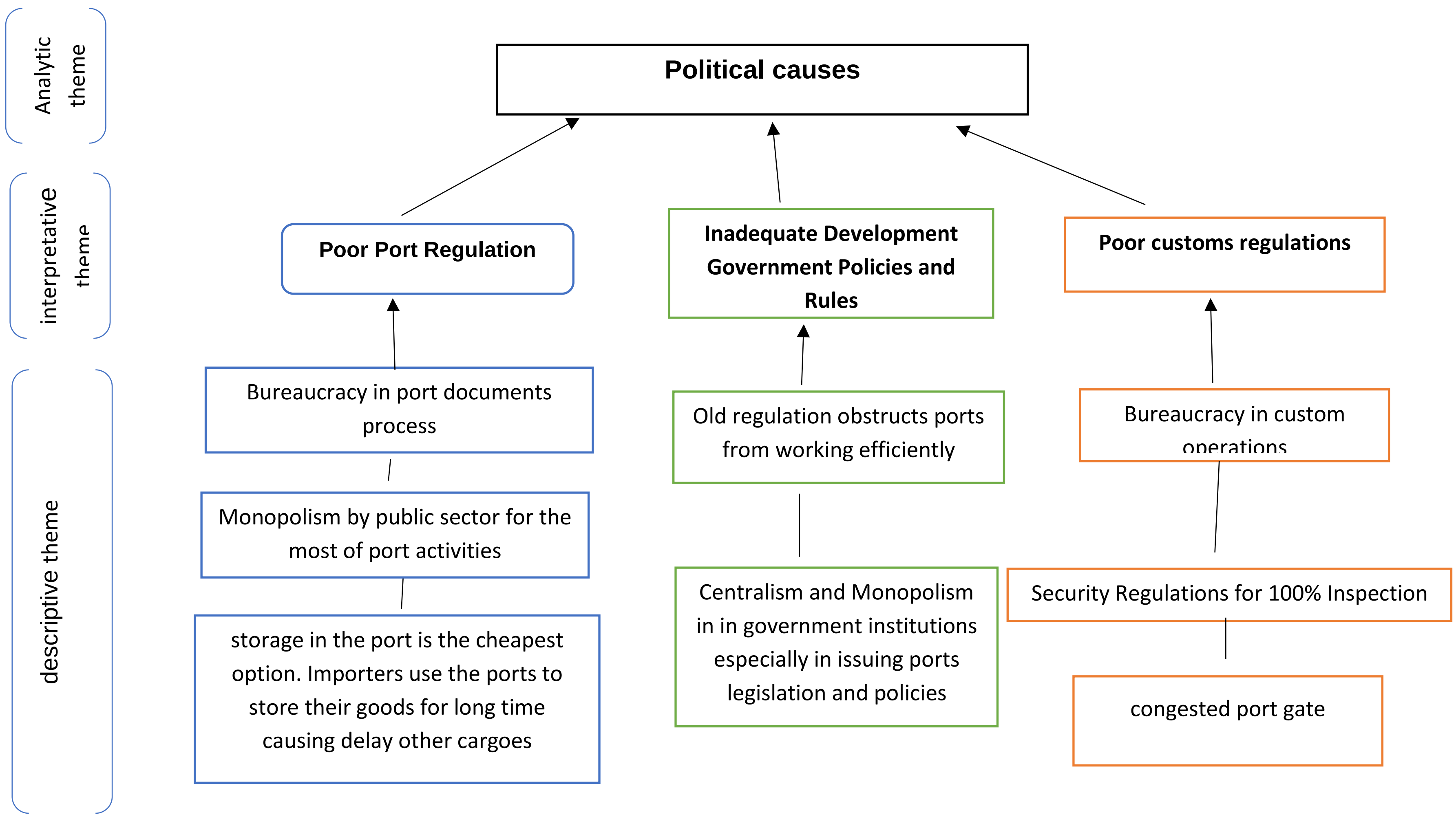
The descriptive, the interpretative and the systematic analytical themes for economical causes of port congestion problem.



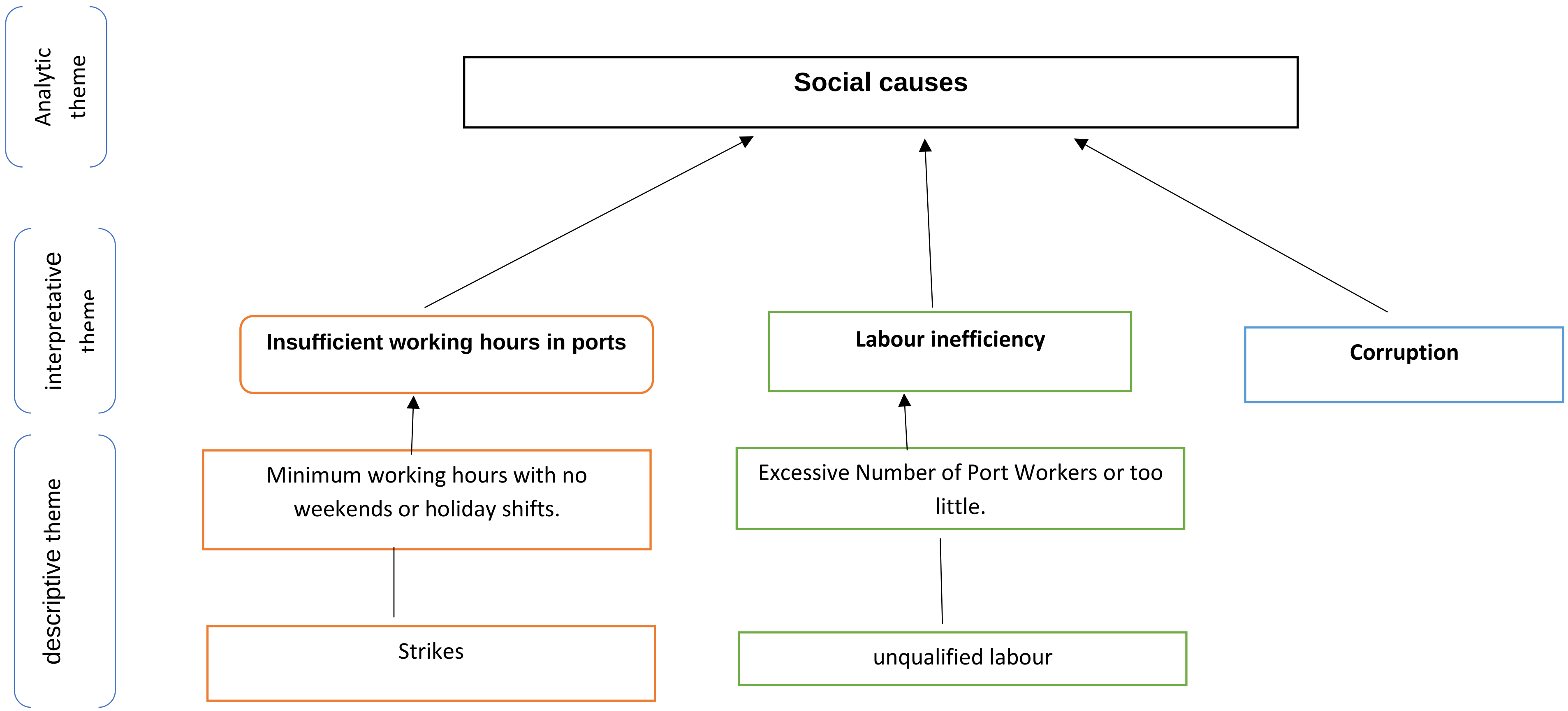
The descriptive, the interpretative and the systematic analytical themes for natural causes of port congestion problem.



The descriptive, the interpretative and the systematic analytical themes for political causes of port congestion problem



The descriptive, the interpretative and the systematic analytical themes for social causes of port congestion problem.



## Appendix D

. The time distribution for the academic interest of port congestion problem

| year of publication | Count of Brief Reference |
|---|---|
| 1961 | 1 |
| 1979 | 1 |
| 1985 | 1 |
| 1987 | 1 |
| 1989 | 1 |
| 1992 | 1 |
| 1995 | 1 |
| 1999 | 1 |
| 2000 | 4 |
| 2001 | 1 |
| 2003 | 1 |
| 2004 | 2 |
| 2005 | 2 |
| 2006 | 9 |
| 2007 | 5 |
| 2008 | 7 |
| 2009 | 3 |
| 2010 | 8 |
| 2011 | 10 |
| 2012 | 8 |
| 2013 | 10 |
| 2014 | 8 |
| 2015 | 14 |
| 2016 | 17 |
| 2017 | 15 |
| 2018 | 9 |
| 2019 | 8 |
| 2020 | 1 |
| **Grand Total** | **150** |

# Appendix E

The definitions of the Port congestion problem from selected papers according to the producing type.

| No: | Reference | What is the definition | Previous Literature/Produced by authors | Previous Literature |
|---|---|---|---|---|
| 1 | Abe and Wilson 2009 | "Congestion index: The sum of the loaded and unloaded containers in TEU at the major container ports in the country i in the year t, divided by the sum of the estimated full physical capacity of the major container ports in the country i in the year t". | Produced by Author(s) | / |
| 2 | Abouarghoub et al. 2017 | "When the economy of a country is improving, the traffic via its ports is increasing along with positive economic development, as a result, a queue of arriving vessels can form, and vessels may have to wait for long periods to be serviced". | Produced by Author(s) | / |
| 3 | Alhameedi et al. 2018 | "From a vessel operator's perspective, port congestion is described as the condition where a vessel on arrival spends more time at anchorage waiting to be berthed". "The terminal operator would express congestion as the number of container/cargoes that are coming to the port as being more than the empty available storage slots in the yard". | Previous Literature | Onwumere 2008 |
| 4 | Chinedum 2018 | "Port Congestion is a scenario associated with delays, queuing and extra time of voyage and dwell time of ships and cargo at the port, which always has unpleasant consequences on Logistics and supply chain." | Produced by Author(s) | / |
| 5 | El-Naggar 2010 | "It happens when the port facilities capacity is fully utilized at all times. In this manner, changes in demand have to be accommodated by forcing ships to wait (at anchorage) until ships that arrived previously had been serviced. " | Produced by Author(s) | / |
| 6 | Fan and Cao 2000 | "It indicates the demand for the use of sea space exceeds the available capacity during that time period". | Produced by Author(s) | / |
| 7 | Fan et al. 2012 | "Congestion is a situation that arises when users interface with others in the utilization of port resources" | Previous Literature | Talley 2006 |
| 8 | Fararoui and Black 1992 | "Port congestion occurs when cargo arrives at the port at a faster rate than that at which it can be cleared, which may be caused by a sudden change in trading conditions (seasonal or economic changes), as in the case of less-developed countries, shut-downs or slow-downs due to strikes or transport accidents, as happens in ports of industrialized countries". | Produced by Author(s) | / |
| 9 | Guan and Liu 2009 | "(Congestion) is a situation where waiting cost at the marine container terminal gate occurs because there are more truck arrivals than the gate system can handle". | Produced by Author(s) | / |
| 10 | Jacobsson et al. 2018 | "Port congestion is a problem at terminals, where increased congestion prolongs turnaround times for trucks receiving containers. Such congestion can arise due to the local regional environments of the terminals and from inefficient terminal and haulier operations , which can stem from poor information flows among the actors, meaning hauliers and terminals who have noted that such flows between hauliers and terminals are critical for their efficient operations." | Previous Literature | Konings 2013 |
| 11 | Jin et al. 2015 | "Port queuing (or waiting-time) costs are extreme congestion costs that arise when the demand for use of a port resource exceeds its supply". | Previous Literature | Talley 2006 |
| 12 | Lee et al. 2007 | "Port traffic congestion may happen when too much workload needs to be handled within a small area at the same time". | Produced by Author(s) | / |

(Continued). The definitions of Port congestion problem from selected papers

| No: | Reference | What is the definition | Previous Literature/Produced by authors | Previous Literature |
|---|---|---|---|---|
| 13 | MAGIBHO 2017 | 1- "Port congestion as a situation wherein a port; ships on arrival spend more time waiting to berth, in this context, more ships will queue at the channel and the outside of the port waiting to get space at the terminal for berth slot."<br>2- "port congestion as insufficient port capacity with traffic arriving at the port."<br>3- "Port congestion as massive un-cleared cargo in the port, resulting in a delay of ships in seaport." | Previous Literature | 1-Onwumere 2008<br>2- Alderton 2005<br>3- Maduka 2004 |
| 14 | Meersman et al. 2012 | "Congestion implies that one transport user, i.e. a ship, impedes another. Consequently, a cost is imposed upon a third party". | Produced by Author(s) | / |
| 15 | MOTONO et al. 2014 | "Port congestion in this study is defined as a container delivery delay to/from the port and/or the terminal, which is caused by excess traffic over the terminal capacity." | Produced by Author(s) | / |
| 16 | Motono et al. 2016 | "Landside congestion is defined as a state where trailers take additional waiting time in the queue either at the destination terminal gate or on the access road to the gate." | Produced by Author(s) | / |
| 17 | Naudé 2016 | "Port congestion is formed when the number of vessels arriving at a port within a given time frame exceeds the number of vessels that can be served by the port during that time frame." | Produced by Author(s) | / |
| 18 | NDIPMUN 2010 | "This port congestion means ships being delayed in port. The generally accepted one is when a ship's laytime at the port is longer than the expected schedule of sailing. port congestion arises when port capacity is insufficient to cope with the traffic arriving at the port." | Previous Literature | Talley 2006 |
| 19 | Noritake 1985 | "Congestion in a port occurs when more ships to be served to arrive at the port than its berths can handle within a given time." | Produced by Author(s) | / |
| 20 | Oyatoye et al. 2011 | 1- "Port Congestion as massive un-cleared Cargo in the Port, resulting in a delay of ships in the seaport."<br>2- "port congestion as a situation where in a port; ships on arrival spend more time waiting to berth." | Previous Literature | 1-Maduka 2004<br>2-Onwumere 2008 |
| 21 | Patalinghug et al. 2015 | "Port congestion is the term used for a situation where ships have to queue up and wait for a spot so they can load or offload." | Previous Literature | Onwumere 2008 |
| 22 | Potgieter 2016 | 1- "Port congestion can be defined as bottlenecks, delays and other supply chain disruptions caused by several different factors. These factors include insufficient capacity and productivity; bunching of vessels; vessel and vehicle scheduling clashes; severe weather conditions; and labour strikes. Port congestion more broadly as bottlenecks, delays and other supply chain disruptions caused by several different factors. These factors include insufficient capacity and productivity; bunching of vessels; vessel and vehicle scheduling clashes; severe weather conditions; and labour strikes."<br>2- "Congestion costs exist if the other short-run costs of port operations, per unit of throughput, are an increasing function of the actual capacity utilization. When actual demand exceeds capacity, extreme congestion costs arise, which we call queuing costs. When a port is said to be congested, it is commonly meant that ships are queuing, waiting to obtain a berth."<br>3- "congestion generally implies that a transport user, such as a vessel, delays another transport user. This consequently results in a cost levied upon a third party, usually the customer. This cost increases as traffic levels increase, thus resulting in increased congestion." | Previous Literature | 1-Schwitzer et al. 2014<br>2-Jansson and Shneerson (1982)<br>3-Meersman et al. 2012 |

(Continued). The definitions of the Port congestion problem from selected papers according to the producing type.

| No: | Reference | What is the definition | Previous Literature/Produced by authors | Previous Literature |
|---|---|---|---|---|
| 23 | POWLES 2004 | "Port Congestion problems are due to the fact that the ports have run out of space and poor terminal flow". | Produced by Author(s) | / |
| 24 | Rajamanickam and Ramadurai 2015 | "Congestion in the port is contributed by the growth in international trade together with the reality that many port facilities are running at or near capacity leading to traffic and port congestion." | Previous Literature | Vacca et al. 2007 |
| 25 | Rajasekar and Rengamani 2017 | "Congestion in the port is contributed by the growth in international trade together with the reality that many port facilities are running at or near capacity leading to traffic and port congestion." | Previous Literature | Vacca et al. 2007 |
| 26 | Ramírez-Nafarrate et al. 2017 | "Port terminal congestion is a situation where the lack of coordination of inland flows is generating long waiting and service times for the trucks, as well as inefficient cargo handling operations in the yard of the port terminal." | Produced by Author(s) | / |
| 27 | Saeed et al. 2018 | "Ports are considered to be congested when users interfere with one another in the use of port resources, which increases users' time in port." | Previous Literature | Talley 2006 |
| 28 | Simões and Marques 2010 | "Congestion is characterized by the decreasing of outputs produced as a consequence of the large increase of inputs used." | Previous Literature | Cherchye et al. 2001 |
| 29 | Talley and Ng 2016 | 1- "Port travel-time congestion occurs when users of port resources interfere with one another to the extent that their travel times incurred in using the resources increase – e.g., when port vehicles travelling over a port pathway interfere with one another to the extent that their travel times in using the pathway increase."<br>2- "Port waiting-time congestion occurs when port users seeking to use a port service have to wait to use the service and consequently interfere with one another to the extent that their waiting times to use the service increase. An example of port waiting-time congestion that is often mentioned in the port literature is that which occurs when containers (transported by trucks) interfere with one another in waiting to use a container port's entrance-gate service (e.g., container security inspection and verification of documents services) to the extent that their waiting times increase."<br>3- "Port service congestion occurs in a port service chain when the port provides a service at one of its nodes (or over one of its links) and the port users of this service at the node (or over the link) interfere with one another to the extent that their times incurred in using the service increase." | Produced by Author(s) | / |
| 30 | Wang and Meng 2019 | "The congestion effect refers to the phenomenon that more customers choosing to use the same facility reduces the facility's utility." | Produced by Author(s) | / |
| 31 | Wanke 2011 | "Port congestion arises when port capacity is insufficient to cope with the traffic arriving at the port." | Previous Literature | Alderton 2005 |
| 32 | Zain et al. 2016 | "A bottleneck can be defined as a subset of congestion in a system that causes the entire process in each stage to slow down." | Previous Literature | Moller 2014 |

Appendix: F

**Questionnaire about port congestion problem.**

**<u>Part: 1.</u> Demographical Information:**

Please answer the following questions by ticking the relevant box:

1. **Your Gender:** ☐ Male ☐ Female ☐ Prefer not to say.

2. **Your Age:** ☐ 20-29 ☐ 30-39 ☐ 40-49 ☐ 50-59 ☐ > 60 ☐ Prefer not to say.

3. **Level of your Education:** ☐ technical college ☐ Bachelor's degree ☐ Master's degree or equivalent ☐ PhD or equivalent ☐ Other, please specify………………………….. ☐ Prefer not to say.

4. **Type of Your Current organization:** ☐ Port state ☐ Port Authority ☐ Port operator ☐Truck company ☐ Ship's owner ☐ship's agent ☐ Cargo clearance agent ☐ Trader ☐ Customs ☐ Other, please specify…………………………………… ☐ Prefer not to say.

5. **The geographic working area for your current organization:** ☐ Europe ☐ Africa ☐ Asia ☐North America ☐ South America ☐Australia ☐ Prefer not to say.

6. **Your Current Job Position:** ☐Top-level manager ☐Middle-Level manager ☐Lower-level manager ☐ Other, please specify ……………. ☐ Prefer not to say.

7. **Years of Experience:** ☐1-5 ☐6-10 ☐11-15 ☐16-20 ☐≥ 21 ☐ Prefer not to say.

**Part: 2 Measuring information**

**Section one:** To measure and reach consensus amongst the industry experts on defining port congestion.

From your background and experience, please choose and thick only one of these following definitions that you think is best defined for the port congestion problem.

1. In general, the problem of port congestion can be defined as ‘the supply of port services and resources, for various reasons, cannot cope with the increasing demand for those services and resources.’ ☐
2. “Port congestion arises when port capacity is insufficient to cope with the traffic arriving at the port”. ☐
3. “It indicates the demand for the use of sea space exceeds the available capacity during that time period”. ☐
4. “a situation where a transport user, such as a ship, causes to delay another transport user (another ship), and this delay translated to extra cost upon the third party (usually the customer)”. ☐
5. “The congestion effect refers to the phenomenon that more customers choosing to use the same facility reduces the facility’s utility.” ☐
6. “Port congestion as a situation wherein a port; ships on arrival spend more time waiting to berth, in this context, more ships will queue at the channel and the outside of the port waiting to get space at the terminal for berth slot.” ☐

**Section two: to identify the causes for port congestion.**

Below is a list of statements describing the reasons behind the arising of port congestion problems at ports. Please indicate the extent to which you agree or disagree with each of the following statements using the scale as follows and then choose three items that you think is the most important ones for causing the port congestion problem:

## Internal causes

**A- <u>Weakness in infrastructures:</u>**

**To what extent do you agree or disagree with each of the following statements? (Please tick only one of the agree scales)**

**1- Technical issues "landside":**

1.1- Insufficient port storage area capacities could cause to arise congestion issues at ports.

□Strongly disagree □Disagree □Slightly disagree □Neither agree nor disagree □Slightly agree □Agree □Strongly agree.

1.2- Insufficient port gates capacities could result in congestion cargoes traffic situations at port gates.

□Strongly disagree □Disagree □Slightly disagree □Neither agree nor disagree □Slightly agree □Agree □Strongly agree.

1.3- Inadequate development in other port infrastructures such as port ways, yard lights, yard refrigerators sockets,….ect., could contribute highly to increase the rate of congestion situations at the port.

□Strongly disagree □Disagree □Slightly disagree □Neither agree nor disagree □Slightly agree □Agree □Strongly agree.

**2- Technical causes "Seaside"**

2.1- Insufficient port berths' capacities at a port could increase the ships waiting times at this port.

☐Strongly disagree ☐Disagree ☐Slightly disagree ☐Neither agree nor disagree ☐Slightly agree ☐Agree ☐Strongly agree.

2.2- Insufficient depths of the sea entrance, sea channels, and port berths for a port could increase the possibility to congest this port.

☐Strongly disagree ☐Disagree ☐Slightly disagree ☐Neither agree nor disagree ☐Slightly agree ☐Agree ☐Strongly agree.

**3- Technical causes "Hinterland-side"**

3.1- Inadequate development in the infrastructures of the hinterland intermodal could lead to arise congestion situations at ports or/and around ports.

☐Strongly disagree ☐Disagree ☐Slightly disagree ☐Neither agree nor disagree ☐Slightly agree ☐Agree ☐Strongly agree.

3.2- Inadequate development in the port hinterland other systems such as telecommunications, internet networks, and banks system could impose delay times for port users and result in congesting this port.

☐Strongly disagree ☐Disagree ☐Slightly disagree ☐Neither agree nor disagree ☐Slightly agree ☐Agree ☐Strongly agree.

**Now, please thick the three most important causes due to weakness in infrastructures that cause port congestion from the following items:**

☐ Insufficient port storage area capacities.

☐ Insufficient port gates capacities.

☐ Inadequate development in other port infrastructures such as port ways, yard lights, yard refrigerators sockets,….ect.

☐ Insufficient port berths' capacities at a port

☐ Insufficient depths of the sea entrance, sea channels, and port berths for a port.

☐ Inadequate development in the infrastructures of the hinterland intermodal.

☐ Inadequate development in the port hinterland other systems such as telecommunications, internet networks, and banks system.

**B- <u>Shortages in facilities</u>**

**To what extent do you agree or disagree with each of the following statements? (Please tick only one of the agree scales)**

**1- Technical issues “Landside”.**

1.1- An inadequate number of port gates can result in congestion problems at the port yards, gates, and accesses.

□Strongly disagree □Disagree □Slightly disagree □Neither agree nor disagree □Slightly agree □Agree □Strongly agree.

1.2- An inadequate number of port cranes could lead to increase time delays in the handle cargoes operations at this port.

□Strongly disagree □Disagree □Slightly disagree □Neither agree nor disagree □Slightly agree □Agree □Strongly agree.

1.3- An inadequate number of other port equipment such as (straddles, trailers, port trucks, X-ray screening machines,….) could result in rising congestion situations at port berths, yards, and gates.

□Strongly disagree □Disagree □Slightly disagree □Neither agree nor disagree □Slightly agree □Agree □Strongly agree.

1.4- Shortages in supplying equipment’s spare parts that might need for repairing them frequently could result in increasing equipment stoppages and delay times in port operations.

□Strongly disagree □Disagree □Slightly disagree □Neither agree nor disagree □Slightly agree □Agree □Strongly agree.

**2- Technical causes “Seaside”**

2.1- The recent increase in ships size (especially container ships) has caused putting more constraints on the existing equipment’s capacities at the port that receive this type of ships.

□Strongly disagree □Disagree □Slightly disagree □Neither agree nor disagree □Slightly agree □Agree □Strongly agree.

2.2- The increase in ships sharing alliance between companies has caused for putting more constraints on the existing equipment’s capacities at the port that receive this type of ships.

□Strongly disagree □Disagree □Slightly disagree □Neither agree nor disagree □Slightly agree □Agree □Strongly agree.

2.3- An inadequate number of tugboats at the port could lead to increasing the waiting times for ships that calling this port.

☐Strongly disagree ☐Disagree ☐Slightly disagree ☐Neither agree nor disagree ☐Slightly agree ☐Agree ☐Strongly agree.

**3- Technical issues "Hinterland-side"**

3.1- Insufficient capacities of port passages and port accesses (Roads, rail lines, and water channels) might lead to arise congestion situations on port berths, port yards, and port gates.

☐Strongly disagree ☐Disagree ☐Slightly disagree ☐Neither agree nor disagree ☐Slightly agree ☐Agree ☐Strongly agree.

**Now, please thick the three most important causes due to shortages in facilities that cause port congestion problem from the following items:**

☐ An inadequate number of port gates.

☐ An inadequate number of port cranes.

☐ An inadequate number of other port equipment such as (straddles, trailers, port trucks, X-ray screening machines,….)

☐ Shortages in supplying equipment's spare parts that might need for repairing them frequently

☐ The recent increase in ships size (especially container ships) has caused putting more constraints on the existing equipment's capacities at the port that receive this type of ships.

☐ The increase in ships sharing alliance between companies has caused for putting more constraints on the existing equipment's capacities at the port that receive this type of ships

☐ An inadequate number of tugboats at the port

☐ Insufficient capacities of port passages and port accesses (Roads, rail lines, and water channels)

**C- <u>Mismanagement issues</u>**

**To what extent do you agree or disagree with each of the following statements? (Please tick only one of the agree scales)**

**1- Technical issues "Landside"**

1.1- Inefficient management for port passages and port accesses could lead to impose time delays on both ships and trucks and result in congestion problems at ports.

☐Strongly disagree ☐Disagree ☐Slightly disagree ☐Neither agree nor disagree ☐Slightly agree ☐Agree ☐Strongly agree.

1.2- Unproductive cargo handling operation could create unwanted time delays and establish congestion nods at the other port operations.

□Strongly disagree □Disagree □Slightly disagree □Neither agree nor disagree □Slightly agree □Agree □Strongly agree.

1.3- Inefficient management for cargo handling equipment could lead to congestion problems at the cargo handling operation and might result in arising congestion situations at all port operations.

□Strongly disagree □Disagree □Slightly disagree □Neither agree nor disagree □Slightly agree □Agree □Strongly agree.

1.4- The increase in the complexity of port operations that has been noticed lately due to the increase in ship size and the increasing in the ships sharing alliance between companies has resulted in reducing the efficiency of cargo handling operations.

□Strongly disagree □Disagree □Slightly disagree □Neither agree nor disagree □Slightly agree □Agree □Strongly agree.

1.5- Employing unqualified staff in ports will lead eventually to decreasing the productivity and the efficiency of the port operations.

□Strongly disagree □Disagree □Slightly disagree □Neither agree nor disagree □Slightly agree □Agree □Strongly agree.

1.6- Imposing cheaper prices for storing cargoes in ports (than outside ports) by port management could lead to overstating time periods for cargoes and resulting in congesting port storing areas.

□Strongly disagree □Disagree □Slightly disagree □Neither agree nor disagree □Slightly agree □Agree □Strongly agree.

1.7- Inefficient port yard template plans (especially in container terminals) could generate congestion situations at these container terminals.

□Strongly disagree □Disagree □Slightly disagree □Neither agree nor disagree □Slightly agree □Agree □Strongly agree.

**2- Technical issues “Seaside”.**

2.1- Inefficient plans for allocating ships at port berths could cause to arise congestion situations at port berths.

□Strongly disagree □Disagree □Slightly disagree □Neither agree nor disagree □Slightly agree □Agree □Strongly agree.

2.2- Accidents at ports sea channels and berths could lead to increase ships waiting times before entering these ports.

□Strongly disagree □Disagree □Slightly disagree □Neither agree nor disagree □Slightly agree □Agree □Strongly agree.

2.3- Poor management for maintaining and repairing port facilities such as tugboats and the sea entrance’s lights might result in delaying ships from entering the port.

□Strongly disagree □Disagree □Slightly disagree □Neither agree nor disagree □Slightly agree □Agree □Strongly agree.

**3- Technical issues “Hinterland-side”**

3.1- The lack of information exchange between port actors (Port operators, Customs, Shippers, and trucks’ companies) could result in inefficient port operations and as consequences increase delays times for ships and/or trucks at the port resources.

□Strongly disagree □Disagree □Slightly disagree □Neither agree nor disagree □Slightly agree □Agree □Strongly agree.

3.2- Inefficient management for the hinterland accesses (Roads, rail lines, and water channels) could lead to traffic congestion situations at ports and around them.

□Strongly disagree □Disagree □Slightly disagree □Neither agree nor disagree □Slightly agree □Agree □Strongly agree.

**Now, please thick the three most important causes due to Mismanagement (technical issues) that cause port congestion problem from the following items:**

□. Inefficient management for port passages and port accesses

□. Unproductive cargo handling operation

☐ Inefficient management for cargo handling equipment

☐ The increase in the complexity of port operations that has been noticed lately due to the increase in ship size and the increasing in the ships sharing alliance between companies

☐ Employing unqualified staff in ports

☐ Imposing cheaper prices for storing cargoes in ports (than outside ports) by port management

☐ Inefficient port yard template plans (especially in container terminals)

☐ Inefficient plans for allocating ships at port berths

☐ Poor management for maintaining and repairing port facilities such as tugboats and the sea entrance's lights

☐ Accidents at ports sea channels and berths

☐ The lack of information exchange between port actors (Port operators, Customs, Shippers, and trucks' companies)

☐ Inefficient management for the hinterland accesses (Roads, rail lines, and water channels)

## 4- Policies Issues

**To what extent do you agree or disagree with each of the following statements? (Please tick only one of the agree scales)**

4.1- Bureaucracy and severe custom's regulations might lead to increasing the processing time and impose extra time delays on entering ships to the port and clearing cargoes from ports.

☐Strongly disagree ☐Disagree ☐Slightly disagree ☐Neither agree nor disagree ☐Slightly agree ☐Agree ☐Strongly agree.

4.2- Centralism and monopolism in government public sectors have contributed highly to cause congestion at ports, especially in developing countries' ports.

☐Strongly disagree ☐Disagree ☐Slightly disagree ☐Neither agree nor disagree ☐Slightly agree ☐Agree ☐Strongly agree.

4.3- Poor port regulation and policies have contributed greatly to arise the port congestion situations at ports.

☐Strongly disagree ☐Disagree ☐Slightly disagree ☐Neither agree nor disagree ☐Slightly agree ☐Agree ☐Strongly agree.

4.4- A 100% cargo inspection policy at some ports has caused to increase in the cargo dwelling time at port yards and port gates.

☐Strongly disagree ☐Disagree ☐Slightly disagree ☐Neither agree nor disagree ☐Slightly agree ☐Agree ☐Strongly agree.

4.5- Inadequate development government policies and regulations (especially in developing countries) have caused a decline in the port operation efficiency and productivity of their ports.

Strongly disagree  Disagree  Slightly disagree  Neither agree nor disagree  Slightly agree  Agree  Strongly agree.

**Now, please thick the three most important causes due to Mismanagement (policies issues) that cause port congestion problem from the following items:**

- . Bureaucracy and severe custom's regulations
- . Centralism and monopolism in government public sectors
- Poor port regulation and policies
- A 100% cargo inspection policy at some ports
- Inadequate development government policies and regulations (especially in developing countries)

## 5- Social Issues

**To what extent do you agree or disagree with each of the following statements? (Please tick only one of the agree scales)**

5.1- The excessive number of port labours has contributed highly to unproductive operations in ports (especially at traditional public ports) and increasing strikes problems.

Strongly disagree  Disagree  Slightly disagree  Neither agree nor disagree  Slightly agree  Agree  Strongly agree.

5.2- Labour inefficiency is a great cause for imposing time delays at cargoes handling operation in ports.

Strongly disagree  Disagree  Slightly disagree  Neither agree nor disagree  Slightly agree  Agree  Strongly agree.

5.3- Insufficient working hours at ports could be a direct cause for imposing delay times on both operations ship entering and cargo clearing.

Strongly disagree  Disagree  Slightly disagree  Neither agree nor disagree  Slightly agree  Agree  Strongly agree.

5.4- Labour strikes at ports is a significant issue that causes to arise congestion situations at ports.

□Strongly disagree □Disagree □Slightly disagree □Neither agree nor disagree □Slightly agree □Agree □Strongly agree.

5.5- Corruption at ports and government systems such as port operations, customs, and government institutions could lead to imposing time delays on processing ships enters and cargoes clearing operations.

□Strongly disagree □Disagree □Slightly disagree □Neither agree nor disagree □Slightly agree □Agree □Strongly agree.

**Now, please thick the three most important causes due to Mismanagement (social issues) that cause port congestion problem from the following items:**

□. The excessive number of port labours

□. Labour inefficiency is a great cause for imposing time delays at cargoes handling operation in ports.

□ Insufficient working hours at ports is a direct cause for imposing delay times on both operations ship entering and cargo clearing process.

□ Labour strikes at ports

□Corruption at ports and government systems

## External causes

**To what extent do you agree or disagree with each of the following statements? (Please tick only one of the agree scales)**

### D- <u>Natural causes:</u>

1- Bad weather is an environmental uncertainty that could lead to delay ships and congest Seaports.

□Strongly disagree □Disagree □Slightly disagree □Neither agree nor disagree □Slightly agree □Agree □Strongly agree.

2- Tide issues are an environmental uncertainty that could lead to delay ships and congest Seaports.

☐Strongly disagree ☐Disagree ☐Slightly disagree ☐Neither agree nor disagree ☐Slightly agree ☐Agree ☐Strongly agree.

3- Floods issues are an environmental uncertainty that could lead to delay ships and congest Seaports.

☐Strongly disagree ☐Disagree ☐Slightly disagree ☐Neither agree nor disagree ☐Slightly agree ☐Agree ☐Strongly agree.

**E- <u>Economical causes:</u>**

1- The sudden increase in the international trade on a port might lead to arise congestion problems at this port.

☐Strongly disagree ☐Disagree ☐Slightly disagree ☐Neither agree nor disagree ☐Slightly agree ☐Agree ☐Strongly agree.

2- The sudden increase in the trade local demand from a country or a region might lead to arise congestion situations at the ports of this country or the region.

☐Strongly disagree ☐Disagree ☐Slightly disagree ☐Neither agree nor disagree ☐Slightly agree ☐Agree ☐Strongly agree.

3- In a country or a region when the trade (the cargo traffic) is concentrating on a certain port, this could lead to congest this port while the other ports remain ineffective.

☐Strongly disagree ☐Disagree ☐Slightly disagree ☐Neither agree nor disagree ☐Slightly agree ☐Agree ☐Strongly agree.

4- Seasonality (increasing cargo traffic on a port at certain times of the year) might lead to arise a congestion situation at this port in these times.

☐Strongly disagree ☐Disagree ☐Slightly disagree ☐Neither agree nor disagree ☐Slightly agree ☐Agree ☐Strongly agree.

**Now, please thick the three most important causes due to External causes (Economical issues) that cause port congestion problem from the following items:**

☐. The sudden increase in the international trade on a port

☐. The sudden increase in the trade local demand from a country or a region.

☐ Concentrating the cargo traffic on a certain port while the other ports remain ineffective.

☐ Seasonality (increasing cargo traffic on a port at certain times of the year).

Appendix (G)

# port congestion problem

## Survey Flow

Start of Block: Block 1

**Questionnaire about port congestion problem.**

A successful identification of the reasons behind the cause for congestion problem in a port is very critical since knowing these causes will undoubtedly help the government and ports' managers to increase the ports' efficiencies and reduce the congestion in their ports. However, the identification of these causes has been described as a quite complex and multi-dimensional process as these causes are varied from country to country and sometimes from port to port. Most port congestion problems can be solved if causes are identified, analysed and then proper actions should be taken to solve these bottlenecks. We invite you to participate in this study which seeks to identify the most common reasons that cause to arise congestion problems at ports. General information: This study is an independent academic PhD research to identify the reasons behind the congestion problems at seaports and container terminals. Please provide your opinion by answering the questions according to your background and previous experience. If by any chance you think that you are not the right one to complete this survey, please would you pass it to the one who you think might be knowledgeable to answer this questionnaire. The responses provided by you will be kept strictly anonymous and confidential, where the job performance has no relation to the goal of this study. Also, the researcher will not be able to obtain your identity in any way from your completed questionnaire. Your participation in the survey is entirely voluntary and can be withdrawn at any time without giving a reason. The data from the study will be used solely for the purpose of academic research. If you need any clarification on this questionnaire, please feel free to contact me by email at: **EddrgashTA@cardiff.ac.uk.** Answering and completing this questionnaire will take approximately from10 to 15 minutes.

Thanks in advance for your kind co-operations.

Tarig Ali Eddrgash
A PhD student at logistic and operation management department
Cardiff business school at Cardiff University.
CF10 3EU, Cardiff, UK
Email: **EddrgashTA@cardiff.ac.uk**

End of Block: Block 1

Start of Block: Block 2

**Consent to participate**

I understand and agree with the information given above and I am giving my consent to participate to this research.

○ yes I consent (1)

○ No I do not consent (2)

End of Block: Block 2

Start of Block: Default Question Block

**Part: 1.**
**Demographical Information:**

**Please answer the following questions by ticking the relevant box:**

**Your gender:**

○ Male (1)

○ Female (2)

○ Prefer not to say (3)

---

**Q2**
**Your Age:**

○ 20-29 (1)

○ 30-39 (2)

○ 40-49 (3)

○ 50-59 (4)

○ 60 or over (5)

○ Prefer not to say (6)

---

**3 Level of your Education:**

- Technical college (1)
- Bachelor's degree (2)
- Master's degree or equivalent (3)
- PhD or equivalent (4)
- Other, please specify (5) ________________________________________________

---

**4 Type of Your Current organization. you can choose more than one.**

- Port state (1)
- Port Authority (2)
- Port operator (3)
- Truck company (4)
- Ship's owner (5)
- ship's agent (6)
- Cargo clearance agent (7)
- Trader (8)
- Customs agent (9)
- Other, please specify (10) ________________________________________________

---

**5 The geographic working area for your current organization. you can choose more than one.**

▢ Europe (1)

▢ Africa (2)

▢ Asia (3)

▢ North America (4)

▢ South America (5)

▢ Australia (6)

---

**6 Your Current Job Position**

○ Top-level manager (1)

○ Middle-Level manager (2)

○ Lower-level manager (3)

○ Other, please specify (4) ________________________________________________

---

7 Years of Experience

○ 1-5 (1)

○ 6-10 (2)

○ 11-15 (3)

○ 16-20 (4)

○ 21 and over (5)

---

**Part: 2 Measuring information**

**Section one: To measure and reach a consensus amongst the industry experts on defining port congestion. From your background and experience to what extent do you agree or disagree with each of the following statements? (Please tick only one of the agree scales).**

| | Strongly disagree (26) | Disagree (27) | Somewhat disagree (28) | Neither agree nor disagree (29) | Somewhat agree (30) | Agree (31) | Strongly agree (32) |
|---|---|---|---|---|---|---|---|
| 1) In general, the problem of port congestion can be defined as ‘the supply of port services and resources, for various reasons, cannot cope with the increasing demand for those services and resources.’ (1) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 2) “Port congestion arises when port capacity is insufficient to cope with the traffic arriving at the port”. (2) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 3) “It indicates the demand for the use of sea space exceeds the available capacity during that time period”. (3) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 4) “a situation where a transport user, such as a ship, causes to delay another transport user (another ship), and this delay translated to extra cost upon the third party (usually the customer)”. (4) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 5) “The congestion effect refers to the phenomenon that more customers choosing to use the same facility reduces the facility’s utility.” (5) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 6) “Port congestion as a situation wherein a port; ships on arrival spend more time waiting to berth, in this context, more ships will queue at the channel and the outside of the port waiting to get space at the terminal for berth slot.” (6) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

**9 Now please choose and thick only one of these following definitions that you think is best defined for the port congestion problem.**

○ 1. In general, the problem of port congestion can be defined as 'the supply of port services and resources, for various reasons, cannot cope with the increasing demand for those services and resources.' (1)

○ 2. "Port congestion arises when port capacity is insufficient to cope with the traffic arriving at the port". (2)

○ 3. "It indicates the demand for the use of sea space exceeds the available capacity during that time period". (3)

○ 4. "a situation where a transport user, such as a ship, causes to delay another transport user (another ship), and this delay translated to extra cost upon the third party (usually the customer)" (4)

○ 5. "The congestion effect refers to the phenomenon that more customers choosing to use the same facility reduces the facility's utility." (5)

○ 6. "Port congestion as a situation wherein a port; ships on arrival spend more time waiting to berth, in this context, more ships will queue at the channel and the outside of the port waiting to get space at the terminal for berth slot." (6)

……………………………………………………………………………………………………………

**10 Section two: to identify the causes for port congestion**.

**Below is a list of statements describing the reasons behind the arising of port congestion problems at ports. Please indicate the extent to which you agree or disagree with each of the following statements using the scale as follows and then choose three items that you think is the most important ones for causing the port congestion problem: items that you think is the most**

**Internal causes**

**A- Weakness in infrastructures:**

**To what extent do you agree or disagree with each of the following statements? (Please tick only one of the agree scales)**

| | Strongly agree (1) | Agree (2) | Somewhat agree (3) | Neither agree nor disagree (4) | Somewhat disagree (5) | Disagree (6) | Strongly disagree (7) |
|---|---|---|---|---|---|---|---|
| Insufficient port storage area capacities could cause to arise congestion issues at ports. (1) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Insufficient port gates capacities could result in congestion cargoes traffic situations at port gates. (2) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Inadequate development in other port infrastructures such as port ways, yard lights, yard refrigerators sockets,….ect., could contribute highly to increase the rate of congestion situations at the port. (3) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Insufficient port berths' capacities at a port could increase the ships waiting times at this port. (4) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Insufficient depths of the sea entrance, sea channels, and port berths for a port could increase the possibility to congest this port. (5) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Inadequate development in the infrastructures of the hinterland intermodal could lead to arise congestion situations at ports or/and around ports. (6) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Inadequate development in the port hinterland other systems such as telecommunications, internet networks, and banks system could impose delay times for port users and result in congesting this port. (7) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

**11 Now, please thick the three most important causes due to weakness in infrastructures that cause port congestion from the following items:**

- ☐ Insufficient port storage area capacities (1)
- ☐ Insufficient port gates capacities. (2)
- ☐ Inadequate development in other port infrastructures such as port ways, yard lights, yard refrigerators sockets,….ect (3)
- ☐ Insufficient port berths' capacities at a port (4)
- ☐ Insufficient depths of the sea entrance, sea channels, and port berths for a port. (5)
- ☐ Inadequate development in the infrastructures of the hinterland intermodal (6)
- ☐ Inadequate development in the port hinterland other systems such as telecommunications, internet networks, and banks system. (7)

Page Break

**12 B-** **Shortages in facilities**

**To what extent do you agree or disagree with each of the following statements? (Please tick only one of the agree scales).**

| | Strongly agree (1) | Agree (2) | Somewhat agree (3) | Neither agree nor disagree (4) | Somewhat disagree (5) | Disagree (6) | Strongly disagree (7) |
|---|---|---|---|---|---|---|---|
| An inadequate number of port gates can result in congestion problems at the port yards, gates, and accesses. (1) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| An inadequate number of port cranes could lead to increase time delays in the handle cargoes operations at this port. (2) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| An inadequate number of other port equipment such as (straddles, trailers, port trucks, X-ray screening machines,….) could result in rising congestion situations at port berths, yards, and gates. (3) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Shortages in supplying equipment's spare parts that might need for repairing them frequently could result in increasing equipment stoppages and delay times in port operations. (4) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| The recent increase in ships size (especially container ships) has caused putting more constraints on the existing equipment's capacities at the port that receive this type of ships. (5) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| The increase in ships sharing alliance between companies has caused for putting more constraints on the existing equipment's capacities at the port that receive this type of ships. (6) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| An inadequate number of tugboats at the port could lead to increasing the waiting times for ships that calling this port. (7) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Insufficient capacities of port passages and port accesses (Roads, rail lines, and water channels) might lead to arise congestion situations on port berths, port yards, and port gates. (8) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

**13 Now, please thick the three most important causes due to shortages in facilities that cause port congestion problem from the following items:**

- ☐ An inadequate number of port gates. (1)
- ☐ An inadequate number of port cranes. (2)
- ☐ An inadequate number of other port equipment such as (straddles, trailers, port trucks, X-ray screening machines,….) (3)
- ☐ Shortages in supplying equipment’s spare parts that might need for repairing them frequently (4)
- ☐ The recent increase in ships size (especially container ships) has caused putting more constraints on the existing equipment’s capacities at the port that receive this type of ships. (5)
- ☐ The increase in ships sharing alliance between companies has caused for putting more constraints on the existing equipment’s capacities at the port that receive this type of ships (6)
- ☐ An inadequate number of tugboats at the port (7)
- ☐ Insufficient capacities of port passages and port accesses (Roads, rail lines, and water channels) (8)

**14 C- Mismanagement issues**

**To what extent do you agree or disagree with each of the following statements? (Please tick only one of the agree scales)**

| | Strongly agree (1) | Agree (2) | Somewhat agree (3) | Neither agree nor disagree (4) | Somewhat disagree (5) | Disagree (6) | Strongly disagree (7) |
|---|---|---|---|---|---|---|---|
| Inefficient management for port passages and port accesses could lead to impose time delays on both ships and trucks and result in congestion problems at ports. (1) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Unproductive cargo handling operation could create unwanted time delays and establish congestion nods at the other port operations. (2) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Inefficient management for cargo handling equipment could lead to congestion problems at the cargo handling operation and might result in arising bottlenecks at all port operations. (3) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| The increase in the complexity of port operations that has been noticed lately due to the increase in ship size and the increasing in the ships sharing alliance between companies has resulted in reducing the efficiency of cargo handling operations. (4) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Employing unqualified staff in ports will lead eventually to decreasing the productivity and the efficiency of the port operations. write Statement 5 (5) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Imposing cheaper prices for storing cargoes in ports (than outside ports) by port management could lead to overstating time periods for cargoes and resulting in congesting port storing areas. (6) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Inefficient port yard template plans (especially in container terminals) could generate congestion situations at these container terminals. (7) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Inefficient plans for allocating ships at port berths could cause to arise congestion situations at port berths. (8) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Accidents at ports sea channels and berths could lead to increase ships waiting times before entering these ports. (9) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Poor management for maintaining and repairing port facilities such as tugboats and the sea entrance's lights might result in delaying ships from entering the port. (10) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| The lack of information exchange between port actors (Port operators, Customs, Shippers, and trucks' companies) could result in inefficient port operations and as consequences increase delays times for ships and/or trucks at the port resources. (11) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Inefficient management for the hinterland accesses (Roads, rail lines, and water channels) could lead to traffic congestion situations at ports and around them. (12) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

**15 Now, please thick the three most important causes due to Mismanagement (technical issues) that cause port congestion problem from the following items:**

- ▢ Inefficient management for port passages and port accesses (1)
- ▢ Unproductive cargo handling operation (2)
- ▢ Inefficient management for cargo handling equipment (3)
- ▢ The increase in the complexity of port operations that has been noticed lately due to the increase in ship size and the increasing in the ships sharing alliance between companies (4)
- ▢ Employing unqualified staff in ports (5)
- ▢ Imposing cheaper prices for storing cargoes in ports (than outside ports) by port management (6)
- ▢ Inefficient port yard template plans (especially in container terminals) (7)
- ▢ Inefficient plans for allocating ships at port berths (8)
- ▢ Poor management for maintaining and repairing port facilities such as tugboats and the sea entrance's lights (9)
- ▢ Accidents at ports sea channels and berths (10)
- ▢ The lack of information exchange between port actors (Port operators, Customs, Shippers, and trucks' companies (11)
- ▢ Inefficient management for the hinterland accesses (Roads, rail lines, and water channels) (12)

**16 Policies Issues**
**To what extent do you agree or disagree with each of the following statements? (Please tick only one of the agree scales) k to write the question text**

| | Strongly agree (1) | Agree (2) | Somewhat agree (3) | Neither agree nor disagree (4) | Somewhat disagree (5) | Disagree (6) | Strongly disagree (7) |
|---|---|---|---|---|---|---|---|
| Bureaucracy and severe custom's regulations might lead to increasing the processing time and impose extra time delays on entering ships to the port and clearing cargoes from ports. to write Statement 1 (1) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Centralism and monopolism in government public sectors have contributed highly to cause congestion at ports, especially in developing countries' ports. (2) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Poor port regulation and policies have contributed greatly to arise the port congestion situations at ports. (3) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| A 100% cargo inspection policy at some ports has caused to increase in the cargo dwelling time at port yards and port gates. (4) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Inadequate development government policies and regulations (especially in developing countries) have caused a decline in the port operation efficiency and productivity of their ports. (5) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

**17 Now, please thick the three most important causes due to Mismanagement (policies issues) that cause port congestion problem from the following items**:

- ☐ Bureaucracy and severe custom's regulations (1)
- ☐ Centralism and monopolism in government public sectors (2)
- ☐ Poor port regulation and policies (3)
- ☐ A 100% cargo inspection policy at some ports (4)
- ☐ Inadequate development government policies and regulations (especially in developing countries) (5)

**8 Social Issues**

**To what extent do you agree or disagree with each of the following statements? (Please tick only one of the agree scales**)

| | Strongly agree (1) | Agree (2) | Somewhat agree (3) | Neither agree nor disagree (4) | Somewhat disagree (5) | Disagree (6) | Strongly disagree (7) |
|---|---|---|---|---|---|---|---|
| The excessive number of port labours has contributed highly to unproductive operations in ports (especially at traditional public ports) and increasing strikes problems. (1) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Labour inefficiency is a great cause for imposing time delays at cargoes handling operation in ports. (2) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Insufficient working hours at ports could be a direct cause for imposing delay times on both operations ship entering and cargo clearing. (3) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Labour strikes at ports is a significant issue that causes to arise congestion situations at ports. (4) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Corruption at ports and government systems such as port operations, customs, and government institutions could lead to imposing time delays on processing ships enters and cargoes clearing operations. (5) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

**19 Now, please thick the three most important causes due to Mismanagement (social issues) that cause port congestion problem from the following items:**

- ▢ The excessive number of port labours (1)
- ▢ Labour inefficiency is a great cause for imposing time delays at cargoes handling operation in ports. (2)
- ▢ Insufficient working hours at ports is a direct cause for imposing delay times on both operations ship entering and cargo clearing process. (3)
- ▢ Labour strikes at ports (4)
- ▢ Corruption at ports and government systems (5)

Page Break

**20 External causes**

**D- Natural causes:**

**To what extent do you agree or disagree with each of the following statements? (Please tick only one of the agree scales)**

| | Strongly agree (1) | Agree (2) | Somewhat agree (3) | Neither agree nor disagree (4) | Somewhat disagree (5) | Disagree (6) | Strongly disagree (7) |
|---|---|---|---|---|---|---|---|
| Bad weather is an environmental uncertainty that could lead to delay ships and congest Seaports. (1) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Tide issues are an environmental uncertainty that could lead to delay ships and congest Seaports. (2) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Floods issues are an environmental uncertainty that could lead to delay ships and congest Seaports. (3) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

**21 E- Economical causes:**

**To what extent do you agree or disagree with each of the following statements? (Please tick only one of the agree scales)**

| | Strongly agree (1) | Agree (2) | Somewhat agree (3) | Neither agree nor disagree (4) | Somewhat disagree (5) | Disagree (6) | Strongly disagree (7) |
|---|---|---|---|---|---|---|---|
| The sudden increase in the international trade on a port might lead to arise congestion problems at this port. (1) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| The sudden increase in the trade local demand from a country or a region might lead to arise congestion situations at the ports of this country or the region. (2) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| In a country or a region when the trade (the cargo traffic) is concentrating on a certain port, this could lead to congest this port while the other ports remain ineffective. (3) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Seasonality (increasing cargo traffic on a port at certain times of the year) might lead to arise a congestion situation at this port in these times. (4) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

---

**22 Now, please thick the three most important causes due to External causes (Economical issues) that cause port congestion problem from the following items:**

- ▢ The sudden increase in the international trade on a port (1)
- ▢ The sudden increase in the trade local demand from a country or a region. (2)
- ▢ Concentrating the cargo traffic on a certain port while the other ports remain ineffective. (3)
- ▢ Seasonality (increasing cargo traffic on a port at certain times of the year). (4)

End of Block: Default Question Block

---

Appendix (H)

List of X1 items variable and their sources from literature.

| CODE | ITEM VARIABLES | SOURCES |
|---|---|---|
| X1 | **Definition for port congestion problem** | |
| **X1.1** | In general, the problem of port congestion can be defined as 'the supply of port services and resources, for various reasons, cannot cope with the increasing demand for those services and resources.' | Eddrgash 2019 |
| **X1.2** | "Port congestion arises when port capacity is insufficient to cope with the traffic arriving at the port". | Alderton 2005; Wanke (2011) MAGIBHO (2017) |
| **X1.3** | "It indicates the demand for the use of sea space exceeds the available capacity during that time period". | Fan and Cao 2000; |
| **X1.4** | "a situation where a transport user, such as a ship, causes to delay another transport user (another ship), and this delay translated to extra cost upon the third party (usually the customer)". | Meersman et al (2012); Potgieter 2016 |
| **X1.5** | "The congestion effect refers to the phenomenon that more customers choosing to use the same facility reduces the facility's utility." | Wang and Meng (2019) |
| **X1.6** | "Port congestion as a situation wherein a port; ships on arrival spend more time waiting to berth, in this context, more ships will queue at the channel and the outside of the port waiting to get space at the terminal for berth slot." | Onwumere 2008; Patalinghug et al. 2015; Oyatoye et al. 2011; MAGIBHO 2017 |

Source: this research Author

List of X2 items variable and their sources from literature.

| CODE | ITEM VARIABLES | SOURCES |
|---|---|---|
| **X2** | **Weakness in infrastructures** | |
| **X2.1** | Insufficient port storage area capacities | Covic 2017; Facchini and; Mossa 2020; Jeevan and Roso 2019; Jiang et al. 2012; Jin et al. 2016; Kwateng et al. 2017; Lubulwa et al, 2011; Rajasekar and Rengamani 2017; Ramírez-Nafarrate et al. 2017; Roy et al. 2016; Ruiz-Aguilar et al. 2015; Ruiz-Aguilar et al. 2019. |
| **X2.2** | Insufficient port gates capacities | Jizba et al. 2015; Keceli 2016; Sharif et al. 2011; Wein et al. 2006. |
| **X2.3** | Inadequate development in other port infrastructures such as port ways, yard lights, yard refri gerators sockets,….ect. | Abe and Wilson 2009; Abouarghoub et al. 2017; Aldcroft 1961; Alhameedi et al. 2018; Bernstein 2006; Chinedum 2018<br>Cullinane and song 1998; Finlay et al. 2003; GIDADO 2015; MAGIBHO 2017; Ojadi and Walters 2015; Oyatoye et al. 2011. |
| **X2.4** | Insufficient port berths' capacities at a port | Agostini and Saavedra 2014; Alvarez et al. 2010; Alattar et al. 2006; Chen et al. 2010; Dragović et al. 2006; DRAGOVIC´ et al. 2005; Eliiyi et al. 2008; El-Naggar 2010; Fan and Cao 2000; Fararoui and Black 1992; Goodchild and Daganzo 2006; Hoque and Biswas 2007; ILATI et al. 2014; Islam and Olsen 2011; Ismail et al. 2015; Jin et al. 2015; Jordan et al. 2007; Kiani et al. 2006; Kofjač et al. 2013<br>Fornaji And Westcott 2013; Naudé 2016; NDIPMUN 2010; Ngo et al. 2017; Noritake 1985; Patalinghug et al. 2015; Potgieter 2016<br>POWLES 2004; Shahpanah et al. 2014a; Shahpanah et al. 2014b; Sheikholeslami and Ilati 2018; Sheikholeslami et al. 2013; Soriguera et al. 2006; Souf-Aljen et al. 2016; Stephens and Ukpere 2011; Sun et al. 2017; Wanke 2011<br>Yang et al. 2013; Zrnic´ et al. 1999. |
| **X2.5** | Insufficient depths of the sea entrance, sea channels, and port berths for a port. | Asteris et al. 2012; Inoue 2000; Li and Jia 2019; Meersman et al. 2012 |
| **X2.6** | Inadequate development in the infrastructures of the hinterland intermodal. | Regan and Golob 2000; Roso 2008<br>Teye et al. 2016, Wan et al. 2013;<br>Wang and Meng 2019; Zhang et al. 2013. |
| **X2.7** | Inadequate development in the port hinterland other systems such as telecommunications, internet networks, and banks system. | Abe and Wilson 2009; Abouarghoub et al. 2017; Aldcroft 1961; Alhameedi et al. 2018; Bernstein 2006; Chinedum 2018; Cullinane and song 1998; Finlay et al. 2003; GIDADO 2015<br>MAGIBHO 2017; Ojadi and Walters 2015; Oyatoye et al. 2011. |

Source: this research Author

List of X3 items variable and their sources from literature.

| CODE | ITEM VARIABLE | SOURCE |
|---|---|---|
| X3 | **Shortages in facilities** | |
| **X3.1** | An inadequate number of port gates. | Jizba et al. 2015; Keceli 2016; Sharif et al. 2011; Wein et al.2006; Chen and Yang 2010; De Borger and De Bruyne 2011; Dekker et al. 2013; Giuliano and O'Brien 2007; Islam et al. 2013; Jula et al. 2006; Lalla-Ruiz et al. 2018; Lange et al. 2017; Minh and Huynh 2017; Namboothiri and Erera 2008; Peng et al. 2018; Phan and Kim 2016; Rajamanickam and Ramadurai 2015; Ruiz-Aguilar et al. 2016; Veloqui et al. 2014. |
| **X3.2** | An inadequate number of port cranes. | Arnaout et al. 2013; Choo et al. 2010; Moghadam et al. 2011; Alattar et al. 2006; Alhameedi et al. 2018; Chen et al. 2010; Covic 2017; DRAGOVIC´ et al. 2005; Eliiyi et al. 2008; Goodchild and Daganzo 2006; ILATI et al. 2014; Jiang et al. 2012; Jin et al. 2016; Roy et al. 2016; Shahpanah et al. 2014a; Shahpanah et al.2014b; Sheikholeslami and Ilati 2018; Fan and Cao 2000; Meersman et al. 2012; Wang et al. 2014; Soriguera et al. 2006. |
| **X3.3** | An inadequate number of other port equipment such as (straddles, trailers, port trucks, X-ray screening machines,.). | Abe and Wilson 2009; Abouarghoub et al. 2017; Aldcroft 1961; Alhameedi et al. 2018; Bernstein 2006; Chinedum 2018; Cullinane and song 1998; Finlay et al. 2003; GIDADO 2015; MAGIBHO 2017; Ojadi and Walters 2015; Oyatoye et al. 2011; Agostini and Saavedra 2014; Alvarez et al. 2010; Cullinane and song 1998; GIDADO 2015; Ojadi and Walters 2015; Ruiz-Aguilar et al. 2015; Ruiz-Aguilar et al. 2019; Alattar et al. 2006; Eliiyi et al. 2008; Oyatoye et al. 2011; Saeed et al. 2018; Soriguera et al. 2006; Noritake 1985; POWLES 2004; Shahpanah et al. 2014a; Shahpanah et al. 2014b; Stephens and Ukpere 2011; World shipping council 2015. |
| **X3.4** | Shortages in supplying equipment's spare parts that might need for repairing them frequently. | Li 2019; Navarro et al. 2015; Fereidoonian and Mirzazadeh 2012; MAGIBHO 2017; Abouarghoub et al. 2017; Goodchild and Daganzo 2006; Naudé 2016; GIDADO 2015; Ojadi and Walters 2015; Saeed et al. 2018; Soriguera et al. 2006; Elentably 2017; Fornaji and Westcott 2013. |
| **X3.5** | The recent increase in ships size (especially container ships) has caused putting more constraints on the existing equipment's capacities at the port that receive this type of ships. | Chen et al. 2013; Davies and Kieran 2015; Fan et al. 2012; Han et al. 2008; Hervás-Peralta et al. 2019; HU et al. 2008; Ilmer 2006; Li and Lam 2017; Veloqui et al. 2014; Maguire et al. 2010; Motono et al. 2016; Neagoe et al. 2017; Phan and Kim 2015; SHABAYEK and YEUNG 2000; Shabayek and Yeung 2001; SONG et al. 2019; Wan et al. 2013; Yeo et al. 2007; Yi et al. 2019; Zhang et al. 2013; Asteris et al. 2012; Jeevan and Roso 2019; Jin et al. 2016; Kwateng et al. 2017; Ngo et al. 2017; Sheikholeslami and Ilati 2018; Sun et al. 2017; Jiang et al. 2012; Lange et al. 2017; Navarro et al. 2015; Roy et al. 2016; Saurí et al. 2011; heikholeslami et al. 2013; Wang et al. 2014; Zhen et al. 2016. |
| **X3.6** | The increase in ships sharing alliance between companies has caused for putting more constraints on the existing equipment's capacities at the port that receive this type of ships. | Davies and Kieran 2015; Han et al. 2008; Ilmer 2006; Motono et al. 2016; Shabayek and Yeung 2001; SONG et al. 2019; Yi et al. 2019; Jeevan and Roso 2019; Jin et al. 2016; Sheikholeslami and Ilati 2018; Simões and Marques 2010; Teye et al. 2016; Jiang et al. 2012; Saurí et al. 2011; Sheikholeslami et al. 2013. |
| **X3.7** | An inadequate number of tugboats at the port | EASA 1986; ILATI et al. 2014; Shahpanah et al. 2014a; Shahpanah et al. 2014b; Meersman et al. 2012; NDIPMUN 2010; Sheikholeslami et al. 2013 |
| **X3.8** | Insufficient capacities of port assages and port accesses (Roads, rail lines, and water channels) | Ku et al. 2012; Lee et al. 2007; Chen and Yang 2010; De Borger and De Bruyne 2011; Dekker et al. 2013; Giuliano and O'Brien 2007; Islam et al. 2013; Jula et al. 2006; Lalla-Ruiz et al. 2018; Lange et al. 2017; Minh and Huynh 2017; Namboothiri and Erera 2008; Peng et al. 2018; Phan and Kim 2016; Rajamanickam and Ramadurai 2015; Ruiz-Aguilar et al. 2016; Veloqui et al. 2014. |

Source: the research Author

List of X4 items variable and their sources from literature.

| CODE | ITEM VARIABLES | SOURCES |
|---|---|---|
| **X4** | **Mismanagement issues** | |
| **X4.1** | Inefficient management for port passages and port accesses | Ku et al. 2012; Lee et al. 2007; Sharif et al. 2011; Alhameedi et al. 2018; Lange et al. 2017, Moghadam et al. 2011; Namboothiri and Erera 2008; Peng et al. 2018; Phan and Kim 2016; Rajamanickam and Ramadurai 2015; Ruiz-Aguilar et al. 2016; Veloqui et al. 2014; Lubulwa et al, 2011; Maguire et al. 2010; Rahmanto 2016; Regan and Golob 2000; Ruiz-Aguilar et al. 2015; Ruiz-Aguilar et al. 2019; Wan et al. 2013; Wang and Meng 2019; Zhang et al. 2013. |
| **X4.2** | Unproductive cargo handling operation | Navarro et al. 2015; Paggi et al. 1979; Chinedum 2018; Choo et al. 2010; Fereidoonian and Mirzazadeh 2012; Kun 2015; MAGIBHO 2017; Moghadam et al. 2011; World shipping council 2015; Zhang et al. 2008; Abouarghoub et al. 2017; Cullinane and song 1998; Goodchild and Daganzo 2006; Jin et al. 2015; Monem 2015; Murty et al. 2005; Zrnic´ et al. 1999. |
| **X4.3** | Inefficient management for cargo handling equipment | Carr and Crum 1995; Fereidoonian and Mirzazadeh 2012; Jacobsson et al. 2018; Kun 2015; Monem 2015; Murty et al. 2005; Saeed et al. 2018; Yi et al. 2019; Zhang et al. 2008; Abouarghoub et al. 2017; Dragović et al. 2006; EASA 1986; Jin et al. 2015; Li and Jia 2019; Oyatoye et al. 2011; Wang et al. 2014; Chen et al. 2010; Chinedum 2018; DRAGOVIC´ et al. 2005; GIDADO 2015; Ojadi and Walters 2015; Saeed and Larsen 2015; Yang et al. 2013; Yu and et al. 2018; Zhen 2016. |
| **X4.4** | The increase in the complexity of port operations that has been noticed lately due to the increase in ship size and the increasing in the ships sharing alliance between companies. | Davies and Kieran 2015; Han et al. 2008; Ilmer 2006; Motono et al. 2016; Shabayek and Yeung 2001<br>SONG et al. 2019; Yi et al. 2019; Jeevan and Roso 2019; Jin et al. 2016; Sheikholeslami and Ilati 2018; Simões and Marques 2010; Teye et al. 2016; Jiang et al. 2012; Saurí et al. 2011; Sheikholeslami et al. 2013; Goodchild and Daganzo 2006; Ramírez-Nafarrate et al. 2017; Souf-Aljen et al. 2016; Yu and et al. 2018. |
| **X4.5** | Employing unqualified staff in ports | Islam and Olsen 2011; MAGIBHO 2017; Abouarghoub et al. 2017; Meersman et al. 2012; GIDADO 2015; Elentably 2017; Fornaji and Westcott 2013; NDIPMUN 2010. |
| **X4.6** | Imposing cheaper prices for storing cargoes in ports (than outside ports) by port management | Saurí et al. 2011; GIDADO 2015; Patalinghug et al. 2015. |
| **X4.7** | Inefficient port yard template plans (especially in container terminals). | Zhen et al. 2016; Zhen 2016; Yu and et al. 2018 |
| **X4.8** | Inefficient plans for allocating ships at port berths. | Simões and Marques 2010; Monem 2015; Murty et al. 2005; Wanke 2011; Zrnic´ et al. 1999; Naudé 2016; Roy et al. 2016; Sheikholeslami et al. 2013; Souf-Aljen et al. 2016; Li and Jia 2019; Ojadi and Walters 2015; Yang et al. 2013; Yu and et al. 2018; World shipping council 2015; Shahpanah et al. 2014a; Shahpanah et al. 2014b; Sheikholeslami and Ilati 2018; Stephens and Ukpere 2011; Potgieter 2016; NDIPMUN 2010. |
| **X4.9** | Poor management for maintaining and repairing port facilities such as tugboats and the sea entrance's lights. | Li 2019; Navarro et al. 2015; Fereidoonian and Mirzazadeh 2012; MAGIBHO 2017; Abouarghoub et al. 2017; Goodchild and Daganzo 2006; Naudé 2016; GIDADO 2015; Ojadi and Walters 2015; Saeed et al. 2018; Soriguera et al. 2006; Elentably 2017. |
| **X4.10** | Accidents at ports sea channels and berths. | Elentably 2017; Fararoui and Black 1992; Inoue 2000; Li and Lam 2017; Chinedum 2018. |
| **X4.11** | The lack of information exchange between port actors (Port operators, Customs, Shippers, and trucks' companies). | Wein et al. 2006; Islam et al. 2013; Paggi et al. 1979; Sharif et al. 2011, Jacobsson et al. 2018; MOTONO et al. 2014; Namboothiri and Erera 2008; Neagoe et al. 2017; Phan and Kim 2015; Phan and Kim 2016; SHABAYEK and YEUNG 2000; Zain et al. 2016 |

Source: the research Author

(continued) List of X4 items variable and their sources from literature.

| CODE | ITEM VARIABLE | SOURCE |
|---|---|---|
| **X4.12** | Inefficient management for the hinterland accesses (Roads, rail lines, and water channels) could lead to traffic congestion situations at ports and around them. | Bentolila et al. 2016, Chen and Jiang 2016, Chen and Yang 2010, Cox et al. 2009, De Borger and De Bruyne 2011 Dekker et al. 2013, Giuliano and O'Brien 2007, Gracia et al. 2017, Guan and Liu 2009, Islam et al. 2013, Jula et al. 2006 Lalla-Ruiz et al. 2018, Lange et al. 2017, Maguire et al. 2010 Minh and Huynh 2017, Motono et al. 2016, Namboothiri and Erera 2008, Neagoe et al. 2017, Peng et al. 2018, Phan and Kim 2015, Phan and Kim 2016 |
| **X4.13** | Bureaucracy and severe custom's regulations | Carr and Crum 1995; Keceli 2016; Kwateng et al. 2017; Navarro et al. 2015; Rajamanickam and Ramadurai 2015; Rajasekar and Rengamani 2017; Ramírez-Nafarrate et al.2017; Sharif et al. 2011; Stephens and Ukpere 2011; Wan et al. 2013. |
| **X4.14** | Centralism and monopolism in government public sectors | Cullinane and song 1998; MAGIBHO 2017 Ojadi and Walters 2015; Patalinghug et al. 2015. |
| **X4.15** | Poor port regulation and policies | Aldcroft 1961; Chinedum 2018; Elentably 2017; GIDADO 2015; Naudé 2016; NDIPMUN 2010; Oyatoye et al. 2011; POWLES 2004; Saeed and Larsen 2015; Saeed et al. 2018. |
| **X4.16** | A 100% cargo inspection policy at some ports | Alhameedi et al. 2018; Arnaout et al. 2013; Bakshi et al. 2011; Bentolila et al. 2016; Bernstein 2006; Jizba et al. 2015; Minh and Huynh 2017; Regan and Golob 2000; Wein et al. 2006. |
| **X4.17** | Inadequate development government policies and regulations (especially in developing countries) | De Borger and De Bruyne 2011; Finlay et al. 2003; Simões and Marques 2010; World shipping council 2015. |
| **X4.18** | The excessive number of port labours | NDIPMUN 2010 |
| **X4.19** | Labour inefficiency is a great cause for imposing time delays at cargoes handling operation in ports. | Monem 2015; Navarro et al. 2015; Patalinghug et al. 2015; POWLES 2004; Rajamanickam and Ramadurai 2015; Rajasekar and Rengamani 2017; Sheikholeslami and Ilati 2018; Soriguera et al. 2006; Stephens and Ukpere 2011 |
| **X4.20** | Insufficient working hours at ports is a direct cause for imposing delay times on both operations ship entering and cargo clearing process. | Alhameedi et al. 2018; Bentolila et al. 2016; Maguire et al. 2010 Regan and Golob 2000; Ruiz-Aguilar et al. 2019 |
| **X4.21** | Labour strikes at ports | AbuAlhaol et al. 2018; Aldcroft 1961; Chinedum 2018; Elentably 2017; Fararoui and Black 1992; GIDADO 2015; Fornaji and Westcott 2013; MAGIBHO 2017; Meersman et al. 2012; Naudé 2016; Ojadi and Walters 2015; Oyatoye et al. 2011; Saeed et al. 2018; Simões and Marques 2010; World shipping council 2015 |
| **X4.22** | Corruption at ports and government systems | Eddrgash 2019 |

Source: the research Author

List of X5 items variable and their sources from literature.

| CODE | ITEM VARIABLES | SOURCES |
|---|---|---|
| **X5** | **Natural causes** | |
| **X5.1** | Bad weather | AbuAlhaol et al. 2018; Chinedum 2018; Elentably 2017; GIDADO 2015; Inoue 2000; Islam and Olsen 2011; Meersman et al. 2012; Naudé 2016 NDIPMUN 2010; Potgieter 2016; Saeed et al. 2018; Shabayek and Yeung 2001; World shipping council 2015. |
| **X5.2** | Tide issues | Alattar et al. 2006; Fararoui and Black 1992 ILATI et al. 2014; Ilmer 2006; Lalla-Ruiz et al. 2018; Li and Jia 2019; Sheikholeslami and Ilati 2018; Simões and Marques 2010; Sun et al. 2017. |
| **X5.3** | Floods issues | AbuAlhaol et al. 2018; Inoue 2000; Naudé 2016 |

Source: the research Author

List of X6 items variable and their sources from literature.

| CODE | ITEM VARIABLES | SOURCES |
|---|---|---|
| X6 | **Economical causes** | |
| **X6.1** | The sudden increase in the international trade on a port | All 150 articles from the systematic review (chapter 4). |
| **X6.2** | The sudden increase in the trade local demand from a country or a region | AbuAlhaol et al. 2018; Alhameedi et al. 2018; Arnaout et al. 2013; Bentolila et al. 2016; Chinedum 2018; Covic 2017; Cox et al. 2009; Facchini and Mossa 2020; Fan et al. 2012; Fararoui and Black 1992; Finlay et al. 2003; GIDADO 2015; Jula et al. 2006; Kwateng et al. 2017; Fornaji and Westcott 2013; MAGIBHO 2017; Rahmanto 2016; Ramírez-Nafarrate et al. 2017; Saurí et al. 2011; Sheikholeslami et al. 2013; Wang and Meng 2019. |
| **X6.3** | Concentrating the cargo traffic on a certain port while the other ports remain ineffective. | Fan and Wilson 2012, Fan et al. 2012, GIDADO 2015; NDIPMUN 2010; Ojadi and Walters 2015; Oyatoye et al. 2011; Patalinghug et al. 2015; Regan and Golob 2000; Saeed and Larsen 2015; SONG et al. 2019; Stephens and Ukpere 2011; Teye et al. 2016. |
| **X6.4** | Seasonality (increasing cargo traffic on a port at certain times of the year). | Shabayek and Yeung 2001 |

Source: the research Author

Appendix (J).

Cardiff University
Prifysgol Caerdydd

Cardiff Business School
Ysgol Busnes Caerdydd

27/07/2021

Dear Tarig Eddrgash,

**Research project title:** Port congestion problem at developing countries' ports

**SREC reference: 2021082**

The School Research Ethics Committee (SREC) reviewed the above application via its proportionate review process.

**Ethical Opinion**

The Committee gave a favourable ethical opinion of the above application on the basis described in the application form, protocol and supporting documentation.

**Additional approvals**

This letter provides an ethical opinion only. You must not start your research project until all appropriate approvals are in place.

**Amendments**

Any substantial amendments to documents previously reviewed by the Committee must be submitted to the Committee via CARBS-ResearchEthics@cardiff.ac.uk for consideration and cannot be implemented until the Committee has confirmed it is satisfied with the proposed amendments.

You are permitted to implement non-substantial amendments to the documents previously reviewed by the Committee but you must provide a copy of any updated documents to the Committee via CARBS-ResearchEthics@cardiff.ac.uk for its records.

**Monitoring requirements**

The Committee must be informed of any unexpected ethical issues or unexpected adverse events that arise during the research project. The Committee must be informed when your research project has ended. This notification should be made to the Research Office within three months of research project completion.

**Documents reviewed by Committee**

The documents reviewed by the Committee were:

| | | |
|---|---|---|
| Research integrity training certificate | Version 4 | Date |
| Ethics application | | 27/07/2021 |
| Consent form | | |
| Participant information sheet | | |
| Questionnaire | | |

**Complaints/Appeals**

If you are dissatisfied with the decision made by the Committee, please contact Dr Carmela Bosangit (BosangitC@cardiff.ac.uk) in the first instance to discuss your complaint. If this discussion does not resolve the issue, you are entitled to refer the matter to the Head of School for further consideration. The Head of School may refer the matter to the University Research Integrity and Ethics Committee (URIEC), where this is appropriate. Please be advised that URIEC will not normally interfere with a decision of the Committee and is concerned only with the general principles of natural justice, reasonableness and fairness of the decision.

Please use the Committee reference number on all future correspondence.

**The Committee reminds you that it is your responsibility to conduct your research project to the highest ethical standards and to keep all ethical issues arising from your research project under regular review.**

**You are expected to comply with Cardiff University's policies, procedures and guidance at all times, including, but not limited to, its Policy on the Ethical Conduct of Research involving Human Participants, Human Material or Human Data and our Research Integrity and Governance Code of Practice.**

Yours sincerely,

Dr Carmela Bosangit

Chair of School Research Committee

CARDIFF UNIVERSITY
PRIFYSGOL CAERDYDD

## CONSENT FORM

Title of research project: **Port congestion problem at developing countries' ports**

SREC reference: 2021082
committee: CARBS Research Ethics Committee
Name of Chief/Principal Investigator: Tarig Ali Eddrgash

**Please initial box**

| | |
|---|---|
| I confirm that I have read the information sheet dated 7/7/2021 version ………. for the above research project. | |
| I confirm that I have understood the information sheet dated 7/7/2021 version …………… for the above research project and that I have had the opportunity to ask questions and that these have been answered satisfactorily. | |
| I understand that my participation is voluntary and I am free to withdraw at any time without giving a reason and without any adverse consequences (e.g. to medical care or legal rights, if relevant). I understand that if I withdraw, information about me that has already been obtained may be kept by Cardiff University. | |
| I understand that data collected during the research project may be looked at by individuals from Cardiff University or from regulatory authorities, where it is relevant to my taking part in the research project. I give permission for these individuals to have access to my data. | |
| I understand who will have access to personal information provided, how the data will be stored and what will happen to the data at the end of the research project. | |
| [IF RELEVANT] I understand that after the research project, anonymised data may be made publicly available via a data repository and may be used for purposes not related to this research project. I understand that it will not be possible to identify me from this data that is seen and used by other researchers, for ethically approved research projects, on the understanding that confidentiality will be maintained. | |
| I understand how the findings and results of the research project will be written up and published. | |
| I agree to take part in this research project. | |

___________________________ ____________________ ___________________________

| |
|---|
| Participant ID no<br>*Do not include box for anonymised samples* |

Name of participant (print) Date Signature

Name of person taking consent (print) Date Signature

**Role of person taking consent (print)**

**THANK YOU FOR PARTICIPATING IN OUR RESEARCH**

**YOU WILL BE GIVEN A COPY OF THIS CONSENT FORM TO KEEP**

CARDIFF UNIVERSITY
PRIFYSGOL CAERDYDD

**PARTICIPANT INFORMATION SHEET**

**Port congestion problem at developing countries' ports.**

You are being invited to take part in a research project. Before you decide whether or not to take part, it is important for you to understand why the research is being undertaken and what it will involve. Please take time to read the following information carefully and discuss it with others, if you wish.

Thank you for reading this.

**What is the purpose of this research project?**

A successful identification of the reasons behind the cause for congestion problem in a port is very critical since knowing these causes will undoubtedly help the government and ports' managers to increase the ports' efficiencies and reduce the congestion in their ports. However, the identification of these causes has been described as a quite complex and multi-dimensional process as these causes are varied from country to country and sometimes from port to port. Most port congestion problems can be solved if causes are identified, analysed and then proper actions should be taken to solve these bottlenecks. This study is an independent academic PhD research to identify the reasons behind the congestion problems at seaports and container terminals. We invite you to participate in this study which seeks to identify the most common reasons that cause to arise congestion problems at ports.

**Why have I been invited to take part?**
You have been invited because you are considered as port stakeholder in managerial level and have good experience which will enable you to be beneficial for this research aim: identifying the causes for port congestion problem.

**Do I have to take part?**
No, your participation in this research project is entirely voluntary and it is up to you to decide whether or not to take part. If you decide to take part, we will discuss the research project with you [and ask you to sign a consent form]. If you decide not to take part, you do not have to explain your reasons and it will not affect your legal rights.
You are free to withdraw your consent to participate in the research project at any time, without giving a reason, even after signing the consent form.

**What will taking part involve?**
Your participant involves filling an online survey questionnaire which you will done it only one time and it might take from you around 10 to 15 minute to finish it. You will receive the survey questionnaire through email or a webpage link in text massage. Also, there is no audio or visual record needs for this survey.

**Will I be paid for taking part?**
No. You should understand that any data you give will be as a gift and you will not benefit financially in the future should this research project lead to the development of a new treatment/method/test/assessment.

**What are the possible benefits of taking part?**
There will be no direct advantages or benefits to you from taking part, but your contribution will help us to understand and identify the causes for port congestion problems and find solutions for them.

**What are the possible risks of taking part?**
No possible risks can be account on you from taking part in this research.

**Will my taking part in this research project be kept confidential?**
All information collected from (or about) you during the research project will be kept confidential and any personal information you provide will be managed in accordance with data protection legislation.

**What will happen to my Personal Data?**
No personal data will be collected in the survey questionnaire.

**What happens to the data at the end of the research project?**
The data will be kept for three years after the completion of this PhD research (till September 2026. The research data might be publicised and any requiring of sharing data within the University and/or shared outside of the University will be via a data repository through a restricted access method.

**What will happen to the results of the research project?**
It is our intention to publish the results of this research project in academic journals and present findings at conferences. Participants will not be identified in any report, publication or presentation. Also, there is no intention to use verbatim quotes from participants.

**What if there is a problem?**
If you wish to complain or have grounds for concerns about any aspect of the manner in which you have been approached or treated during the course of this research, please contact me the researcher: Tarig Ali Eddrgash by email at:…. . If your complaint is not managed to your satisfaction, please contact My supervisor: Dr. Dr Wessam Abouarghoub at email address: ….
If you are harmed by taking part in this research project, there are no special compensation arrangements. If you are harmed due to someone's negligence, you may have grounds for legal action, but you may have to pay for it.

**Who is organising and funding this research project?**
The research is organised by Phd student: Tarig Ali Eddrgash and supervisors by: Dr. Wessam Abouarghoub, Prof. Stephen Pettit, and Prof. Anthony Beresford.

**1. Who has reviewed this research project?**
This research project has been reviewed and given a favourable opinion by the CARBS Research Ethics Committee .

**Further information and contact details**

Should you have any questions relating to this research project, you may contact us during normal working hours:

Tarig Ali Eddrgash.
Mobil:
Cardiff Business School , Aberconway Building, Cardiff University
Cardiff
CF10 3EU

**Thank you for considering to take part in this research project. If you decide to participate, you will be given a copy of the Participant Information Sheet and a signed consent form to keep for your records.**

CARDIFF UNIVERSITY
PRIFYSGOL CAERDYDD

**CARBS RESEARCH ETHICS COMMITTEE**

**APPLICATION FOR ETHICAL REVIEW**

| For Office Use Only | |
|---|---|
| SREC Reference: [x] | Meeting/Review Date: [x] |

| **SECTION 1. GENERAL INFORMATION** | | |
|---|---|---|
| Application Type: | ☐ Staff<br>☐ PGT/Masters Student | √ PGR student<br>☐ Undergraduate |
| Research Project Title: | Port congestion problem at developing countries' pc | |
| Short Title (where applicable): | | |
| For Staff Projects | | |
| Name of Chief/Principal Investigator: | | |
| Contact details: | | |
| Other members of research team: | | |
| For Student Projects | | |
| Name of Student: | Tarig Ali Eddrgash | |
| Contact details: | | |
| Name of Supervisor(s): | Wessam Abouarghoub<br>Stephen Pettit<br>Anthony Beresford | |
| Contact details: | | |
| Other members of research team: | | |

| **SECTION 2. SCREENING QUESTIONS** | | | |
|---|---|---|---|
| | | **Yes** | **N** |
| 2.1 | Is the research project categorised as 'Research' (as defined in the Cardiff University Policy on the Ethical Conduct of Research involving Human Participants, Human Material or Human Data Ethics Policy)? | **yes** | |

| | | | |
|---|---|---|---|
| 2.3 | Does the research project require review by an external ethics committee (refer to Appendix 1 of the Ethics Policy)? Please note that this includes all research projects involving participants who lack the capacity to consent.<br><br>*If **yes**, the research project should be submitted to the relevant external ethics committee for review and does not fall within the remit of this Committee. Please contact the Research Governance Team for further advice. **Please do not continue with this application.*** | | **No** |
| 2.4 | Has the research project been ethically reviewed by another university or research institution (for example, where the Chief/Principal Investigator for the research project is based at another institution)?<br><br>*If **yes,** please provide evidence of the review conducted (such as an outcome letter or communication) and the ethical review policy of the relevant institution or committee and send to* CARBS-ResearchEthics@cardiff.ac.uk. ***Please do not continue with this application.*** | | **No** |
| 2.5 | Does the research project only involve the use of information that is publicly and lawfully available e.g., census data and population statistics published by government departments? Note: research projects involving the use of Human Data obtained from social media (or similar internet forums) do not fall within this category.<br><br>*If **yes**, **please complete Section 3 only*** to provide a summary of your research project and details on the information and its source. You may refer to the Framework for Ethical Review of Research using Secondary Data/or Publicly Available Data for guidance. | | **No** |
| 2.6 | Does the research project fall within the scope of the UK Policy Framework for Health and Social Care Research? This Framework broadly applies to research taking place within, or involving, the health and social care systems.<br><br>*If **yes**, you will need to apply to the Research Governance Team for Sponsorship using the Advanced Project Information Proforma (APIP) (available on the Cardiff University intranet). The Research Governance Team will advise you on the approvals that are required for the research project after it has conducted a review of the APIP and supporting documentation. **Please do not continue with this application until you have sought advice from the Research Governance Team.*** | | **No** |
| 2.7 | Does the research project involve the collection or use of Human Tissue (including, but not limited to, blood, saliva and bodily waste fluids)?<br><br>*If **yes**, the research project should be submitted to the Human Tissue Act Compliance Team (HTACT) prior to submission to an ethics committee. **Please do not continue with this application until you have sought advice from HTACT.*** | | **No** |
| 2.8 | Does the research project fall within the scope of the University's Security-sensitive Research Policy? This Policy broadly applies to research involving terrorism, extremism or radicalisation (or access to materials of such a nature).<br><br>*If **yes**, you must register the research in accordance with the Policy and comply with the IT and security arrangements contained in the Policy.* | | **No** |

| | | | |
|---|---|---|---|
| 2.9 | Has the research project received appropriate peer/scientific review? (For student research projects, review by the research project supervisor is an acceptable form of scientific review)<br><br>*For staff, peer review is not essential but may improve the quality of the application and speed up the application process.* | **Y es** | |
| 2.10 | Have you <u>and</u> all other Cardiff University co-applicants/ /Supervisors/Members of the research team (as listed in Section 1) completed the University's Research Integrity Online Training Programme?<br><br>*If **no**, please complete the training before submitting the application to this Committee. If **Yes, please include evidence of successful completion with this application.*** | **Y es** | |
| 2.11 | | | |

| | |
|---|---|
| **SECTION 3. PROJECT SUMMARY** | |
| 3.1 | Summarise the research project (including the purpose and its methodology) usi language that would be understood by a lay person. |

This research is expanding to my SSRM Master Dissertation for investigating the port congesti problem in developing countries using Libya as a case study. The dissertation results identifi eight main causes and their solutions for port congestion problem in Libya. To generalize the findings in developing countries, there is a need for second step where a more robust methodolo needs to be applied. So in this research (PhD thesis) I first will carry out a systematic literatu review to explore the phenomena within the previous literature. Then I will attempt to model t port congestion problem in developing countries using a simulation technique. In my Thesis I w combine both quantitative and qualitative research. For the quantitative research, the data will collected from the daily operation movements in Libyan ports (arriving ships, waiting tim berthing time, departure time, and berths throughputs) during the years from 2012 to 2020.
Moreover, I will conduct online survey research target the port stakeholders to validate t identified causes for port congestion. Based on these data I will use the factor analysis approa to test the previous findings for port congestion in developing countries' ports and produce model for the port congestion problem (causes and solutions), which can be generalized for developing countries.

| | |
|---|---|
| 3.2 | State the research question(s). |

What are the main causes for port congestion problem in developing countries and there proper solutions?

| | |
|---|---|
| 3.3 | Estimated start date. |

September 2021

| | |
|---|---|
| 3.4 | Estimated end date (usually the end of data collection). |

April 2022

| | |
|---|---|
| 3.5 | Is the research project funded? *If yes, please name the funding body.* |

**No**

| | | | |
|---|---|---|---|
| 3.6 | Are there any potential conflicts of interest? *If **yes**, please confirm the action yo propose to take to address such conflicts.*<br><br>*Information and guidance on conflicts of interest is contained in the Research Integr Online Training Programme and the Research Integrity and Governance Code of Practic* | | |
| No | | | |

| | | | |
|---|---|---|---|
| **SECTION 4. FULL REVIEW CRITERIA** | | | |
| Your answers to the questions in this Section 4 will help the Committee determine wheth your project requires full or proportionate review.<br><br>If all 'No' boxes apply, your project may be considered for proportionate review.<br><br>If a 'Yes' box applies, your project will proceed to full review <u>unless</u> the School h approved a Ethics Protocol for that particular criterion. Where an Ethics Protocol applie this is confirmed below. If you have complied with the Ethics Protocol, your project ma be considered for proportionate review. | | | |
| | | **Yes** | |
| 4.1 | Will the research project be performed without the participants' prior consent?<br><br>If you have answered YES to 4.1 have you complied with the CARBS ethics protocol? This can be found here. You are expected to explain this in Section 6.1. | | |
| 4.2 | Does the research design include an element of deception, including covert research? | | |
| 4.3 | Will the research project involve children under the age of 18 or 'at risk' (vulnerable) adults or groups?<br><br>*The Cardiff University Safeguarding Children and Adults at Risk: Policy and Guidance sets out examples of 'at risk' or 'vulnerable' adults.* | | |
| 4.4 | Does the research project include topics which may be considered highly sensitive for participants?<br><br>*This includes sexual behaviour, illegal activities, political, religious or spiritual beliefs, race or ethnicity, experience of violence, abuse or exploitation, and mental health.*<br><br>If you have answered YES to 4.4 have you complied with the CARBS ethics protocol? This can be found here. | | |
| 4.5 | Does the research project require access to records of a sensitive or confidential nature, including Special Category Data?<br><br>*Special Category Data is defined in data protection legislation and currently includes information about an individual's: racial or ethnic origin; political opinions; religious beliefs; trade union membership; physical or mental* | | |

| | | | |
|---|---|---|---|
| 4.6 | Is permission of a gatekeeper required for initial or continued access to participants?<br><br>*This includes participants in custody and care settings, or research in communities where access to research participants is not possible without the permission of another adult, such as another family member or a community leader.*<br><br>If you have answered YES to 4.6 have you complied with the CARBS ethics protocol? This can be found here. | | |
| 4.7 | Does the research project involve intrusive or invasive procedures?<br><br>*This includes the administration of substances, vigorous physical exercise, procedures involving pain or more than mild discomfort to participants (including the risk of psychological distress, discomfort or anxiety to participants).* | | |
| 4.8 | Does the research project involve visual or audio recordings where participants may be identified?<br><br>If you have answered 'yes' to 4.8, have you complied with the School's ethics protocols on audio and/ or visual recordings<br>a) AUDIO<br>b) VISUAL<br><br>If you have answered YES to 4.8 have you complied with the CARBS ethics protocol? This can be found here. | | |
| 4.9 | Does the research project involve the collection or use of human tissue? | | |
| 4.10 | Does the research project involve more than a minimal risk of harm to the safety and wellbeing of participants and/or the Researchers?<br><br>*Please answer this question based on your assessment of the risks involved in this project. Further information about possible harm or potential risks to participants/researchers must be provided in Section 7 of this form.*<br><br>If you have answered YES to 4.10 have you complied with the CARBS ethics protocol? This can be found here. | | |
| **If you have answered YES to any of the above, please use this space to address how you will address these points in an ethically sensitive way.** | | | |
| **SECTION 5. PARTICIPATION AND RECRUITMENT** | | | |
| 5.1 | How will you identify and recruit participants to the research project? | | |
| Port stakeholders' managerial level. The emails will be supplied by my supervisor. | | | |

| | |
|---|---|
| 5.2 | How many participants are you aiming to recruit? *If applicable, please include breakdown of participants by type and number.* |
| Minimum 200 participants | |
| 5.3 | What are the inclusion and exclusion criteria for participants? |
| Should be a Port stakeholders' managerial level | |
| 5.4 | Will the research project involve participants that are Cardiff University staff students or clients of the University (or the place in which you may otherwise work *If applicable, please provide details.* |
| **No** | |
| **SECTION 6. CONSENT PROCEDURES** | |
| 6.1 | Will informed consent be obtained from participants? If so, how? *Please inclu who will be taking consent, how consent will be recorded, when participants will provided with information about the research project, and how long potenti participants will be given to decide whether to take part.* |
| Yes. It is in the first page of the online survey | |
| 6.2 | Will participants be offered any incentives to take part in the research project?<br><br>If you have answered YES to 6.2 have you complied with the CARBS ethi protocol? This can be found here. |
| **No** | |
| 6.3 | If a questionnaire is to be used, will you give participants the option of omitti questions they do not wish to answer? |
| **Yes** | |
| 6.4 | Will participants be informed that their participation is voluntary and that they m withdraw at any time and for any reason? |
| **Yes** | |
| **SECTION 7. POSSIBLE HARM TO PARTICIPANTS/RESEARCHERS** | |
| 7.1 | Is there is a risk of the participants experiencing physical, emotional psychological harm or distress? *If yes, please provide details of how ethical issu will be handled and how any risks will be minimised. Please consider whether t research project includes topics which could be considered as highly sensitive f participants.* |
| **No** | |
| 7.2 | Is there a risk of the Researcher(s) experiencing physical, emotional psychological harm or distress? *If yes, please provide details of how ethical issu will be handled and how any risks will be minimised.* |
| **No** | |
| **SECTION 8. DATA MANAGEMENT, CONFIDENTIALITY AND DATA PROTECTION** | |

| | |
|---|---|
| 8.1 | How, and by whom, will data be collected? |
| Online survey conducts by me. | |
| 8.2 | Will you be accessing or collecting Personal Data (identifiable personal informatio as part of the research project? *If yes, please confirm what data will be access and/or collected (including details of the information participants are asked provide on a written consent form) and by who.* |
| **No** | |
| 8.3 | How long will you retain the Personal Data collected in connection with the research project?<br><br>*Note for Staff/PGR/PGT projects: Consent Forms should be retained for the period specified in Section 2.9 ('Research Project Conduct') of the University's Research Records Retention Schedule If other identifiable information is being collected, researchers must ensure that this is limited to the information necessary to achieve the relevant purpose (data minimisation) <u>and</u> that consideration is given to whether the information can be pseudonymised/anonymised (or otherwis removed) without affecting the integrity of the research data. In most cases, it will be reasonable to keep Personal Data for the period specified in the University's Research Records Retention Schedule <u>if</u> retention is required to maintain the integrity of the research data and the steps above have been followed.*<br><br>*Note for UG projects: the retention period specified in the University's Research Records Retenti Schedule does not apply to UG projects unless the data is to be published. If there is no intention to publish, records and data should be retained until the end of the appeals process (students usually have 28 days from the date of their transcript/results to make an appeal).* |
| No personal data will be collected. | |
| 8.4 | What efforts will be made to anonymise the data collected (where possible)? |
| No personal data will be collected. However appropriate anonymity and confidentiality will be guaranteed for the questionnaire respondents and also they will be informed tha their answer details will be kept anonymous in the final version of the thesis. | |
| 8.5 | Are you proposing to utilise 'public task' as the lawful basis for processing Person Data for the purposes of the research project (as recommended in the University <u>GDPR Guidance for Researchers</u>)?<br><br>*If no, please explain why and what alternative lawful basis you propose to use.* |
| No personal data will be collected. | |
| 8.6 | Have you utilised/incorporated into your Participant Information Sheet tl following sections from the University's template Participant Information Shee *'What will happen to my Personal Data'* and *'What happens to the data at the end the research project?'*<br><br>*If **no**, please explain why this has not been used and how you have otherwise ensured th the relevant data protection/privacy information has been provided to participants.* |
| **Yes** | |
| 8.7 | For how long will the collected anonymised data be retained?<br><br>*Note for Staff/PGR/PGT projects: Anonymised research data should be retained for the peri specified in Section 2.9 ('Research Project Conduct') of the University's Research Records Retenti Schedule.* |

| |
|---|
| Three years after September 2023 which is the date for submitting this PhD research |

| | |
|---|---|
| 8.8 | Who will have access to the data? |
| Me and my Main supervisor | |
| 8.9 | Will the data be shared in any way, for example through deposit in a data repositor with third parties, or a transcription service? |
| **Yes,** the research data might be publicised and any requiring of sharing data within the University and/or shared outside of the University will be via a data repository through restricted access method**.** | |

| |
|---|
| **SECTION 9. OTHER ETHICAL CONSIDERATIONS** |
| Please outline any other ethical considerations raised by the research project and how y intend to address these. You are obliged to bring to the attention of the SREC any ethic issues not covered in this Ethics Review Application Proforma. |
| **SECTION 10. SUPPORTING DOCUMENTS** |
| I have attached the documents, as indicated in the table below, in support of this applicatio<br><br>Please note that the documents listed below **MUST BE** provided where relevant to t research project, alongside any other documents relevant to recruitment, consent a participation. |

| | | **Yes** | **No** | **Versio no.** (whe applicabl |
|---|---|---|---|---|
| 1 | Research Project Protocol/Proposal | | | |
| 2 | Recruitment Adverts/Invitation Letters | | | |
| 3 | Participant Information Sheet | Yes | | |
| 4 | Consent Form | Yes | | |
| 5 | Data Collection Tools (e.g. questionnaires) | **Yes** | | |
| 6 | Other participant communications (e.g. debrief sheets) | | | |
| 7 | Evidence of Research Integrity training completion | **yes** | | |
| **SECTION 11. SIGNATURES AND DECLARATIONS** | | | | |

| SECTION 11. SIGNATURES AND DECLARATIONS | |
|---|---|
| General declaration<br>I confirm that:<br>a. The information in this form is accurate to the best of my knowledge and belief and I take full responsibility for it.<br>b. I have the necessary skills, training and or/expertise to conduct the research project as proposed.<br>c. I am familiar with the University's health and safety requirements and policies and that all relevant health and safety measures have been taken into account for the research project.<br>d. I am familiar with, and will comply with, the University's Policy on the Ethical Conduct of Research involving Human Participants, Human Material or Human Data and the University's Research Integrity and Governance Code of Practice.<br>e. The relevant equality and diversity considerations have been taken into account when designing the research project.<br>f. If the research project is approved, I undertake to adhere to the research project protocol, the terms of the full application as approved and any conditions set out by the Committee and any other body required to review and/or approve the research project.<br>g. I will notify the Committee and all other review bodies of substantial amendments to the protocol or the terms of the approved application, and to seek a favourable opinion from the Committee before implementing the amendment. | |
| **FOR STAFF PROJECTS** | |
| Signed:<br><br>Chief/Principal Investigator | |
| Print name: | |
| Date: | |
| **FOR STUDENT PROJECTS** | |
| Signed:<br><br>Student | Signed:<br><br>Supervisor |
| Print name: | Print name: |
| Date: | Date: |

**Please submit the completed application and supporting documents to CARBS-ResearchEthics@cardiff.ac.uk**

**Your electronic submission should contain wet-ink or electronic signatures of all relevant parties. Please note that if any information is missing, the application may be returned to you.**

# Research and Innovation Services

*This is to certify that*

## Tarig Eddrgash

*has successfully completed*

19/20 Research Integrity Training (Student)

*on*

14 October 2019

**Correlations**

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Appendix (K)

Appendix (L)

| Rotated Component Matrix[a] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Component | | | | | | | | |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| X2.1 | | | | | .747 | | | | |
| X2.2 | | | | | .656 | | | .339 | |
| X2.3 | | | .342 | | .681 | | | | |
| X2.4 | | | | | .604 | | | | |
| X2.5 | | | .403 | | .440 | | .416 | | |
| X2.6 | | | .554 | | .344 | | | | |
| X2.7 | | | .511 | | .368 | | | | .309 |
| X3.1 | | | | | .324 | | | .493 | |
| X3.2 | | | | .304 | | .698 | | | |
| X3.3 | | | | | | .689 | | | |
| X3.4 | | | .372 | | | .611 | | | |
| X3.5 | | | .577 | | | | | .319 | |
| X3.6 | | | .748 | | | | | | |
| X3.7 | | | .333 | | | | | .661 | |
| X3.8 | | | .454 | | | | | .534 | |
| X4.1 | .647 | | | | | | | .443 | |
| X4.2 | .640 | | | | | .391 | | | |
| X4.3 | .546 | | | | | | | .367 | |
| X4.4 | | | .665 | .322 | | | | | |
| X4.5 | .628 | | | .374 | | | | | |
| X4.6 | | | .368 | .384 | | | | | |
| X4.7 | .480 | | | | | .339 | .316 | | |
| X4.8 | .485 | .311 | | | | .475 | .311 | | |
| X4.9 | .606 | | | | | | | .405 | |
| X4.10 | .611 | | .324 | | | | | | |
| X4.11 | .633 | | | | | | .382 | | |
| X4.12 | .445 | .558 | | | | | | | |
| X4.13 | | | | | | | | | .753 |
| X4.14 | .333 | .494 | | | | | | | .351 |
| X4.15 | | .715 | | | | | | | |
| X4.16 | | | | | | .349 | | | .554 |
| X4.17 | | .664 | | | | | | | .360 |
| X4.18 | | .709 | | | | | | | |
| X4.19 | | .502 | | .348 | | | | | |
| X4.20 | | .488 | | .378 | | | | .428 | |
| X4.21 | | .515 | | | | | | .482 | |
| X4.22 | .470 | .466 | | | | | | | .419 |
| X5.1 | | | | .423 | | | .612 | | |
| X5.2 | | | | | | | .816 | | |
| X5.3 | | | .331 | | | | .748 | | |
| X6.1 | | | | .649 | | | | | |
| X6.2 | | | .316 | .764 | | | | | |
| X6.3 | | | | .693 | | | | | |
| X6.4 | | | | .576 | | .311 | | | .411 |

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.[a]
a. Rotation converged in 32 iterations.