Gordon Institute of Business Science
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Addressing the innovation lag of port congestion in Durban, South Africa

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Abstract

One of the key indicators of port performance lies in port's efficiency in minimising port congestion. However, the port of Durban like many other ports in Africa and the world is faced with a congestion challenge. This study aimed to identify the causes of congestion and proffer a solution to alleviate congestion. By understanding the causes of congestion, adopting incremental solutions can achieve the desired outcome.

A qualitative, exploratory research study was conducted with 14 participants from the maritime sector that have experienced port congestion. Data analysis was done through thematic analysis where all data collected was transcribed and the researcher observed and articulated emerging themes to attach meaning to the respondents' interpretations and perceptions of their own lived reality on what causes port congestion in Durban and possible solutions thereof.

The key findings confirmed that Wind, Labour issues and Equipment are the main causes of congestion in the Port of Durban. Further research to determine the impact of climate change on congestion is needed. The incremental and radical solutions proffered by the participants was compared to the causes of congestion.

This study contributes to the field of maritime studies, by understanding the causes of congestion in the Port and the field of innovation studies by contributing to innovative theory.

Keywords

Port Congestion, Smart Ports, Innovation, Weather, Port Inefficiency

Declaration

I declare that this research project is my own work. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration at the Gordon Institute of Business Science, University of Pretoria. It has not been submitted before for any degree or examination in any other University. I further declare that I have obtained the necessary authorisation and consent to carry out this research.

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Trishna Misra Date

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Acronyms

Chief Executive Officer (CEO)

Container Terminal Operations Contract (CTOC)

Council for Scientific and Industrial Research (CSIR)

Durban Container Terminal (DCT)

FTP (Fruit Terminal)

Global Value Chain (GVC)

Kilometres per Hour (kph)

Marine Container Terminal (MCT)

Roll on - Roll off (Ro-Ro)

Rubber Tyre Gantry’s (RTG)

Tractor Trailer Unit (TTU)

Transnet National Ports Authority (TNPA)

Transnet Port Terminals (TPT)

Truck Appointment System (TAS)

Twenty-Foot Equivalent Units (TEU)

Ultra Large Container Ships (ULCS)

United States of America (USA)

Very Large Container Ships (VLCS)

CHAPTER 1: INTRODUCTION TO THE RESEARCH PROBLEM

1.1. INTRODUCTION

The Port of Durban is an instrumental port in South Africa and one of the busiest ports in Africa (Naicker, 2018). Transporting cargo via the sea has become a common method of trading. However, it is overwhelmed with congestion issues from both landside operations and seaside operations. Scholars posit congestion is a phenomenon triggered by equipment breakdown, larger container vessels entering the port with more cargo, queuing of vessels and trucks, extra voyage time, time delays association to dwell of ship, aging infrastructure, and lack of maintenance. Congestion has had a negative effect on the country, with the consequences suffered by the Logistics operators as well as the supply chain. Trade agreements and transportation contracts are severely affected with the end consumers being burdened by the uncontrollably escalated costs (Gidado, 2015) and sometimes logistics companies absorbing the extra costs associated with the delays. These increased costs are coupled with the high terminal handling charges, making South African ports some of the most expensive in the world (Raballand, Refas, Beuran & Isik, 2012). The formation of a decongestion task team in late 2019 further emphasised the importance placed to ensure the port becomes an efficient port and congestion in the port's Bayhead Precinct and surrounding road networks are addressed adequately (Transnet National Ports Authority, 2020).

1.2. BACKGROUND AND CONTEXT TO THE RESEARCH PROBLEM

1.2.1. Importance of seaports in trade

Sea trade is a significant factor of globalisation, it also plays a vital role in the economic contributions of the countries partaking in sea trade, with more than eighty percent (80%) of the world's trade being seaborne (Munim & Schramm, 2018). Seaports play an

important role in the maritime supply chains connecting the main carriage (ships) and hinterland transportation (road and rail) (Lange, Schwientek & Jahn, 2017). The most important aspects of logistics performance are logistic costs and the reliability of port supply chains (Munim &Schramm, 2018). Besides the cost related to the distance to be travelled, seaport efficiency adds to the maritime costs of transportation (Clark, Dollar, & Micco, 2004). In particular, the impact of a port's performance and infrastructure play a vital role in a country's economy (Munim &Schramm, 2018). In this regard, scholars posit that it is paramount that developing countries invest in the infrastructural upgrading and innovate the way ports are managed to make logistics more efficient as this will lead to an increase in trade via sea and economic growth. Over the years, global demand for goods has continued to increase, therefore global supply chains are continuously transporting more containers worldwide with containerised cargo estimated to have increased by 8% in 2019 (Molavi, Lim & Race, 2020, p.8).

Global trade has also grown tremendously over the course of the centuries. However, global trade is heavily reliant on good and efficient logistics performance, as it requires connectivity via roads, rail, and sea and an inefficient or inadequate transportation system can have a negative and adverse impact on a country's trading abilities (Fink, 2002). South Africa relies on receiving cargo via sea as well as on road transportation for ensuring that the goods reach the rest of the population. Ports play an important part in improving value chain of a country especially in the current trend of globalisation and integrated economies (Hoa & Haasis, 2017). Ports play a significant role in the entire value chain as they are the transport node that connects the sender and receiver of goods (Hoa & Haasis, 2017). In this regard, ports play a key role by building, nurturing, and maintaining mutually beneficial relationships and collaboration with traditional partners such as the shipping companies, terminal operators, forwarding companies, warehouse operator and so on (Hoa & Haasis, 2017).

1.2.2. Port authority and management in South Africa

Ports, railways, pipelines, and related infrastructure are run and operated by the South African state-owned enterprise, Transnet (Dyer, 2014). Meanwhile, the South African government is the sole shareholder in Transnet. However, Transnet is financially and

operationally autonomous and is responsible for carrying out South African port developments that includes Durban (Dyer, 2014). Transnet runs all eight (8) ports in South Africa (Meyiwa & Chasomeris, 2020, p.179) via the Transnet Port Terminals (TPT) that is a division of the Transnet State Owned Company Limited (Patel, 2015). The Port of Durban stretches over 1,850 hectares with a 21 kilometres shore (Rodrigue, Cooper & Merk, 2014, p.35). This leaves limited options for future expansion outside substantially modifying the physical and environmental setting of the harbour. Transnet has embarked on utilising a property owner model, which means that Transnet National Ports Authority (TNPA) owns the land. Transnet leases large pieces of land to the private sector, which consists of shipbuilding, ship repair companies, cargo terminals, cruise terminals, and other companies that might not be related to the maritime sector, adding to the congestion on the roads leading to the Port and utilising space that can be utilised for Port expansion. Meyiwa & Chasomeris (2020) research indicated that the proceeds from TNPA operations subsidise other divisions of Transnet and are not always reinvested into the ports.

1.2.3. Capacity and economic importance of the port of Durban

Durban is a South African maritime city with approximately 3.1 million people (Statista, 2020) on the East Coast of Africa (Dyer, 2014). The port of Durban holds more than 70% of containerised trading in South African ports with approximately 4000 vessels calling at the port per year (Dyer, 2014, p.1). Indeed, the port of Durban ranks among the busiest ports in Africa, handling over 74 million tons of cargo annually (Patel, 2015). The port of Durban serves as a gateway between Far East trade, South-South trade, Europe, and the USA, and East and West Africa regional trade (Patel, 2015, p. 1). The Port of Durban operates as two terminals, Pier 1 and Pier 2 that have a total capacity of 3.6 million TEU (Twenty-foot Equivalent Units) each year (Patel, 2015, p. 1).

The Durban port is a significant part of South African economy and its potential inefficiencies have significant implications for jobs and the economy of Durban and South Africa (Dyer, 2014). The future of the continued relevance and commercial value of the Durban port is under threat from inefficiencies and a lag in meeting the port user requirements of the modern day such as the failure to accommodate new generation

bigger vessels and high costs for port users (Dyer, 2014). For example, the Durban annual container handing charges for a Supermax vessel of US$250,000 is too high in comparison with international competitor averages of US$150,332 whereas the Panamax vessel is charged US$275,000 in Durban compared to a world average of US$62,415 (Dyer, 2014, p.1). In this regard, lowering port costs for users is necessary if Durban were to maximise potential benefits from the port.

The Port of Durban is faced with other the ever-increasing threat of African rivals who are embarking on substantial port expansion projects, including Southern Hemisphere competitors such as Rio de Janeiro, Melbourne, and Sydney (Dyer, 2014). In particular, the ports such as Walvis Bay, Maputo, Luanda, Dares-Salaam and Mombasa pose a threat of trade diversion from Durban to themselves (Dyer, 2014). Therefore, an efficient port will ensure that the port remains competitive and attract vessels calling on the port rather than moving to other ports that can accommodate the capacity and ensure reliability within Africa. Goddard (2021) reported that Mohammed Akoojee, Chief Executive Officer (CEO) of Imperial Logistics, stated that Kenya, Tanzania, and Mozambique are the alternative port into the landlocked countries like Botswana, Zambia, and Zimbabwe, with more operators opting for this option and Durban losing its market share, as logistically it is becoming cheaper to use these ports.

1.2.4. The challenge of congestion at the port of Durban

As a general fact, congestion in African ports often sees cargo waiting in ports for a period of about 20 days on average (Chinedum, 2018). By way of example, container ship sizes have grown considerably and have led to landside container handling peaking along with high road traffic and sometimes resulting in congested ports (Lange, Schwientek & Jahn, 2017). Here in South Africa, the inefficiency caused by port congestion is cause for national concern, a fact that was highlighted at the State of the Nation Address (SONA) in February 2020 when the State President Cyril Ramaphosa confirmed what the logistics industry has been telling our government for years, that “our ports are congested and inefficient” (Pike, Nichols & Wheeler ,2020). It has been stated that for the freight industry, this was the most significant sentence to be uttered at that year’s SONA. Subsequently, the president confirmed and committed to a fundamental

overhaul of the Durban Port that the government would undertake during 2020 and beyond. In particular, (Pike, Nichols & Wheeler, 2020) argue that by virtue of the Durban port being the third largest container terminal in the Southern Hemisphere, its improvement is crucial in reducing delays and costs passed to the consumer.

The Port of Durban imposes a surcharge of US$500 for delays in clearing containers that are handled by the shipping operators (Hutson, 2019). Captain Salvatore Sarno (Mediterranean Shipping Company (MSC) Chairperson) confirmed in an interview, “our ships cost us US$30,000 a day just to operate; imagine the cost when they remain idle at anchor outside port for a week?” (Hutson, 2019). Captain Sarno stated that MSC lost approximately US$10 million over a 6-month period because of port delays and congestion. Port congestion has a knock-on effect to the entire value chain, with the customer ultimately “fitting the bill” for the delays (Hutson, 2019).

1.3. RESEARCH PROBLEM

Palea Phili (CEO) for the Durban Chamber of Commerce and Industry has stated on several occasions , her concern about port congestion . She stated in an interview with the Mercury that the Durban Chamber of Commerce understands the frustration experienced by the private sector because of downtime , delays and port inefficiencies and is profusely aware of the negative impacts that this is having nationally on the economy as well as the entire global value chain (Rall, 2019).The entire global supply chain (Trucking companies, Logistics operators, Stevedoring companies, Shipping Lines and so on) have complained for a long time about the cost of doing business with the port . The impact of port congestion extends beyond paying port dues and costly services by Transnet, it affects companies who are now having to pay overtime to staff (truck drivers), drivers waiting hours to pick a container without access basic amenities like food, sanitary or resting facilities, deterioration of the road infrastructure, surrounding businesses affected because of the congested road, losses incurred by store owners as a result of late delivery(Rall, 2019).The items listed are only a few of the problems experienced as a result of a congested port.

The Logistics Performance Indicator (LPI), which is a benchmarking tool for trade logistics comparison, placed South African ports at number thirty-three (33) in 2018 compared to when assessed in 2016, when South African Ports was ranked twentieth (20^{th}) from 160 countries (The World Bank, n.d). Dyer (2014) describes port performance as being a combination of port productivity, efficiency, equity, cost, and competitiveness that assess the ports capabilities (Dyer, 2014). The slide in rankings is a concern for South African ports in general and the Port of Durban because of rising competition from African ports who pose a threat of trade diversion from Durban to themselves (Dyer, 2014).

One of the key indicators of port performance lies in a port's efficiency in minimising port congestion. However, the Port of Durban like many other ports in Africa and the world is faced with a congestion challenge (Pike, 2020). As a way of trying to reduce port congestion, Transnet invested US$ 700 million in the year 2002, with a focus on infrastructure, creating capacity and improving equipment (Chinedum, 2018, p.74). In 2012 the planned capital expenditure for Transnet was expected to be R300 billion for the ten (10) year period, however only R87 billion was allocated to ports (Meyiwa & Chasomeris, 2020, p.179). Meyiwa & Chasomeris (2020) stated that the funding was going to come from international investors and the questionable revenue recovery methods applied by Transnet to its stakeholders that are not in accordance with international benchmarking of revenue practices applied by other ports internationally. Transnet National Ports Authority (TNPA) and Transnet Ports Terminals (TPT) have announced on numerous occasions their commitment to economic growth. Meyiwa & Chasomeris (2020) research indicated that despite Transnet's objective of reducing the "cost of doing business in South Africa" through a reduction of logistic costs, it is challenged by the investment strategy applied by TNPA. Despite this commitment, the Durban port is faced with port delays and vehicles are forced to queue for long hours leading to a gridlock along the central Bayhead area, the port's main access road (Kinyua, 2020).

1.3.1. Theoretical need for the study

Lange, et al. (2017), point out that most of the past literature on port congestion in general and truck congestion focused on one stakeholder which has led to limited assessments of the entire port congestion. For example, most research on port congestion solely focused on container terminals (Lange, et al., 2017). On the other hand, the scant research conducted on port congestion solely focused on truck companies or congestion with a few exceptions of research papers that sought to understand port congestion by studying truck companies as well as container terminals (Lange, et al., 2017). Indeed, Lange, et al. (2017), points out that while past research admittedly points out that studying port congestion in that manner is insufficient to fully understand port congestion and methods to reduce such congestion, no research has been executed to fill that gap. By the same token Liu (2010), concurs with Lange, et al., (2017) ; Huynh, Smith, & Harder (2016); Seo, Dinwoodie & Roe (2016) & Pike et al., (2020), by mentioning that literature show that most studies carried out studied containers ports and terminals separately. All the above-cited authors concur that there is need for research that will bring an understanding of the collaboration that all the participating actors need to streamline and integrate their respective operations, allowing us to understand what synergies should exist for better management of port congestion from both the land and seaside perspectives.

Potgieter, Maasdorp, Moodley & Sessions (2015), have stated that the growth of imports and exports of cargo, local industries as well as freight transport are the cause for the increased pressure on port, road, and rail services. Ports are the main actors in the maritime transport and logistics value chain. To meet the requirements for the changing environment, ports need to concentrate on technological and service innovation (ŞAKAR, & SÜRÜCÜ, 2018). Innovation within port structures have become more important as ports battle with limited land availability.

The problem is that the actual causes for congestion in the Port of Durban in both land and sea have not been researched with conclusive evidence to identify the main determinants. Through research and benchmarking other successful ports and their adaption to alleviating congestion, the application of incremental and radical innovation

becomes applicable as ports reinvent the way they operate. Why congestion in ports might have remained such a challenge in many contexts, it is believed that the solution to the problem will allow the Port of Durban to compete successfully as a major contributor to the Global Value Chain (GVC). Problem driven innovation with incremental and radical solutions assist in ensuring competitiveness within the value chain (Coccia, 2017).

The research explores factors that are beyond the obvious explanations provided by scholars. The aim of the research is to (a) exploring this against other causes but also (b) interrogating any innovation features around this and other factors. The innovation lens is important in the broader economic development contexts and it has been implicated in thinking around port developments in many contexts.

Further to this, the research aims to utilising stakeholder engagements via the interviews, to identify potential solutions that could assist in understanding and alleviating the innovation lag. Aakhus, & Bzdak, (2015), argues that the shift to value creating networks which centralises the main problem shared by the actors or stakeholders, will allow these stakeholders to create value by jointly solving the problem at hand. Gidado (2015), further argues that each port should adopt “solution mechanisms” when addressing uniquely provoking congestion practices. It is thus hoped that this research will contribute to theory on incremental and radical solutions to mitigating port congestion by proposing solutions that are unique and specific to Durban.

1.3.2. Business and economic need for the study

The Port of Durban is considered a good benchmark for Sub Saharan African ports due to its sheer size, the huge amount of cargo it handles and its key location (Kgare, Raballand & Ittmann, 2011). For instance, the Port of Durban handles container, break-bulk and bulk cargo for the local and inland areas of South Africa and beyond (Potgieter, et al., 2015). It is also important to note that the Maritime Industry in Durban contributes approximately 1.5% to 2.0% of the national Gross Domestic Product (GDP), between R25 billion and R35 billion, making it one of the most important ports in South Africa (Durban, n.d.). Dyer (2014) also shows the importance of the port of Durban when he

states that high volumes of container trade contribute significant economic activity and development to the greater Durban. Moreover, the port has other economic opportunities such as the existing shipyards which contribute over R300 million annually and hundreds of jobs to the local economy, tourism through port tours, yachting, heritage operation to name a few; industrial benefits such as heavy marine related industry and beneficiation (Dyer, 2014). Rosario (2020) reasons that since South Africa has a coastline, covering nearly 30 000 kilometres, professionally managed ports have the potential to create direct jobs and indirect jobs in the various sectors that depend on the port's efficiency on handling cargo.

Freight and Logistics operators have voiced their opinions in various news reports indicating that South Africa is losing cargo to Kenya, Mozambique, and Tanzania, where port development has been taking place on a large scale, similar point raised by Dyer(2014). The development of these ports opens increased competition for South Africa and consequently affecting planned economic growth that Transnet has indicated it is aligned to. By understanding the causes of congestion and how the port can address these challenges, will enable it to recover from the status of a less efficient port compared to other global ports, thereby retrieving the lost market share that South Africa once enjoyed.

1.4. RESEARCH OBJECTIVES

This research focusses on the port of Durban's current constraints that are causing congestion and has three research objectives listed below. In this regard, the research will seek to understand the causes of port congestion in Durban from both the landside and seaside perspectives. This research will also seek to proffer solutions that are needed to mitigate port congestion. In this regard, the following are the research objectives:

1. To understand the causes of port congestion from a land and sea perspective in the Port of Durban.

2. To determine current innovation and other methods adopted by successful ports in addressing port congestion and their applicability to the Port of Durban.
3. To proffer solutions or innovations to the congestion challenges faced at the port of Durban.

1.5. SCOPE OF THE RESEARACH

This research aims to get expert and highly technical responses from people deemed to have intricate knowledge on port operations. For this reason, this research uses purposive sampling to gain a deeper insight on the causes of port congestion in Durban and proffer possible methods that can be used to reduce port congestion. For example, respondents from shipping lines were selected to understand seaside port congestion while freight and cargo operators aided in understanding port congestion from a landside perspective and input into seaside effects of congestion and port experts from Transnet were also part of the research respondents.

1.6. CONCLUSION

Chapter One introduced the research problem and a background to the research problem to bring context to the research problem. The chapter also presented the research objectives. The chapter also highlighted the significance of this research both in the contribution to existing literature and practice in so far as fully understanding the causes of port congestion. Finally, the chapter clarified the scope of this research and reasons thereof. Chapter Two is the literature review that focuses on understanding the causes of congestion and possible solutions applied by various ports globally. This is followed by Chapter Three which consists of the research questions developed from the literature review that was conducted in Chapter Two. Chapter Four is about the research methodology applied and the approach undertaken in terms of data collection. Chapter Five involves analysing the research questions and the participants' responses. The analysis of the results is then scrutinised against the literature review in Chapter Two and further research, a discussion of the results is undertaken in Chapter Six. Finally,

Chapter Seven states the future research that needs to be undertaken as well as a summary of the research objectives and findings.

CHAPTER 2: LITERATURE REVIEW

2.1. INTRODUCTION

Globalisation and free trade have increased the flow of goods between countries. China is leading the way in terms of free trade, taking advantage of the benefits from opening markets and trade liberalisation. It has come at a consequence; ports face congestion issues that add to the cost of doing business in a particular area (Haralambides, 2017). This paper focuses on identifying the causes of congestion in the Port of Durban and the incremental and radical innovative strategies that can assist to alleviate the current congested ports. Literature from a wide array of sources was identified to add insight into the causes of port congestion(2.3) and the possible solutions(2.5, 2.6, 2.7, 2.8) to meet the research objectives of addressing the innovation lag concerning port congestion. The first stage is to add context to the problem by understanding the Port of Durban (Location , Infrastructure and Equipment utilised)as discussed in 2.2 .The literature review was divided into categories under key themes in the literature as illustrated in Figure1 below.

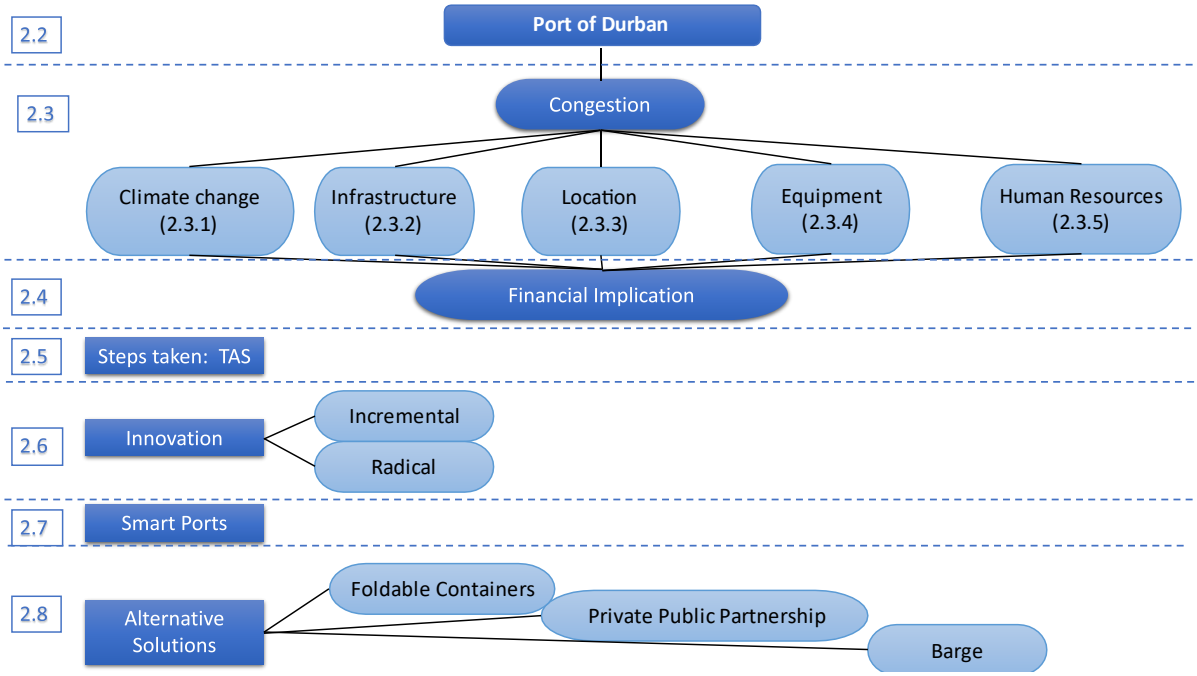

Figure 1: Chapter Breakdown

2.2. DURBAN PORT CONTEXT AND ITS FEATURES

The Port of Durban rests on 1,850 hectares of land, limiting the expansion capacity of the port. People and companies directly and indirectly involved in the maritime sector, as tenants of Transnet, share the port. Future expansion of the port is limited and can only be considered in another area outside the current port structure (Naicker, 2018). To comprehend why the port is congested, an understanding of port facilities as well as the equipment that is used, is necessary. This section aims at drawing a picture in the mind of the reader of the current facilities and equipment, to understand how congestion affects the various parts of the port.

The Port of Durban consists of 58 berths and 300 km of rail tracks operated by Transnet (Rodrigue, et al., 2014). The Port of Durban has five main terminal facilities. Figure 2 below, shows these facilities with the Point being utilised as a multipurpose break-bulk terminal and Roll on - Roll off (Ro-Ro) facility that manages the vehicle trade (Rodrigue, et al., 2014). There is also a cruise terminal with a dedicated cruise facility which has had a recent uplift. The Maydon Wharf facility is also a multipurpose bulk facility, handling break-bulk, dry bulk and liquid bulk, tenants of TNPA occupy the spaces around this area either as freight forwarding companies, logistics companies and so on (Rodrigue, et al., 2014). The Durban Container Terminals (DCT) consists of Piers 1 (capacity is constrained to 2.7 million TEU's) with berths 101-107 and Pier 2 (capacity is constrained to 700 000 TEU's) with berths 108-205 (Rodrigue, et al., 2014). Although TPT is part of Transnet, the land is leased by the one division (TPT) from the other division being TNPA. The Island View prescient consists of liquid bulk terminals for petroleum products and the Bluff Prescient handles the Dry bulk mainly coal and manganese (Rodrigue, et al., 2014). The Shipbuilding and Ship Repair facilities are on Bayhead Road, surrounded by tenants of Transnet that are directly or indirectly related to port operations or the maritime sector. TPT manages the port operations except for the liquid bulk and the fruit terminal; however, the TNPA controls the port (Patel, 2015).

Figure 2: Arial view of Port of Durban (Rodrigue, Cooper & Merk, 2014, p.35)

With respect to equipment, Naicker (2018) describes the process of embarking or disembarking of containers through a Ship to Shore gantry crane. The crane places the container from the ship onto a Tractor Trailer Unit (TTU) that then transfers the container to the storage area where the Rubber Tyre Gantry (RTG) crane then removes and stacks the containers (Naicker, 2018). A RTG is a mobile gantry crane used for stacking and placing of containers in intermodal operations (Naicker, 2018). Pier 1 has adopted a TTU and RTG combination, Pier 2 operates largely with Straddle carriers uplifting at ships side and transporting to and from stack (Naicker, 2018).

2.3. PROBLEMS OF CONGESTION

Invest SA (2020) describes South Africa as a hub for maritime operations in the “South-South trade corridor from Asia to the East Coast of South America, and for the connector routes along the East and West coasts of Africa”. However, one of Africa’s busiest ports is in Durban, South Africa and like its counterparts, it too is congested. For example, Potgieter, et al. (2015), stated that the growth of imports and exports of cargo, local industries such as freight transporters are the cause for the increased pressure on port, road, and rail services. Operations of the port are negatively impacted, as vessels’ turnaround times are affected by the amount of time spent at ports. Transnet’s National

Ports Authority's financial report for 2019 indicated that the ship turnaround time for "DCT failed to achieve its targets at both Pier 1 and Pier 2, with Pier 1 achieving 62 hours against target of 55 hours and Pier 2 achieving 72 hours against a target of 53 hours" in comparison Ngqura which achieved a 29-hour turnaround time and Cape Town Container Terminal (CTCT) of 31 hours (Transnet National Ports Authority, 2019). Reasons behind port congestion are predominantly due to poor infrastructure, the amount of time it takes for cargo to be hauled from vessels leads to traffic at the port docks as trucks wait for cargo (Chinedum, 2018). Such port inefficiencies are a major obstacle to port productivity and performance.

Port efficiency is defined as the comparative performance against other ports in terms of activity and efficiency (Liu, 2010). In this way, performance combines indicators of port productivity, efficiency, equity, cost, and competitiveness to assess the port capabilities (Dyer, 2014). Meanwhile, port productivity is described as the ratio of output relative to input, or maximisation of returns from an initial injection for quantity or contribution in a port environment (Dyer, 2014).

Port inefficiencies almost always cause port congestion in the form of longer dwell time of ships and cargo at the ports, ship berth and work congestion, vehicle work and gate congestion, cargo stack (Gidado, 2015), queuing, extra time of voyage (Chinedum, 2018). With Clark, Dollar, & Micco (2004) adding infrastructure, organised crime, excessive port regulation that hinder outcome are also causes of port inefficiency. This has negative repercussions on the logistics and supply chain, which often means additional handling costs (Clark, et al ,2004), loss and disruption of trade and transport agreements (Gidado, 2015). In summary, this relates to the fundamental problems experienced by the world in terms of congestion in the ports.

Gidado (2015) states that there are several factors affecting port efficiency. For instance, African ports should enhance planning, regulation, capacity, invest in basic infrastructure, modern equipment, efficiency, or a combination of these (Gidado, 2015). By way of example, Gidado (2015) listed the following general types and causal factors of port congestion in Africa observed at the port of Durban, South Africa; Port of Mombasa, Kenya; Port of Doula, Cameroon; Port of Lagos, Nigeria and the Port Said,

Egypt. The port congestion types in the observed African ports include ship berth congestion, mainly caused by ships waiting on the port entry routes often as a result of congested landside operations or weather conditions; Ship work congestion, mainly caused by the loading and/or unloading of the ship; vehicle gate congestion, mainly caused by poor systems and processes of inland access to the port via trucks that for South African have scheduled arrivals at the port gate; vehicle work congestion, mainly resulting from loading or unloading of trucks; cargo stack congestion, caused by a longer stay of cargo at the storage area beyond the reasonable timeframe and ship entry/exit route congestion, which arises when there is blockage on the marine side access routes to the port facility (Gidado, 2015), often experienced in the port of Durban .

On the other hand, other causative factors of congestion in African ports include accidents that could damage port equipment; industrial action; sudden rise or peak in trade demand; rise in global trade; landside transport congestion that could delay the evacuation and delivery of cargo in and out of the port; delays caused by cumbersome registration, licensing and documentation; congestion of cargo at storage yards and sheds due to bad weather that halts ships or cargo operations (Gidado, 2015). Rosario (2020), concurred with weather conditions affecting the port of Durban by elaborating that on average five (5) days a month are affected by weather conditions in the Port of Durban, further stating that productivity and equipment breakdown have added to congestion in the port.

On the other hand, Raballand et al. (2012), states that the cargo dwell time in Sub-Saharan African ports takes about two (2) weeks on average, compared to larger ports in Asia, Europe, and Latin America, which take less than a week. Dwell time refers to how quickly cargo is flowing through the system (Chinedum, 2018). Meanwhile, longer dwell times have delayed the progress into a competitive global value chain (GVC) and trade network, which requires leaner processes and efficient cost structure (Raballand et al., 2012). Dwell time is an indicator of port's efficiency, the longer the dwell time the more adverse the effects on the country's economic growth, with goods reaching consumers later than the expected time (Chinedum, 2018).

It is worth noting that concerning this, cargo dwell time in Durban improved because of prohibitive charges for storage after the first three days which are allowable for free storage (Gidado, 2015). However, the result of such a measure is that storage charges at the port of Durban are almost six times higher than other ports (Gidado, 2015). Arguably, this has a potential of placing the port of Durban at an uncompetitive position against other ports in South Africa and Africa in general. It can also be argued that although placing prohibitive charges for storage after day three has somewhat eased cargo dwell time at the port of Durban, the lingering question(s) is why the port still faces port congestion.

Gidado (2015) states that the Port of Durban and Port Said in Egypt are the least congested ports in Africa, attributing that mainly to the regulation of cargo dwell time, the timeframe within which transactions are concluded at ports and the punitive charges levied against those who do not stick to the prescribed timeframe. Despite this, the Durban port still faces congestion challenges (Pike et al., 2020) and in fact, the Durban port is under threat of trade diversion from other ports within South Africa and Africa (Dyer, 2014). To get back to the point, Gidado (2015) recommends that punitive regulations should be adopted to force shippers to take delivery in good time. In agreement, (Guan, 2009) also suggest that to mitigate gate congestion at a port, financial penalty should be placed on the port user. As much as this is one of the many solutions that can be adopted to ease port congestion, it can be argued that it is a narrow view of looking at this as a solution to the complex and multifaceted issue of port congestion. Admittedly, Gidado (2015) agrees that each port should adopt solution mechanisms for tackling unique congestion inducing practices. Interestingly, Gidado (2015) seem to concur with this writer when he writes that, most solutions offered by scholars on effects of port congestion seem to follow the pattern of solutions relating to addressing port pricing problems. In fact, Gidado (2015) went as far as stating that to a larger extent issues surrounding seaport congestions are what the port wish they had but cannot achieve.

In a slightly different vein, Gidado (2015) states that port congestion in Africa is caused by either capacity constraints or procedural delays resulting from weak planning and regulation. This assertion is arguably inadequate to fully explain the causes of port

congestion as the author does not categorically state what ‘capacity constraints’ entail in this regard. Accordingly, this research aims to understand the specific causes of port congestion and proposition possible solutions to that effect that are specific to the port of Durban. The literature review undertaken explored equipment, infrastructure, location of the port of Durban, the effect of climate change and labour employed at the port.

2.3.1. Climate Change

Gidado (2015) cited changing weather conditions to be a cause of congestion, however the scholar did not elaborate on the extent of delays and congestion experienced as a result of weather conditions. Very little litereature exists on weather conditions and the impact on the port. However, Rosario (2020) stated that the Durban Container Terminal (DCT) in the years 2016/2017, 2017/2018 and 2018/2019 handled 1 294 949 units, 1 304 891 units and 1 286 491 units respectively, an average of 1,3 million units per annum. Meanwhile the number of working days at the DCT are 360 days, considering that there is terminal closure for three days on Christmas, New Year’s Day, and Workers Day (Rosario, 2020). On the waterside, when one makes hypothetical allowance for disruption in cargo operations due to bad weather at an extreme five (5) days a month, the actual number of working days can be concluded to be 300 days per annum as ship to shore gantries cut off at wind speeds exceeding 70kph (Rosario, 2020). However, the annual working days for the landside operations of the DCT may be expected to be 360 days because it remains operational as the straddle are not affected by bad weather, therefore trucks continue to load and offload, regardless (Rosario, 2020).

Mather and Stretch (2012), through the study of sea level rise and coastal storms in Durban, found that if a small rise in sea levels is expected the Durban Harbour would be able to tolerate the increase however a 1m increase will be the start to the problems that the harbour will experience as this will result in the “wave overtopping of the entrance breakwaters”, leading to infrastructure and equipment loss and extra maintenance. In 2014, the Environmental and Climate Protection Department within the eThekwini Municipality reported that there would be an expected increase in rainfall of approximately 500mm between the year 2065 and 2100 (eThekwini Municipality, n.d.).

Sea levels are expected to rise above the current rate of 2.7 (+/- 0.05) mm/year. Durban faces an increased number of risks because of climate change (eThekwini Municipality, n.d.). Rising Sea levels, high wind speeds and increased coastal storms, will affect the operations of the port (eThekwini Municipality, n.d.)

Potgieter, Goedhals-Gerber & Havenga (2020), explain that in the event of windy conditions in Cape Town Ports, the ports are equipped with devices on all the heavy-duty equipment called an anemometer. This device measures the wind direction and speed. Sending a signal to the operator, at wind speed of 80kph to 100kph, of the impeding danger. The device sends a signal to the crane system to shut down the equipment should operations continue. Vibration plates are installed on the gantry and cranes, which signal unsafe working conditions. Although this is vital safety measure, it is also a contributor to port congestion (Potgieter, et al., 2020). Transnet (2019) provided insight into the Transnet's container terminal operations by stating that Cape Town experienced erratic wind conditions from 65kph to 100kph with the terminal stopping operations at 80kph (Transnet, 2019). The equipment operating limits during wind conditions are Ship to Shore cranes at 80kph and Rubber Tyre Gantry at 72kph -Slow down; 80kph for Cut out (Transnet, 2019). The strategy applied by Cape Town is a wind strategy that focuses on quick recovery with gangs operating on night shift and a diversion of vessels as well (Transnet, 2019).

Becker, Acciaro, Asariotis,Cabrera, Cretegny, Crist, & Velegrakis (2013), highlighted the various ports adoption of climate change strategies. The Rotterdam Climate Proof Programme aims to have the port resilient to climate change by 2025, the study focused on new port developments and reconstruction that are climate proof (Becker et al., 2013). The Port of San Diego (California) has the Climate Mitigation and Adaptation Plan which includes all stakeholders that are involved directly or indirectly to the maritime sector (Becker et al., 2013).

Mather and Roberts (2015) stated that Durban is a coastline that is vulnerable to climate change because of poor planning, design and layout and climate variability. Rail (2015) preluded that high winds affect bulk gantry and container crane operations thus creating a need to develop robust designs for the quay gantry cranes that can tolerate wind speed

that have usually caused port closure. Rail (2015) further stated that planning and maintenance of the equipment is essential to reduce further delays, especially after closure of port operations. Becker, Inoue, Fischer, & Schwegler (2012), further elaborated that planning for climate change will require ports to reconsider an array of paradigms, which include designing infrastructure that could withstand the elements of climate change beyond the average port administrator's career.

The Durban Climate Action Plan 2019 refers to the Development of an inland intermodal hub, which will allow for approximately 30% of the cargo transported on road to shift to rail (eThekwini Munipality n.d.). The plan takes into consideration the action required to improve cost efficiencies in terms of haulage and action steps required to maximise carbon efficiency in the port but does not consider climate change impacts in and around the port of Durban. The International Finance Corporation and the Port of Muelles (Cartagena, Colombia), particularised a comprehensive climate change study of the port and considering the financial, environmental implications and social aspects in and around the port that are affected due to the changing climate (el Bosque,2011). The study also elaborates on the port assets operations because of climate change and the implication on trade climate (el Bosque, 2011). Transnet's Climate change responses reports identifies the physical risks as the rising sea level impact on port infrastructure. It furthers states that unexpected sea level rise will be dependent on low carbon endeavours. The identified action plan aims at understanding the risk and exposure of the business to climate change and building resilience around it (Transnet, 2020).

The Integrated Development Plan (IDP) report includes the climate change impact on eThekwini by 2030 eThekwini Munipality(2019). The increased temperatures and the extreme weather events, sea level rise and climate variability are included in the report as an impact of climate change. The SWOT analysis for spatial and environment operational responses to climate change and sea level rise are identified as weaknesses and key challenges facing eThekwini eThekwini Munipality(2019)

The Port of Dover closely monitors weather conditions and predications daily. Weather sensitive assets are secured timeously with a post storm inspection done immediately (Port of Dover, 2015). The port employs proactive measures through maintenance plan

that reduces the risk of delays (Port of Dover, 2015). Mbonambi (2018) describes the weather conditions experienced by Durban as summer being the season with a lot of rain especially in the afternoon and sometimes evening thunderstorms which are intense. The scholar describes the winters as mild to warm with an average temperature of 20 degrees. The windy conditions are usually experienced in August until January (Mbonambi, 2018). The effects of climate change can have a minimum effect if the correct equipment, infrastructure, and the way people utilise their skills to manage the risks associated to changing weather conditions.

2.3.2. Infrastructure (Rail and Port Expansion)

Humphrey, Stokenberga, Herrera Dappe, Hartmann, & Iimi (2019), described the transport revolution as being tied to colonial settlement combined with the exploitation of the region's economic resources. The transport reform for Durban was in 1904, which connected ports and rail system to back crop farming and mining production that were increasing regionally (Humphreys, et al., 2019). Although the port has increased its port capacity with various upgrades, it has however seen a shift from rail to road with the road infrastructure being damaged (Muchunu, 2021), increasing congestion of the roadways to and from all ports.

Humphrey, et al. (2019), researched various ports In Africa, their findings include the World Bank placing Durban in the 70th positions, respectively, for container operations in a sample of 110 ports of similar size and scope. This is not a global ranking system and if considered in terms of all ports urban will rank as one of the most inefficient ports of the world (Humphreys, et al., 2019). The investigation revealed that one factors affecting efficiency include the existence of an effective rail connection to the port (Humphreys, et al., 2019). Delays associated to poor rail infrastructure have been echoed by Andrew Pike, also stating that the underutilisation of rail in the transportation of cargo, which is partly due to problems in the integrated logistics, that feeds into the ports (Hancock, 2020). Consequently, the good road infrastructure in South Africa is crumbling under the weight of trucks and leading to massive road congestions (Hancock, 2020). In a like manner, Guan (2009), noted that an increase in cargo volume, with an

increase in the use of rail for the distribution of container distribution in the USA resulting in efficient ports. In this way, increased use of rail can have a positive effect on terminal performance.

Dyer (2014), points out that most past research done on port inefficiencies and congestion have focused on the benefits of port expansion. Dyer (2014), sought to address the seldom talked about huge costs of port expansion which is often associated with under or overcapacity costs (Dyer, 2014). Indeed, this is an important discussion when one looks at port expansion as one of the possible solutions that can be used to decongest ports albeit at a huge financial cost. However, this research sought to understand the causes of port congestion from the various key port players and ascertain whether port congestion at Durban is a result of capacity, technical, human resource, port management or any other reason without necessarily focusing on the debate about port expansion.

Dyer (2014), argues that the alternative to expanding the Port of Durban and ports in general is to improve current efficiency, as this is a more cost-effective substitute. For one thing, several port projects from New York to Ngqura fail to utilise their full potential (Dyer, 2014). Notably, the port of Ngqura in the Eastern Cape was an expensive project to build but it is underutilised (Dyer, 2014). This then begs the question that is the often-touted port expansion a panacea to port inefficiencies or could it be that the answer to port inefficiencies and congestion lies in port enhancing performance of existing port facilities without necessarily expanding the ports.

In this regard, Dyer (2014) advocates for an improvement in port efficiency and productivity as opposed to the expensive port expansion option. In agreement, Guan, (2009) also found that port expansion was not necessary but rather the port should focus on improving port service, mainly in human productivity. For example, Transnet committed to invest a massive R250 billion up to 2050 in port expansion expenditure needed to convert the former Durban International Airport and the Bayhead Basin railway yard sites into further dugout port extensions to reach an annual 20 million TEU's of cargo handling capacity (Dyer, 2014). Naicker (2018) research stated that for cost savings to be seen as being immediate, automation of operations is needed resulting in

a small number of operators employed. Naicker (2018) further describes automation as a meeting of information technology and engineering. Automation involves ensuring that the skills of people and their respective responsibilities are synchronised.

Besides this, rival competition for ship traffic from Walvis Bay, Mombasa and other factors restricting growth, the projected trade volumes and the number of vessels/potential throughput calling at the Durban port even sufficient to justify investment in additional port capacity (Dyer, 2014). Although the research by Dyer (2014), sheds a lot of light on the huge cost burden of port expansion and the concerns of stakeholders such as environmentalists and communities. That research mainly focused on the pros and cons of port expansion about environmental impact, financial cost and community disruptions that may be caused by port expansion in Durban and the need for stakeholder engagements in such projects (Dyer, 2014). In as much as that dimension is very crucial, it falls short of addressing the root causes of port congestion in Durban and propose possible solutions that could mitigate port congestion and possibly render port expansion unnecessary, which is the view that Dyer (2014) was championing and advocating.

Dyer (2014) recommended that future research could consider ways of improving port performance and efficiency for the benefit of various port users such as the private sector, transhipment, strategic callers, dry bulk, wet bulk, transport and ships' agency service providers and others through consulting port players. In that vein, this research attempted to understand the causes and areas of port congestion from the targeted respondents in this research who were purposively and deliberately drawn from a disparate cross section of port players.

As a way of trying to provide a solution to port congestion, (Gidado, 2015) recommends that the widths of channels leading into the ports of Durban, Lagos and Port Said should be expanded and continuously dredged to ease the entry and exit of ships. Increasing cargo storage capacity at storage yards, sheds and warehouses is another recommendation that can be used by African ports to ease port congestion (Gidado, 2015).

Although the port terminals have a significant role to play in alleviating these congestions, the bigger responsibility rests on the shoulders of all the stakeholders in the supply chain. As a start, investing in digitisation and other new and innovative technologies as well as in skilled personnel (Manaadiar, 2020) are becoming crucial for the modern ports to enable them to handle the Very Large Container Ships (VLCS) and Ultra Large Container Ships (ULCS) which have created challenges both for seaports and hinterland (Behdani, Wiegmans, Roso, & Haralambides ,2020). Ports have not kept up to date with the growing size of container ships causing capacity issues of inland modes and inland terminals (Prokopowicz, & Berg-Andreassen, 2016), thus making shipping network design essential to ensuring that congestion and sustainability issues are being dealt with (Tran, Hans-Dietrich & Buer, 2017). Ports are required to adapt to the changing sizes of vessels through innovative mechanisms like port feeder barge operations resulting in higher total costs of operations in the port with consumers ultimately bearing the cost (Tran et al., 2017).

2.3.3. Location

Hall & Jacobs (2012) argue that as a way of trying to avoid future underutilisation of ports, location of a port is important. Hall & Jacobs (2012) argue that it is futile to see seports with a single persepctive that ports are primarily strategic nodes in global trade routes and shipping networks and that the time for ports and their host cities that could develop together as integrated functional-economic spaces was over.This thinking was based on the notion that from an operational perspective alone, the development of hub-and-spoke systems demonstrated that ex-urban, strategically located transhipement ports along the main shipping lanes could be designed and rationally planned at greenfield locations away from all the constraining factors encountered in urban areas (Hall & Jacobs, 2012).

In this regard, Hall & Jacobs (2012) argue that the predictions of most containers being handled in purely transhipment ports opearating in spaces that conform only to the logic of route and network structures has proven inflated. For example, the Durban Port continues to dominate its ‘better’ located neighbour, Richards Bay. In fact, the word’s

top ports are located in highly populated urban areas. Therefore, these authors arguably sway one from the belief that ports located in highly built and populated locations such as the Durban Port are, over time, rendered inefficient due to lack of urban congestion and at times lack of physical land on which the port can be expanded on. Despite all these disadavantages and the negative externalities ports generate such as pollution, urban ports still have advantages over non-urbanised locations when it comes to attracting and redirecting cargo flows even when these cargo flows are destined for extended hinterlands (Hall & Jacobs, 2012).

Liu (2010), points out that by using input variables such as infrastructure and machinery to measure port and terminal efficiency, that research ignored the various physical configurations of ports and terminals that could also have a serious bearing on whether a port is able to meet demand effectively and efficiently. Speaking about this, Dyer (2014), mention that when one looks at the geophysical positions of the Port of Durban, it is a mammoth and expensive undertaking to expand the port as it is surrounded by the City and the Indian Ocean. In this regard, Dyer (2014), queries that is it then not more rational to ensure a more productive, cost efficient port configuration is designed to provide sufficient overall port capacity, in line with expected and actual demand for port infrastructure, services and related marine activities.

Dyer (2014) concludes by stating that it is advisable to consult with all relevant stakeholders in the preparation, construction, and execution of ports unlike the current trend where the state or the municipality does so. Dyer (2014) further laments that while there are some consultations done before port construction or improvements, often the most directly able and qualified to offer valuable insight into such projects, as key port users and the local community are often ignored or underutilised.

2.3.4. Equipment

Rosario (2020) points out that on the waterside, the modest deployment of 12 gantries, which has been the case in the past, each gantry would be expected to undertake 360 moves in 24 hours (Rosario, 2020). The above deduction shows a glaring spare capacity

of 25% notwithstanding the 60-day expected annual disruption to operations as aforementioned (Rosario, 2020). On the other hand, the landside operations at the DCT are equipped with three (3) towers, each serving the North Quay, East Quay and the South Quay (Rosario, 2020). Each of the towers is provided with approximately 25 bays where in order to smoothly turnaround trucks, 9 straddles are needed to be deployed per tower (Rosario, 2020). In this regard, each straddle is expected to perform nine moves per hour, translating a capacity of 5800 units that can be handled per day (Rosario, 2020). As aforementioned, the DCT handles an average of 1.3 million units over 360 working days, which infers a demand of only 36000 units to be handled per day (24hours) equating to a spare capacity of 38% *ceteris paribus* (Rosario, 2020). Considering a deployment of nine straddles per tower, twenty-seven in total, road congestion will be outmoded (Rosario, 2020). Driving equipment to maximum capacity is related to training and development of people. Poor training and development results in productivity being constrained. Motau (2015) stated that the ship-to-shore gantry cranes will have to operate at full capacity to achieve the 35 moves per hour compared to the 28 moves it is currently doing. A review of a twin lift system, which will allow the gantry to carry two 40-foot containers in a single lift and the quart capabilities, allows four 20-foot containers to be carried on or off the ship on a single lift. Driving equipment to maximum capacity is related to training and development of people. Poor training and development results in productivity being constrained.

2.3.5. Human Resources

Rosario (2020) argues that the DCT need to reintroduce worker incentive schemes that linked performance to monetary incentives as is the global norm. For example, the shipping lines pay an additional premium of 10% on the terminal handling charge if the Container Terminal Operations Contract (CTOC) rate of productivity is achieved (Rosario, 2020). In the past, Transnet used to share such earned additional revenue with the entire supply chain in operations, which kept workers motivated to achieve higher performance (Rosario, 2020). Ever since Transnet management decided to transfer such earned additional revenue to the Transnet Group, the company lost on all counts, as worker performance declined which in turn led to massive losses in various

industrial and farming sectors and the port lost its credibility in terms of efficiency (Rosario, 2020).

Liu (2010) also shows the importance of worker management and motivation by pointing out that one of the limitations of that research is that it did not get human resource numbers and factors around human productivity. Similarly, Hoa & Haasis (2017), also argues that the key to port efficiency could also lie in improving human resource competence, education, and training. Snelgar, Renard & Venter (2013), argue that for organisations to remain efficient and profitable, budgets be allocated to deliver higher levels of value to the employees through the development of effective reward strategies. Understanding that everyone is different is an essential component in developing an effective reward system. Individuals have specific preferences that will attract, retain, and motivate a high performing workforce, by developing a rewards system that takes into consideration pay and non-pay rewards elements whilst also considering the individual's needs, will be a combination that ensures employees are engaged and motivated to perform (Snelgar et al., 2013).

Mitroussi and Notteboom (2015), stated that the terminal operators are willing to pay for dock work in either monetary or non-monetary forms to ensure that employees can meet market demands by increasing labour productivity to ensure continuous operations or to minimise the risk of "hidden costs" incurred by way of operational inefficiencies (breakdown of equipment, shortages, and lack of spare parts, and so on), staff shortages, cargo damage incidents and strikes. The current port structure is embedded in operational issues due to spare shortages, reactive maintenance, absenteeism, staff not trained to operate machines, to motivate staff to achieve higher productivity, a reward system that incorporate monetary and non-monetary rewards should be incorporated. Whereas Tausif (2012) states that public sector employees are not satisfied with understanding task significance, the opportunities to learn new things as well as task significance thus affecting their outlook on job satisfaction. Ultimately affecting intrinsic rewards. Nujjoo and Meyer (2012), elaborated that extrinsic monetary rewards affect a person's commitment and when a person receives a bonus or any monetary reward employees reciprocate their loyalty to the organisation.

To appreciate what motivates an employee an understanding of expectancy theory is needed. Lloyd and Mertens (2018), described expectancy theory as the motivational forces that drive an individual's belief that a certain effort will lead to a desired performance which will in turn result in a reward of some nature, however their research expanded into the social aspect, considering the changing working environment, globalisation, cultures and social aspects of a job and its effect on worker performance. Lloyd and Mertens (2018), research revealed that workers motivation is influenced by four key factors, namely stronger intra-industry relationships currently experienced by port employees as they are expected to engage with different players, geographical co-worker relationships (with engagement of workers globally that are employed in the port), societal expectations and (Transnet's) corporate policy.

Andrew Pike, Transport and logistics Head at Bowmans, laments the human resource policies at Transnet by blaming the constant change of CEO's at Transnet as a major cause of lack of proper planning (Hancock, 2020). Consequently, most of the country's policies on port infrastructure planning, development and management are often not implemented or take too long to take off and/or be completed (Hancock, 2020). For example, the Durban dig-out port conceived 10 years ago, which is aimed at increasing capacity and reducing congestion with phase 1 of the project, is only expected to be completed in the year 2037. Alternatively, the dig-out port was meant to be substituted by a berth-deepening project at the Durban container terminal, but this too has not been realised (Hancock, 2020). Both projects are aimed at increasing capacity at the container terminal by a couple of million TEU's and deepening the berthing to handle the larger vessels with capacity of 18 000 TEU's to 20 000 TEU's (Hancock, 2020). This again cements the argument of the lengthy time taken before any progress can be made, including the elements of human resources.

On the other hand, Memedovic, Ojala, Rodrigue & Naula (2008), argue that for developing countries to better participate in the global value chain (GVC) based on their respective resources and comparative advantages, investments in human resource training to develop specialised skills and efficient customs procedures and infrastructure are essential (Memedovic et al., 2008). Innovation within these areas will have a substantial impact on ensuring efficient port operations (Memedovic et al., 2008) and reduced costs.

2.4. FINANCIAL IMPACT OF PORT CONGESTION ON PORT USERS

Raballand, Refas, Beuran, & Isik (2012), state that an efficient and cost-effective transport system will make African countries competitive. In that regard, there is need for research that can help in understanding the cost burden that freight costs impose on trade, investment, and growth (Raballand, Refas, Beuran, & Isik, 2012). For example, (Hummels & Schaur, 2012) showed through empirical evidence that lengthy delays in transport logistics significantly reduce trade. Notably, the automotive manufacturing and assembly industry which heavily relies on imports (the bulky of such imports come into the country through the seaports) to assembly for exports identified reducing inventories as a key aspect in reducing industry costs (Hummels & Schaur, 2012). However, slow import processing and longer cargo dwell time of imports at the ports increases inventories and inventory costs for the automotive industry diminishing its global competitiveness against competitors elsewhere in the world (Hummels & Schaur, 2012). As an illustration, in a world of 'just in time' logistics manufactures and retailers aim to reduce inventory holding costs by using their carriers as moving warehouses substituting for costly and high-level inventory holding costs (Guan, 2009). However, the benefits of the envisaged just in time production are not realised if manufactures end up paying more for inventory that has overstayed at ports as is the case as highlighted by the plight of automotive manufactures in South Africa (Hummels & Schaur, 2012).

Lewis, Erera, & White (2006), mention that temporary port closures due to bad weather, labour disruptions and so on, lead to lengthy cargo delivery times and increase inventory management costs in the entire supply chain. By way of a numerical / quantitative study, the authors found that temporary port closures lead to an increase in expected supply chain inventory holding and penalty costs by a staggering 136% with some firms seeing an erosion of their operating profits in the process (Lewis, Erera, & White, 2006). In this regard, the authors stress that it is of greater economic importance in investing to increase the port processing capabilities especially for highly utilised ports to minimise the costs associated with congestion when the ports reopen after a temporary closure

(Lewis et al., 2006). This is clearer evidence that any delay in the movement of cargo within ports has huge negative financial implications for all parties involved.

On the other hand, North America ports faced capacity problem, compounded by the increasing size of vessels that exerted more pressure on port capacity and impacts negatively on the entire supply chain efficiency (Guan, 2009). In fact, port congestion creates a negative ripple effect in the entire supply chain network by increasing shipping cost due to schedule adjustments whilst in transit, higher fuel, and increased labour costs. Carriers in turn pass such costs onto haulers or their consumers (Guan, 2009).

Torrey (2017) using statistical models also found the financial cost of truck delays or congestion to the USA economy to be around a whooping US$49.6 billion and 728 million hours of truck driver idle time due to delays. Such research is particularly useful in providing evidence on the cost of congestion and its negative impact on the return of investment for truck owners (Torrey, 2017). The results of that research could be also useful to authorities tasked with the infrastructural planning, road construction and incident management (Torrey, 2017).

The issue of port congestion caused by empty containers in South Africa's Durban port has occurred in countries like the Philippines (Manila), Kenya, Nigeria, Côte d'Ivoire, and the United Kingdom (Manaadiar, 2020). These delays and congestion issues result in costs that are ultimately passed to the suppliers and eventually to the customers affecting the competitiveness of South Africa in the global value chain (GVC).

Internationally, the case of port congestion in Manila meant that, customers were subjected to additional costs because they had to drop off the empty containers in depots that were away from the port thus increasing their transport costs. Additional demurrage and detention charges were incurred due to containers not reaching port because of truck shortage and lengthy queues (Manaadiar, 2020). It is clear from the above citation that port congestion is a major problem in most ports around the world and the negative cost implications it has on business owners and customers. However, the research came short of narrating the causes of such port delays and hence possible solutions. This is a research gap that this research aims to

fill. For example, PWC (2018), concurs with Manaadiar (2020), that while there can be numerous reasons for port congestions, the reality is that all those reasons translate to “additional costs” which Chinedum (2018), specifies these costs to include more than money comprising loss of time, additional resources such as labour and fuel, loss of revenue as the number of trips a trucker can take in a day are significantly lessened and lastly 3rd party losses are also incurred. In all this literature cited above, one point stands out that port delays and congestion have huge cost implications but without addressing the root causes of port congestion and suggestions on possible solutions that are needed to ease port congestion. This can be attributed to the dearth of research conducted on the main issues surrounding port congestion in Durban and the above prognosis is extracted from observations and discussion with actors within the port environment.

Wiegmans & Konings (2015) indicated that the waiting cost at ports includes fuel consumption, labour cost, and capital cost. Notably, the waiting cost of trucks used within the port is expensive because delays of trucks result in delays of ships, whose demurrage is expensive. Moreover, the waiting cost of trucks at the gate is also costly because gate congestion will in turn cause road traffic congestion in and around the port. The Port of Durban imposes a surcharge of US$500 for delays in clearing containers that are handled by the shipping operators (Hutson, 2019). Reducing port congestion is key to the Durban local economy and the rest of the South African economy in general. While reduced tonnage capacity on certain trade routes result in shipping lines declaring blank sailings (Manaadiar, 2020). This is often the case when shipping lines or ship operators are kept waiting at anchorage for an indefinite number of days due to port congestion (Manaadiar, 2020).

A summary of port inefficiencies is stated below in Table 1 based on the literature review.

Table 1: Port Inefficiency

Port Inefficiency Causes	**Scholar**
Growth of imports and exports affecting turnaround time of ships, larger vessels with more cargo	Potgieter, Maasdorp, Moodley & Sessions (2015) Gidado (2015)
Poor Port Infrastructure/ Rail	Chinedum(2018) Hancock (2020), Guan (2008) Clark, Dollar, & Micco (2004)
Poor systems and procedures of landward access to the port via trucks scheduled arrivals at the port gate. Loading or unloading of trucks Accidents that could damage port equipment. Delays caused by cumbersome registration, licensing, and documentation. Congestion of cargo at storage yards and sheds	(Gidado, 2015)
Cargo dwell time in Sub-Saharan African ports takes about two (2) weeks on average, compared to larger ports in Asia, Europe, and Latin America	Raballand, Refas, Beuran & Isik (2012), Gidado (2015)
Underutilised gantry's Equipment breakdown	Rosario (2020) (Gidado, 2015)
Very Large Container Ships (VLCS) and Ultra Large Container Ships (ULCS), extra cargo	Behdani, Wiegmans, Roso, & Haralambides (2020); Prokopowicz, & Berg-Andreassen, (2016), Tran, Hans-Dietrich & Buer (2017) Guan (2009).
Weather conditions, equipment with vibration plates installed on the gantry and cranes to signal unsafe working conditions, stoppages of equipment result in congested ports.	Potgieter, Goedhals-Gerber & Havenga (2020). Mather & Roberts (2015) Rosario (2020)
Motivation of employees, decreased productivity	Liu (2010 (Hoa, 2017) Snelgar, Renard & Venter (2013) Mitroussi & Notteboom (2015) Rosario (2020)
Empty Containers	Manaadiar (2020)
Organized crime , excessive port regulation	Clark, Dollar, & Micco (2004)

2.5. TRUCK APPOINTMENT SYSTEM

Trucks not only add to traffic and congestion at the ports, but they must also tackle the perilous and oftentimes poorly maintained roads to transport imported cargo to the awaiting South African market. The delays beginning from the offloading of the cargo up to the moment the goods arrive for the consumer incur unnecessary costs that are ultimately billed to the unaware public.

Innovation within port structures have become more important as ports battle with limited land availability. Port have adopted the Truck Appointment System (TAS) ,which was introduced in 2002 in the ports of Los Angeles (LA), to address port congestion by controlling the number of trucks arriving at the port (Lange et al., 2017). In May 2020, Port of Durban adopted the TAS within Pier 1 and Pier 2. Grindrod, FPT and Bulk Terminal depots started their own TAS (Africa Ports, 2020). Trucks are required to notify the terminal operators of the time that they intend arrive at the port (Hutson, 2020). These changes in the port operations are still to be evaluated to assess the improvement of landside congestion. However, (Lange et al., 2017) caution that use of different systems can complicate and sometimes make the application of TAS redundant as experienced in the Port of LA (Lange et al., 2017). Interestingly, Grindrod, FPT and Bulk Terminal depots started their own TAS (Hutson, 2020), whereas Pier 1 and 2 are utilised the Transnet system.

The port of Durban formalised a mandatory truck appointment system project which is managed by the Transnet Port Terminals (TPT) Pier 1 and 2 container terminal operation with plans to have a second access road to the port as well as widening the Bayhead and Langerberg roads (Kinyua, 2020). The truck appointment system came into effect in 2020, when port operations were affected as a result of the Global Pandemic. Phumi Blose, the Terminal Manager stated that thirty (30) slots per hour are allocated in the booking system over a 24-hour period. However, this is also based on demand and ports capacity at the time. The port allows a window of 15 minutes before or after the allocated slot time for processing of trucks. The break bulk cargo continues to remain a manual process. Trucks are not allowed to wait in queues without an

appointment (Dass, 2020). .

Meanwhile, Comins (2020), quoted a port user who complained that “the port is working but there are challenges in terms of the truck booking system they have introduced, which has been causing a mess where people who haven’t booked are coming in Island View trucks are causing havoc”. The quote above seemingly suggests a failing system due to lack of transparency, fairness, and a lack of adherence to set rules. The same port user further alleged that bulk trucks from Island View sometimes block the entrance to Pier 1 and 2, preventing trucks carrying containers from dropping off their loads at the scheduled time slots and that TPT should rather address the equipment challenge (Comins, 2020).

However, Durban Port general manager painted a different picture stating that port stakeholder engagement and collaboration had seen efficiency in ships’ waiting time and turnaround time, reduced truck turnaround time and had resulted in improved fluidity of traffic on Bayhead Road leading into the container terminals (Comins, 2020). In addition to this, Sue Moodley, the chairperson of the South Africa Association of Freight Forwarders (SAAFF) concurred and stated that there was improvement to the truck booking system but cautioned that there was still a lot of work to be done by the larger logistics community (Comins, 2020).

It should be noted that contrary to the situation in South Africa where ports are run and managed by the state entity, Transnet, in the USA, freight flow is a business activity run by the private sector (Guan, 2009). However, chronic congestions at the Marine Container Terminal (MCT) gates have led to State legislature in California passing a bill which imposes a US$250 fine per violation on the terminal operators for trucks waiting at the terminal gate for more than 30 minutes despite having an appointment (Guan, 2009). Truck congestion in the United States of America (USA) is primarily caused by container terminals in the USA operating for five days a week limited to 10 to 12 operating hours per day and the terminals have a limited number of gate lanes (Guan, 2009).

Meanwhile, Guan (2009) analysed MCT operations in the Port of New York or New Jersey in the USA, paying particular attention to the truck congestion problem at the MCT gate to quantify truck congestion costs and evaluate congestion mitigating alternatives. The MCT performs ship-shore container transfer, container storage, cargo receiving and cargo delivery (Guan, 2009). Delays at the port facilities was found to be one of the major challenges facing the harbour trucking industry in the USA, eroding the productivity of the trucking industry, and compromising high level service to shippers (Guan, 2009). To make matters worse, truckers are paid per trip, not by hours they work and hence any long waiting delays at the MCT gates cost truckers' time and money (Guan, 2009). The trucking business in South Africa is also faced with similar problems. For example, Hancock (2020) quoting Andrew Pike, law firm Bowmans ports, transport and logistics head writes that the challenge of port congestion has seen truckers that should be transporting up to five or more containers a day often managing one per day if they are lucky at all.

After analysing the MCT gate system operation through field observations of truck arrivals at the MCT, Guan (2009) developed a model based on statistical testing and the queuing theory to quantify truck waiting cost and the terminal operator's (MCT) cost. To extend solution to the port gate congestion, Guan (2009) proposed three optimisation solutions. The first one is optimisation through physical expansion where the gate system can be optimised through marginal expansion of its gate capacity by opening additional gate booths (Guan, 2009). The second optimisation can be done through productivity improvement that relies on the manpower motivation and increased productivity (Guan, 2009).

In this regard, management style and worker motivation are so key that even with an additional cost of a new IT system, the gate operating cost will still be higher as long as human productivity remains low (Guan, 2009). Productivity optimisation also entails that there will be no need for physical expansion to optimally utilise the gate even with the higher gate volumes (Guan, 2009). Truck appointment system is the third optimisation system, which in essence is focused on the demand side of the gate system whereas the first two optimisation strategies focussed on the supply side of the gate system (Guan, 2009). This optimisation approach provides a system for MCT to match supply

to demand for the gate processing capacity and as a result allows the MCT to effectively manage gate resources and congestion (Guan, 2009) as illustrated in Figure 3 below. In summary, gate congestion can be managed by manipulating the three optimisation approaches which is physical expansion, productivity improvement and the truck appointment system (Guan, 2009). Since the first two optimisation approaches are focused on the supply side, the onus is on the MCT to provide enough gate capacity to meet supply (Guan, 2009).

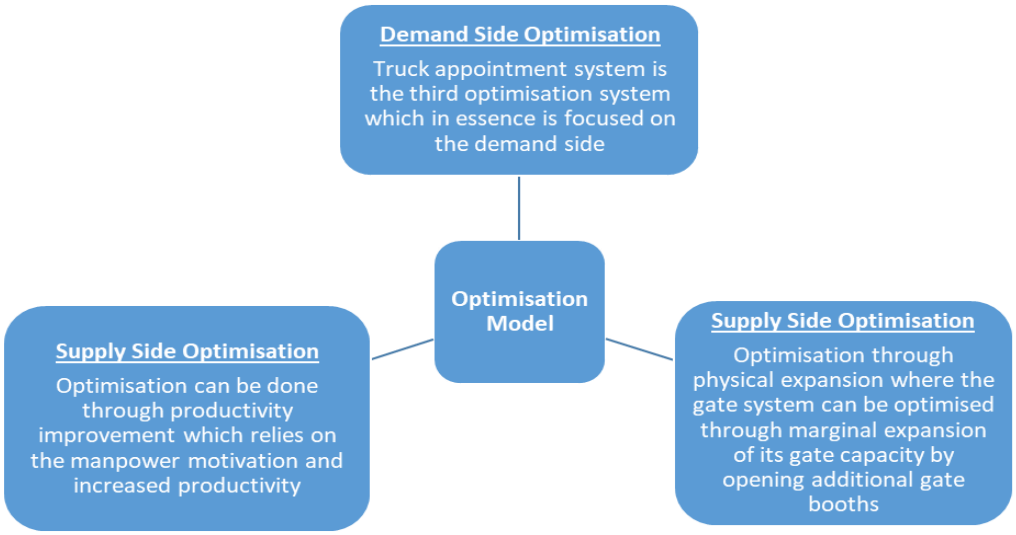

Figure 3: Optimisation Model adapted from Guan, 2009.

Guan (2009) also admits that since his research analysed port congestion from only one part of port terminal operation which is gate congestion, the research excluded other port operational issues such as container yard operation which is directly linked to truck waiting time (Guan, 2009). In this regard, Guan (2009) admittedly points out that in order to fully address freight issues and overall efficiency of ports there is a need for future researchers to understand the varied but interlinked and intertwined port operations such as the link between gate congestion and yard operation (Guan, 2009). Either way, Gidado (2015) argues that Guan's proposed model of solving port congestion is rather an inconclusive method of truck cost optimisation and a weak attempt at offering a workable solution to truck related congestion in a port.

On the other hand, Huynh, Smith, & Harder (2016), argues that truck appointment systems differ in both technological capabilities and implementation in various terminals and signs of the changing system is evident as the latest technologies are explored. Another shortcoming is that most previous studies on the TAS sought to optimise the appointment system from the terminal's perspective and in the process failed to show the impact of the TAS on drayage companies (Huynh, Smith, & Harder, 2016). In conclusion, Huynh, Smith, & Harder (2016), state that there is a gulf between theory and practice in the TAS for marine container terminals, but they are opportunities to close that gap. For example, there is potential value that TAS could improve terminal and drayage operations (Huynh, Smith, & Harder, 2016).

However, past research on this matter has taken a narrow and theoretical view of the TAS and little research has been done on solutions to near-term appointment systems obstacles (Huynh, Smith, & Harder, 2016). In this regard, design of a successful TAS needs an intertwined approach that examines the problem from all perspectives, including that of ocean carriers affected by the TAS, because inland transport is part of their service offerings (Huynh, Smith, & Harder, 2016). For example, Seo, Dinwoodie & Roe (2016); Pike et al.,(2020), mention there is need to understand the collaboration that all the participating actors need to streamline and integrate their respective operations, allowing us to understand what synergies should exist for better management of port congestion from both the land and seaside perspectives. This is aligned to Aakhus, & Bzdak (2015), who state that a shift to value creating networks which centralises the main problem shared by the actors or stakeholders, will allow these stakeholders to create value by jointly solving the problem at hand.

2.6. ROLE OF INNOVATION

2.6.1. The definition of innovation

Transnet has taken the first step towards innovation by adopting the TAS system. There are several definitions of innovation and the term innovation is pervasive among scholars, politicians, business leaders, universities etc. Innovation can be classified as either radical or incremental innovation. For example, minor extensions or tweaks to existing port processes and operations can be deemed incremental innovation (McDermott & O' Connor, 2002). On the other hand, radical innovation involves significant new technologies, processes etc. that are currently non-existent (McDermott & O' Connor, 2002). However, for the purpose of this research this author chose the perspective and definition of innovation from Kahn (2018) because he breaks down innovation into three key categories, which are innovation as an outcome, innovation as a process and innovation as a mindset.

This author found that perspective to the term innovation key as it poses a question(s) to ports on which is the best lens for them to view innovation particularly because ports unlike isolated organisations have several different port players often making the port a complex system. For example, it can be critical for the port system to look at innovation as a process that involves and interconnects all the various port with a view to achieving one and mutually beneficial outcome for all the port players involved. Therefore, looking at innovation by merely looking at a single stakeholder (one firm within or among the many port players) will not suffice. Douaioui, Fri, Mabrouki, & Semma (2018), agree that a port is a complex web of actors who should collaborate and share their resources to produce value. One would then argue that any created value (innovation outcome) rests on an all-encompassing innovation process that includes all port players (process innovation).Besides this, while there is consensus that innovation is the action of bringing something new to the world (Dictionary, 2010), several authors have tried to define innovation according to their area of research or industry. For example, Aronson (2008) defined innovation and innovativeness in drug therapy including pharmaceutical and pharmacokinetic innovativeness while Erdogan, Corlu, & Capraro (2013), looked at

innovation in the context of whether robotics activities improve innovation capacities of students or not. While these studies are key, they did not add value to this research, however, it was delineated that Kahn (2018) perspective to innovation can be useful in a research of this nature.

Kahn (2018), states that the term innovation can be defined in two ways, i.e. (1) the introduction of something new or (2) a new idea, method, or device. In this way, innovation should be an outcome and a process, respectively. Kahn (2018), further underscores that the third dimension to innovation is that innovation should be viewed as a mindset whereby innovation is instilled and ingrained within individuals in an organisation aligned with innovation supportive organisational culture which will allow innovation to flourish. Interestingly, the Dictionary (2010) compares the innovation elements from various scholars as the elements of innovation as being "what is changed (such as product or process changes); how much is changed (whether it is completely new or only perceived as such); the source of the change (sometimes technology); the influence of the change (for example, its social or commercial value)".Kahn (2018) further argues that innovation does not always have to be something totally new or radical in nature, but minor incremental innovation does count. This is so much so because radical innovation is particularly stimulating, risky and may require significant number of resources (Kahn, 2018).This is a question that the port of Durban players may need to consider especially looking at the huge costs associated with radical innovation. For example, small incremental changes such as a change in worker attitude may have huge impact on productivity than huge capital investments in equipment and technology (Teece, Peteraf, & Leih, 2016).

Concisely, innovation as an outcome underlines the output that is sought after whereas innovation as a process looks at how innovation should be organised or coordinated so that outcomes come to realisation. Finally, innovation as a mindset speaks to the acceptance of innovation in the mindset of the individuals in the organisation (Kahn, 2018). In fact, innovation will most likely succeed when organisations view innovation as both an outcome and a process but aided by the right innovation mindset and innovation supportive organisational culture (Kahn, 2018). Kahn (2018), cautions that organisations that strictly focus on outcome will minimise process leading to

inefficiencies such as duplication of effort and overutilisation of resources while organisations overemphasising process can create rigid structures that often make it difficult for outcomes to manifest. This calls for organisations to be able to strike a delicate balance encompassing outcome, process, and mindset (Kahn, 2018). The three dimensions to innovation can be summarised in the Table 2 below and that innovation follows the innovation cycle as shown in Figure 4 below:

Table 2: Understanding Innovation.

Element	Strategic focus	Strategic question	Consideration
Innovation is an outcome	Ends	What do you want to happen?	– Product innovation – Process innovation – Marketing innovation – Business model innovation – Supply chain innovation – Organizational innovation
Innovation is a process	Ways and Means	How will you make it happen?	– Innovation process – Product development process
Innovation is a mindset	State	What should be instilled and ingrained to prepare for the what and the how?	– Individual mindset – Organization culture

Source: Kahn, 2018

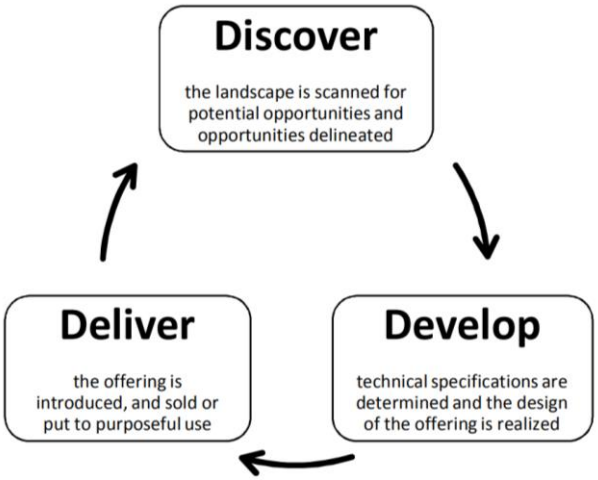

Figure 4: The Innovation Cycle (Kahn, 2018).

Meanwhile, Teece, Peteraf, & Leih (2016), call for the need for organisations to be able to strike a difficult balance between organisational agility and efficiency. This arguably shows the importance of leadership and management in shaping how an organisation develops, shapes, and deploys innovative methods to adapt in a changing environment

and thus remain competitive and profitable in the face of competition and changing customer demands.

Since port actors are said to be co-creators of value, it is imperative to note that improvements in freight transportation are associated with more efficient value chains (Vitsounis & Pallis, 2012). The most important improvements include improving transport efficiency, the development of information technology and thus establishing better ways to have control over the value chains. The technological improvements extend to that of the intermodal transportation (Rodrigue, et al.,2014), to improve port connectivity and efficiency among the various modes of transportation in the port. Since port actors are interdependent role players, port operations are affected by time interdependency too, which as it prevails port actors understandably begin to seek reliable partners that guarantee the delivery of a container at time that are pre-defined (Vitsounis & Pallis , 2012). Kgare, Raballand & Ittmann (2011), state that port performance emerged as the main reason for delays in the transit corridors and the need to disentangling the causes of port congestion is needed to be understood since South Africa has a relatively high trade value.

2.6.2. Incremental and Radical innovation

Christensen (2013) stated that as new technologies emerge to replace old performance resembles intersecting S-curves. With movement on the S-curve being incremental, improvements within an existing innovation or building on the base of established practice (Levin, 2018). However, if a new S-curve is formed it implies a radical innovation (Christensen, 2013). Levin (2018) described radical change as new technologies introduced into an already existing market, it can change the fluidity of the process (Levin, 2018). If a technology is new to the port actors, the end users or whether a process change has occurred or output resulted, if the extent or value of change required by the main actors is sufficient then one can justify the designation of the innovation as radical as opposed to incremental (Ettlie, Bridges & O'keefe, 1984).

Radical changes have occurred in Europe, North America, and Asia, as ports become Smart Ports. Smart Ports are ports that use “new technologies to maximise efficiency

and productivity by making better use of the available space, time, energy and natural resources" (Deloitte Port Services, 2017). Smart Ports aim to address current and future challenges faced by seaports through technological advancements and business model innovations. When planning Internet of things (IoT), ports should understand and have a clear value proposition in mind (ŞAKAR, & SÜRÜCÜ ,2018). As value creation and serving the customer better are key to value innovation(ŞAKAR, & SÜRÜCÜ ,2018) .

The Port of Durban has had a technological upliftment with TAS, although regarding as a radical innovation, it has not addressed the issue of port congestion. Sometimes, technological changes are insufficient and involves a myriad of changes to ensure efficiency in its operations. As ports move through the various stages of its development lifecycle, it is essential to ensure that all the infrastructural, policy and necessary skills exist as it moves through the various life cycle changes to becoming a Smart Port (Deloitte Port Services, 2017). Since the Port of Durban having recently adopted TAS, it has moved from a first come first serve basis.

Little research has been done on port congestion in South Africa and only until recently a committee to address the port congestion issues has been formed. South Africa remains behind in terms of its adoption of innovative strategies to address port congestion. With limited research done in the Port of Durban, benchmarking other efficient ports to assess how South Africa can adopt or adapt the mechanisms utilised will aid the research and provide a platform for analysis to determine the incremental or radical innovations required.

2.6.3. Innovation through smart ports

As earlier mentioned, the Port of Durban has had a slight technological upliftment by launching its own TAS. However, technological changes alone are at times insufficient to solve challenges at hand, as holistic port, efficiency often demands a myriad of changes to ensure efficiency in its operations (Deloitte Port Services, 2017).

The Internet of Things (IoT), Big Data have emerged providing new technological solutions such as the potential to create development opportunities for supply chain management and logistics and hence the rise of new logistics term coined ‘smart logistics’ (Douaioui, Fri, Mabrouki, & Semma, 2018). Since ports are at the centre of port logistics and play a key role of connecting nations and people around the world through global trade, researchers combined port logistics with the intelligence factor to come up with the term, smart ports (Douaioui, Fri, Mabrouki, & Semma, 2018). Ports are the main actors in the maritime transport and logistics value chain. In that vein, (ŞAKAR, & SÜRÜCÜ ,2018) argue that to meet the requirements for the changing environment, ports need to concentrate on technological and service innovation.

Smart ports is based on the automation of terminal ports and interconnection of all players in the port chain via the automated transfer of mobile data in real time (Douaioui, Fri, Mabrouki, & Semma, 2018) to achieve the overall competitiveness of ports and contributing to the integration of the port chain (Erdogan, Corlu, & Capraro, 2013).
As shown in Figure 5 below, smart ports entail the connecting the port logistics chain by utilising systems that ensure harmonisation of operation and traffic at the terminal; Real time management of maritime traffic; cybersecurity ensures the availability, traceability, integrity, and confidentiality of information stored and transmitted (Douaioui, Fri, Mabrouki, & Semma, 2018).

Automating the port operations and equipment (Douaioui, Fri, Mabrouki, & Semma, 2018) requires smart ships equipped with satellite system connected with the smart port in real time leading to automatic collaboration in the planning of docks, cargo handling and the organisation of truckers timeously. Smart containers have sensors on them that allows data to be collected, namely geolocation, temperature, pressure, and so on and automated operations concerns the transportation, the storage, and the handling of containers inside the port terminal (Douaioui, Fri, Mabrouki, & Semma, 2018). Smart shipping and smart ports make it possible to integrate all operations and apply a ‘just in time’ principle for dispatch and loading of cargo whilst at the same time streamlining operations for the logistics sector as well (Berns, Dickson, Vonck & Dragt, 2017).

Transportation automation involves driverless trucks operated electronically. The storage operations utilise the rail cranes without operator, whereby the storage and extraction of containers is done through automated control system. Lastly, dock cranes can be automatic to swiftly load and unload ships, reducing waiting times for ships and trucks and at the same time save energy (Douaioui, Fri, Mabrouki, & Semma, 2018).
In essence smart ports use new technologies to maximise efficiency and productivity by making better use of their space, time, energy, and resources (Deloitte Port Services, 2017; Clay, n.d.). For example, real life smart port activity includes using drones for cargo inspection rather than manually climbing structures for inspection; remotely controlling terminal equipment (trucks and cranes); use of sensors in underwater infrastructures to measure strain and report maintenance issues, reducing the need for divers; creating smart lock gates that respond to weather (Clay, n.d.). Ports and logistics companies have begun to utilise Google Maps to access information on real – time traffic and use this to schedule driver's arrival at the terminal at the least congested time (Deloitte Port Services, 2017).

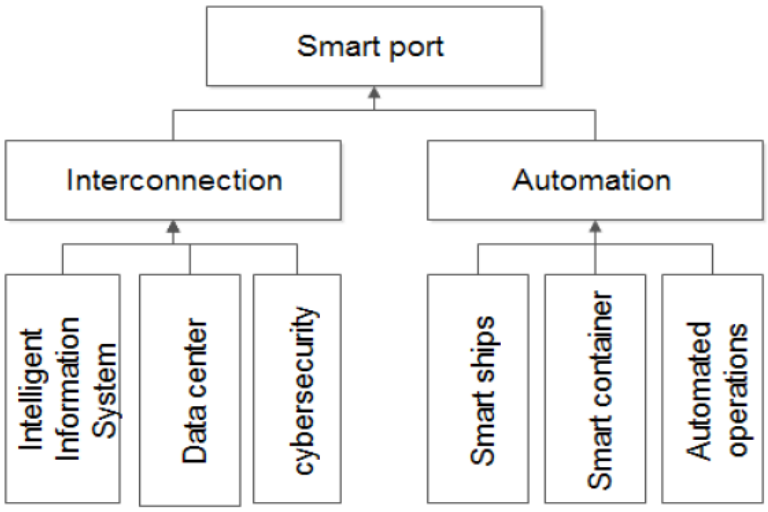

Figure 5: Smart port system (Douaioui, Fri, Mabrouki, & Semma, 2018)

A case in point is the radical changes that have occurred in Europe, North America, and Asia were ports become Smart Ports. Notably, the port of Amsterdam launched multiple apps. For example, the 'I Am Port' app offers real time information on ships locations and itineraries in the port. The 'Port Data' app shows the historical throughput of cargo

of eleven ports, promoting data sharing (Deloitte Port Services, 2017). Innovation cannot be seen alone, the human dimension to innovation and hindrance factors must be considered to determine a way forward in addressing the innovation lag.

2.6.4. Other suggested solutions to mitigate port congestion.

In trying to offer a solution to the costs associated with port congestion, Moon & Hong (2016), advocate for the use of foldable containers as their findings indicated that folding and unfolding of containers results in a rise in the use of foldable containers as there was a reduction of the costs associated to storing and handling containers, despite the additional transportation cost for the reposition storage areas.

Hoa & Haasis (2017) argues for the upgrade and investment of port infrastructure in Vietnam through public private partnerships to reduce capital pressure on government budget. The area of public-private partnerships can be a consideration in South Africa to help the government in funding, constructing and operating ports. Meanwhile, Liu (2010) found that container terminals are proven more productive than multiple purpose terminals and that the container terminal operation industry in the North Mediterranean Sea is over scaled. This conclusion was arrived at after observing that when looking at scale efficiency, container ports and terminals were not using their resources efficiently (Liu, 2010).

As an illustration, at port level it was observed that most container ports show decreasing returns to scale, whereas at the terminal level more than half of the terminals show increasing returns to scale. From the above results, one can argue that it is thus key to ensure increasing returns to scale to justify more investment put towards the expansion of port capacity. However, Liu (2010) concedes that overcapacity is a common and necessary feature of container ports and terminals because that spare/reserve capacity attracts more traffic to the ports as it signals reliability to port users. ŞAKAR, & SÜRÜCÜ (2018) argue that in trying to create value within the industry ports should understand and have a clear value proposition in mind by identifying industry factors that can be reduced, created, raised, or eliminated as shown in Appendix 1.

It should also be noted that port congestion also has a negative impact on the environment through air and noise pollution. For example, Hamburg Port Authority was plagued with congestion problems as well as air pollution associated with truck congestion at ports. The port utilised a self-propelled barge, which has been phenomenally successful in alleviating the congestion experienced in the Port (Malchow, 2014).

Lau & Malchow (2019) found that the use of the self-propelled barge in the Midstream Operations in Hong Kong was much safer, faster, and efficient as less manpower was needed. The barge had a lesser environmental impact than the traditional barges that have operated the waterways in Hong Kong (Lau & Malchow, 2019). South Africa currently does not use any barge operations in moving containers via the waterways and this remains an alternative available for reducing congestion.

2.7. CONCLUSION

As there is limited literature regarding congestion in the Port of Durban. However, research has been done comparing South African ports to the rest of Africa, but this should be reviewed against the ports of the world and better processes followed. The goal of this research is understanding port congestion in the Port of Durban and the possible solutions that could exist in addressing this.

The literature review highlighted port efficiency and productivity issues experienced by the port. Despite the implementation of the truck appointment system congestion still exists in the Port of Durban. The truck appointment system has been beneficial in reducing port congestion in various ports, yet our roads remain congested. This chapter explored other innovation applied as ports move through the various stages towards a smart port structure, along with techniques and methods applied by other ports globally in addressing port congestion. Despite Logistics companies and Ship operators voicing their opinions, the port has been slow in addressing the issues raised.

CHAPTER 3: RESEARCH QUESTIONS

3.1. INTRODUCTION

This chapter highlights three research questions that sought to bring answers to the research problem and achieve the research objectives within the context of the literature reviewed in Chapter Two and from the perspective of the targeted respondents of this research. These questions were formulated based on the researcher who wanted to understand the causes of port congestion at the Port of Durban, innovative and/or other ways that could be adopted to ease port congestion in at the Durban port. The categories for the research questions are outlined in Appendix 2.

3.2. RESEARCH QUESTION 1

What are the main causes of congestion in the Port and Durban (landside and seaside), despite efforts to reduce it?

Congestion results in logistics cost escalating, the causes for congestion in Durban are assumed to be equipment breakdowns and failure to purchase equipment quicker, however this research looked to assess what the stakeholders of the port viewed as being causes of congestion. Therefore, this research sought to get an in depth understanding of their experience with port congestion in Durban as well as what the participants believe are the main causes of congestion, through interviews with key port players, proffered solutions to the challenge of port congestion in Durban can be identified.

3.3. RESEARCH QUESTION 2

What innovation and other methods were used in other ports to mitigate port congestion and their applicability to the port of Durban?

Some ports around the world have introduced the smart ports concept and the truck appointment system as some of the ways to mitigate port congestion. Since ports are at the centre of port logistics and play a key role of connecting people around the world through global trade, it becomes important to assess how ports have established themselves as being some of the best in the world. By benchmarking other countries and how the countries dealt with their port congestion issues, the researcher can evaluate how the Port of Durban could address the current congestion issues.

This optimisation approach provides a system for the port to match supply to demand for the gate processing capacity and as a result allows ports to effectively manage gate resources and congestion (Guan, 2009). The Port of Durban had implemented a similar system, but its efficacy and impact is yet to be fully evaluated, which is an area that this research would tackle.

3.4. RESEARCH QUESTION 3

What are the possible solutions that can be implemented to ease port congestion in Durban?

Past research observed by this researcher show that challenges and solutions put forward to ease port congestion looked at one stakeholder or one dimension to port congestion, like Guan (2009) who only looked at the gate congestion. Indeed, (Lange, Schwientek & Jahn, 2017) point out that trying to understand port congestion in that manner is insufficient to fully understand port congestion and methods needed to reduce such congestion. In that regard, this research aimed to fill that gap by looking at port congestion from both the seaside and landside perspectives to possibly proffer solutions that are holistic to solve port congestion. Using the concept of innovation, the researcher

sort to understand what incremental and radical innovation the Port of Durban could implement to alleviate the current congestion issues.

3.5. CONCLUSION

This chapter presented the three research questions that formed the basis of this research. By virtue of providing answers to these research questions through in depth one on one interviews with the targeted respondents, it was hoped that this research would be able to understand port congestion and proffer solution thereof fully and holistically. The following chapter presents the methodology used for this research.

CHAPTER 4: RESEARCH METHODOLOGY

4.1. INTRODUCTION

The study used the qualitative approach accompanied by an interpretivism philosophy (Leitch, Grisham & Hayes, 2009), that allows the researcher to pose questions, which are structured in a manner that seeks to determine the appropriate criteria for evaluating the quality of the research. It was through such questions that the researcher was able to obtain a holistic view of the research problem which focuses on what the causes for port congestion in the Port of Durban and what incremental and radical innovative technologies, methods and processes can be adopted. Kallio, Pietilä, Johnson and Kangasniemi (2016), stated that when literature background is often fragmented, the reliance on empirical knowledge could be used to strengthen the theoretical studies undertaken. Data was gathered through in depth one on one semi structured interviews with key port actors in Figure 6, until data saturation was reached. Non-probability purposive sampling was used to gain deeper insights on the causes of port congestion from people who have lived through the experience and who are perceived to have intricate and some expert knowledge on port operations (Figure 6).

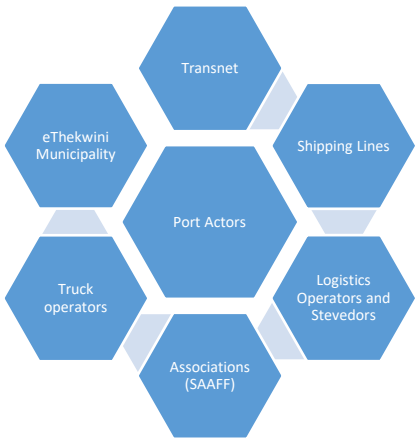

Figure 6: Actors in the port value chain (adapted from ,Pallis, Athanasios and Lambrou, Maria ,2012).

Data analysis was done through thematic analysis where all data collected was transcribed and the researcher observed and articulated emerging themes to attach meaning to the respondents' interpretations and perceptions of their own lived reality on what causes port congestion in Durban and possible solutions thereof. This chapter also looked at the population, sampling, unit of analysis, interview guide, pre-test, data collection, data analysis, research quality, bias, limitations, ethical considerations, and a conclusion of the chapter.

4.2. RESEARCH PARADIGM

The different choice of exploratory studies undertaken depends on the type of outcome expected (Brink, 1998). For this research, the focus will be on phenomenology. Smith (2006) describes phenomenology as a process of documenting a conscious experience as experienced from the participant's point of view rather than to theoretically explain it. Since the approach of this research was inductive in nature, as this was the most frequently used tool for everyday problems dealing with partial information about our world (Goel, Gold, Kapur & Houle, 1997). It was an approach that was used in instances where there was lack or limited information in previous theories and research findings (Liew, Grisham & Hayes, 2018).Indeed, the inductive nature of this research naturally meant that this research followed the constructivism or interpretivism research paradigm (Ponterotto, 2005). The constructivist paradigm allows the researcher to unveil or uncover hidden meaning through conversing with the people who have gone through a particular situation (Ponterotto, 2005). For example, through the interviews that were done with respondents drawn from a wide and diverse pool within the Port of Durban allowed for diverse but valid observations from people who experience port congestion at the Port of Durban.

4.3. RESEARCH DESIGN

This research used a qualitative approach. Qualitative research was aimed at gathering data from the field through interviewing the targeted respondents (Figure 6) to gain a deeper understanding of the causes of port congestion (Patton, 2005).On the other

hand, a qualitative approach was the best means of addressing research problems and the research questions (Azorín & Cameron, 2010). For instance, qualitative research enabled this researcher to gather data from the research participants through interviews. In that way, the researcher could grasp the causes of port congestion from individuals with intricate knowledge and experience on port operations (Lee & Lings, 2008).

4.4. POPULATION

Saunders and Lewis (2012) describe the complete list of the population as the sampling frame. The sampling frame was depicted in figure 6. It consists of stevedoring companies, ship owners, Government (Transnet and eThekwini Municipality), stevedoring companies, truck owners, various cargo owners and logistics operators whose entirety of the population could not be determined as no maritime landscape can be established that encompasses all actors, hence the population was extracted from literature review of Pallis, Athanasios and Lambrou, Maria (2012) ,(Figure 6).

4.5. SAMPLING

According to Saunders and Lewis (2012), sampling avoids wasting time when there was a fixed amount of time to complete a research. Collecting data from a sample means that there will be more time to concentrate on other aspects of the project (Saunders & Lewis, 2012). Saunders and Lewis (2012) also state that a sample size of 4 - 12 participants will probably be enough when undertaking qualitative research. However, the sample size will be extended if saturation and the objectives of the research does not materialise. Data saturation was a stage within the data collection process when the data being collected ceases to provide new or relevant data. In the case of this research data saturation was reached at 12 participants. This research used non-probability sampling technique in the form of purposive sampling.

Purposive sampling was a selection method where the research participants were selected based on the objective of this research study (Tansey, 2007). This research particularly used purposive sampling in the form of homogenous sampling. The

researcher had chosen homogeneous sampling for the population identified, which was a purposive sampling technique, aimed at achieving a sample which had the same or similar characteristics or traits. In the case of the port actors, this was a group of people with are senior in the organisation and have been employed within the maritime landscape. This sampling technique was chosen by the researcher, because the answer to the research problem will likely be an outcome of the interviews held with this group of individuals (Patton, 1990). However, because of the global pandemic, participants were unable to attend the interview sessions as they had been affected by COVID-19, the researcher to ensure the interviews were conducted within the time frame planned adopted a snowballing technique with participants who were affected by port congestion. The representation from other sectors within the maritime landscape provided a reduction in bias from the data that was collected from the interviews.

4.6. UNIT OF ANALYSIS

Kumar (2018) states that the unit of analysis assists in determining “what” type of data a researcher should collect from his or her study and this was then linked to “who” will provide the necessary data. If the incorrect unit of analysis was selected then the research bears the risk of drawing invalid conclusions (Kumar, 2018). The unit of analysis in this research are the views and opinions gathered from interviews with the various actors represented in Figure 6. The research was limited to decision makers who were selected because of their knowledge in container and port operations. For this research, decision makers did not only refer to executive management decision makers but also to senior and junior management. The researcher held interviews with decision makers from the Transnet, the stevedoring companies, logistics operators, maritime associations, and shipping lines. These individuals were particularly and purposively chosen because it was anticipated that they would be able to provide information and insight into the cargo operations taking place at the port. For instance, stevedores are the personnel employed at the port docks to load and unload ships, based on these employment characteristics the stevedores were expected to provide the appropriate insightful and relevant data for the purpose of this research.

The sample consisted of a Transport Economist from eThekwini Municipality (Participant 2), a General Manager for Africa employed by Transnet (Participant 4) and a marine economist (Participant 14) from the South African Association of Freight Forwarders (SAAFF). These three experienced participants that have backgrounds in the port, have contributed to the literature. They are regarded as the experts in the panel of participants chosen. The other eleven (11) participants occupied positions in management, the reason for purposive sampling in this respect was that the participant could make or influence decisions in an organisation, thus having the ability to affect how the respective employers behave towards port congestion. The sample consisted of participants that are from stevedoring companies, truck owners and managers in businesses relating to logistics (trucking), logistics distribution, clearing and forwarding companies in the retail, automotive sectors, bulk cargo haulers and a shipping line provided insight into how their operations are affected by congestion.

4.7. DATA COLLECTION TOOL

Questions that were used in the interview guide were guided and categorised according to the research questions to make sure that the questions provided answers needed to achieve the research aim. In this regard all questions in the interview guide fell under a particular heading and/or subheading in tandem with the research questions. In fact, scholars posit that an interview guide was a crucial aspect of conducting interviews, hence it was important for an interviewer to formulate a list of questions and issues to be covered and addressed during the interview (Koskei & Simiyu, 2015). Nevertheless, the interview guide questions should be clear and unambiguous (Koskei et al., 2015). The questions in the interview guide were categorised according to the three research questions. This was done with keen interest, concern and care being made by the researcher that in as much as the questions were clear and concise, the responses from the respondents addressed the questions sufficiently. In this regard, the pilot study helped the researcher to structure the questions in a manner that was clear and concise. An interview guide was formulated based on the initial literature review done at the proposal stage for the dissertation. The interview guide listed the three objectives that the research aimed to address based on the literature review. The questions per

objective aimed at obtaining further insight in terms of the participant's perspective. The interview guide was submitted for ethical clearance. See Appendix 3 for ethical clearance approval. After the pre-test, the questionnaire was amended to ensure that insight was provided to address the innovation lag.

Chapter Two provided insight into what the potential causes of congestion are based on ports globally, however further insight was needed from participants to understand why congestion exists in the Port of Durban. To proffer a solution, the innovation theory was used as the basis for the study. With advancements in technology, process and systems efficiencies, and new products as well as advancements of products, changing environment, the researcher sort to break the proffered solution into incremental and radical solutions or innovations. The research questions posed in the interview guide was based on the literature review done in Chapter Two. The interview questions were aligned to the objective in a traditional manner as shown in Appendix 4. The research objective explained to the participants and the questions relating to that objective posed in a semi-structured manner to allow for a simulated conversation in a natural manner. A framework from the research objectives, literature review, responses of participants and the theory selected was aligned and a framework formulated in Chapter 6. The questions were not always answered in the proposed manner as set out in the questionnaire with participants addressing other objectives as well (Saunders et al., 2016). The interview guide is included as Appendix 4.

4.8. PRE-TEST

Saunders, Lewis, and Thornhill (2012)**;** Kallio, Pietilä, Johnson & Kangasniemi, (2016) state that a pre-test or pilot study can be viewed as a trial run to test before the full-scale study to identify potential challenges with regards to research questions, sampling method etc. The pilot for this research was done using in depth one on one interviews with two individuals from the targeted population. This helped the researcher to rephrase questions, reword and helped with the order in which questions from the interview guide were to be asked (Kallio, Pietilä, Johnson & Kangasniemi, 2016).

4.9. DATA COLLECTION

In conducting exploratory research of a qualitative nature, semi structured interviews with participants that have knowledge and understanding of the research problem and combining it with in-depth literature review, will add depth to the research (Saunders, Lewis, Thornhill, 2016). The interview guide was formulated from the initial literature review conducted during the proposal formulation stage of the research. The questionnaire was set up based on the three objectives identified through the research in Chapter One and Chapter Two.

Participants were contacted telephonically where the research and consent documents were explained at the initial introductory meeting. The participants shared their email addresses, and a 'Zoom' or 'Microsoft Teams' meeting was set up at the time and date agreed at the introductory meeting . The Zoom and Teams platform were used to conduct the interviews, because of the global pandemic face-to-face interviews could not be conducted. An email invitation, together with the link to the Zoom or Teams meeting was sent to the participants. The consent forms that required their signature was attached in the email as well. Cridland, Jones, Caputi, and Magee (2015) found that by ensuring an informed consent was received, the participants understood the aim of the research as well as the risks associated to the interview in this case and the participants were committed to the engagement.

Scholars posit that techniques and procedures permit a researcher to bring his or her vision into reality (Strauss, & Corbin, 1998). Although the interviews, except one interview, was conducted on an online platform, the techniques that would normally be used at a face-to-face meeting was adopted, as the participants were participating in the interviews from their homes, the participants were feeling more comfortable sharing insight into the questions posed. The researcher used semi-structured interviews (Saunders, 2012), as they are the preferred method of data gathering when one seeks to probe for further information as well as to navigate the direction of an interview when addressing sensitive and complex issues (Barriball & While, 1994). As such the informal nature of the semi structured interviews conducted by the researcher provided deeper insight on the individual opinions of the actors in the maritime industry through further

probing on certain respondents' answers (Kajornboon, 2005). The semi-structured interview questions were disseminated into themes or categories to ensure that the research objectives were met. The questions that the researcher used were meant to encourage the research participants to express their opinions, experiences, and expert knowledge (Koskei et al*.,* 2015) on port congestion and the potential innovation techniques, methods and processes that might exist to alleviate the problem. The respondents' responses were recorded on the Teams and Zoom sessions, which have the functionality to record the sessions. This was done after gaining consent from the respondents to record the interviews.

The researcher was also able to build trust (Anney, 2014) and rapport with the interviewees which allowed them to speak honestly and openly whilst sharing as much detail and insight as possible by introducing the research topic in a friendly manner as well as drawing on the participants experience and the aim of the research. In summary, Saunders, Lewis, and Thornhill (2012) argue that interviews have a huge advantage as a data collection method over other methods because they offer much more data as compared to say surveys. Nevertheless, interviews are time consuming with regards to arranging to meet and doing the interviews themselves, transcribing and results analysis. This was made even more challenging due to the COVID-19 pandemic, which meant that physical meetings were at time impossible.

The data obtained from the interview (recordings and transcripts) are safely stored to ensure the validity of the research is assured (Noble & Smith, 2015). The consent forms, although received via email from eleven (11) participants is accessible for verification, together with the original email to ensure compliance to ethical practices (Saunders & Lewis, 2012). The consent forms sent to the participants have been included in appendix 5. The three (3) other Participants had agreed verbally that they had read the consent letter and understood the contents thereof; this is included in the recordings.

4.10. DATA ANALYSIS

The interview was transcribed using Google word transcription and verified via the researcher, who listened to the interview and read the transcribed document to ensure completeness and accuracy of data, for analytical purposes and use in Chapter 5. This research used thematic analysis as the tool of choice to analyse the collected data. Evans and Lewis (2018), state that thematic analysis was a process of identifying patterns and themes within the data from data collection stage to the stages of interpreting the data (Evans & Lewis, 2018). It was through this process that the researcher can determine whether the research was developing a worthy theme.

Braun and Clarke (2006) concede that a theme should capture important information about the data in relation to the research questions. Braun et al., (2006) proceed by stating that the theme will appear more than once across the dataset, however, the frequency of instances does not automatically indicate the importance of one over the other. The reason behind this was the importance of a theme was determined by how it communicates to the researcher's theoretical position (Evans & Lewis, 2018). Thematic analysis entailed discerning patterns emerging form the transcribed responses. Transcribing the audio interviews prevented the researcher from speculating what the participants thought or said during the interviews, thus avoiding any assumptions Vaughn & Turner, 2016).

4.11. RESEARCH QUALITY

The researcher made use of data triangulation, using various means of data gathering such as academic texts and interviews. Scholars define triangulation as a strategy for improving the validity and reliability of research (Golafshani, 2003) or research findings using "multiple and different methods, investigators, sources and theories to obtain corroborating evidence" (Onwuegbuzie & Leech, 2007). Data triangulation was one form of triangulation that assist in reducing prejudice and it cross-examines the integrity of the participants' responses, using different data gathering methods (Anney, 2014).

Triangulation was also said to improve the analysis and understanding of participants and therefore assists in the researcher's interpretation of the data (Golafshani, 2003). The research will source relevant primary and secondary material (official documents and news reports in public domains) to consider alongside the interview data obtained. Since this study was qualitative in nature, the data collection methods required the researcher to be immersed in the participant's world (Bitsch, 2005; Onwuegbuzie & Leech, 2007). The more time the researcher spends engaging in field work, the more the researcher gains a deeper understanding of the core issues that might affect the quality of the data (Anney, 2014). In the case of this research, the researcher is integrally involved in the maritime sector and understands the dynamic and complex nature of the industry.

The researcher also made use of a transcribing software and confirmed that the audio interviews were correctly transcribed and thereafter the researcher will use the code-recode strategy to compare whether the information changes or stays the same (Anney, 2014). Basit (2003) states that coding or categorising data plays an important role in analysis, this was because these codes allocate meaning to information compiled in a study or research. The validity and reliability of data was dependent on the data conveying a certain amount of meaning rather than the use of the same words, even though the research used the frequency analysis as a tool to analysis the common words used by the participants in the interview. Hsieh and Shannon (2005) stated that frequency of words is not important, the latent content analysis, which is the analysis the data and providing interpretation, is important. Data comprising this meaning helps to somewhat systemise the semi-structured interviews and assist the researcher to compare the data (Barriball & While, 1994).

4.12. BIAS

Morse (2015) described bias as being inherent in qualitative study, as the sample chosen has not been done so using a random sample technology that selects the sample. Morse (2015) further stated that the best research occurs when the participants exhibit "pure" behaviour to the questions posed, thereby not presenting an average

outcome. By using a stepwise verification process during the data gathering phase, the research is ensured that the data will correct itself as it is verified at each stage of checks and analysis as can be seen on Chapter Six and through triangulation.

The results from this research may be criticised as being biased in that the respondents were all white-collar employees who are arguably out of touch with the reality on the ground. In this regard, to improve the research quality and reduce research results bias, the researcher could have also interviewed shop floor workers who say offload ships or even truck drivers. However, it should be noted that this was impossible due to time constraints and the fact that a research of this nature needed responses from individuals deemed to have expert and intricate knowledge on port operations.

The researcher also tried to reduce research results bias and improve the quality of the research by drawing respondents from the wide and varied cross sections within the maritime sector. This was intended to get varied and valuable data from the various individuals within the various sectors of the maritime industry. A further attempt to reduce bias was through peer review (Morse, 2015) of the research that assisted with ensuring validity of research (Wadams & Park, 2018). By having peers that are not related to the industry or sector, the unbiased views will assist in the synthesis of findings (Wadams & Park, 2018).

4.13. LIMITATIONS

The study sought to gain insight on the causes of port congestion in Durban at a time when the global pandemic, COVID-19 had disrupted global supply chains including the maritime transport and logistics. This somewhat may have clouded the thinking and responses of some of the respondents as some of them were speaking to the current port congestion situation. This could give a misleading picture on the state of port congestion in Durban as global supply chains have been negatively disrupted due to the travel restrictions placed on the movement of goods and people among countries of the world.

The study was also limited to studying port congestion in Durban without comparing and understanding the competition the Durban port faces from other local ports or even ports within Africa. On the other hand, one of the limitations of this study was that the global pandemic, COVID-19 denied the researcher the chance of meeting physically with the respondents. This had a potential impact of denying the researcher a chance to interpret nonverbal cues often easily visible in a relaxed natural physical interview setting as both verbal and nonverbal communication can be key in a social research of this nature that seek to understand people's thoughts and behaviours. On the other hand, scholars posit that semi structured interviews can be disadvantageous and can be limiting for the interviewer in terms of determining bias opinions from information (Koskei, 2015). The interview was limited to the experiences of the participants and this could restrict the information obtained regarding the subject matter (Essays UK, 2018). A further limitation was access to information that was once available on public domains. Requests for information from Transnet have an approval time of between 60 to 90 days before information can be accessed. This was beyond the planned research time allotted.

The load shedding that was experienced during December 2019 and January 2020 had affected the recordings of two interviews. This affected two interviews that was conducted during the stages of load shedding were Participant 13 and Participant 14. The interviews were abruptly stopped because of the varying load shedding times and the participant agreed to answer the questions telephonically and via emails.

As the research is currently a trending issue within the maritime sector, the researcher looked to current newspaper and articles in magazines to understand what stakeholders have emphasised as possible causes and if any solutions have been offered. However, the researcher relied on Hutson (a field reporter within the maritime sector) and Rosario, (an executive in a shipping line) for their reported insight into port congestion.

4.14. ETHICAL CONSIDERATIONS

Since interviews of this nature involve human interaction and are at times accompanied by probing and interrogating certain responses from the interviewees, it was of paramount importance that the researcher understands the possible sensitivities of certain questions and/or probing. In this regard, all research respondents were made to understand the nature and purpose of the research (Rhodes, Bowie, & Hergenrather, 2003). The researcher also made the respondents aware that their participation in the research was out of their own volition and that they could elect to withdraw from the process at any time during the interview process without facing any legal contestations or financial loss. The researcher also interviewed the participants after making sure that they understand the questions and that the questions did not involve any words or phrasing that the respondents would have found uncomfortable or compromising them or the companies they work for. All interviews were recorded upon getting permission to do so from the respondents. Rhodes, Bowie, & Hergenrather (2003) states that with changing technology makes it complicated to ensure that the participants details remain anonymous.

4.15. CONCLUSION

This chapter highlighted the research methodology in terms of how data was collected and the need to use qualitative research and interviews. The chapter also highlighted the limitations and bias that this research was susceptible to and how the researcher tried to minimise the impact. The research methodology adapted aided in ensuring that the research objectives can be realised through a valid and reliable data collection process . The research did pose some limitations , especially as the global pandemic had affected participants that were initially approached to participate; however, their opinions , views and perceptions have been included in the literature review through current reports and articles published online. The next chapter detailed data presentation and the research results.

CHAPTER 5: RESULTS

5.1. INTRODUCTION

This chapter presents the results of the research in accordance with the research questions from chapter three. As the foundation for the study was an exploratory study, an understanding of what are the causes of port congestion in Durban was essential to proffer solutions to the congestion challenges faced by the port. To understand how congestion is experienced at seaside and landside, semi-structured interviews with Participants who were experts in the fields of port operations as well as people involved in the maritime landscape was conducted. As the study was inductive, a thematic analysis was conducted to establish the key themes that emerged from the data collected through the semi structured interviews.

In this chapter, a presentation of the summary of the participants feedback are presented through themes. This includes verbatim quotations from the participants as they add to the body of knowledge on the research. The results of the interviews were gathered in accordance with the research questions from chapter 3. This entailed research into understanding why the Port of Durban remains congested, what was implemented in other ports around the world to ease congestion and finally what solutions exist that the port of Durban could implement. The results are presented under each question. The questions were asked in a linear manner to add structure to the interview after the pilot interview was done.

5.2. DESCRIPTION OF THE SAMPLE

The sample comprised of fourteen (14) Participants who were individuals in organisations related to the value chain within the maritime sector and affected by port congestion. Their extensive experience was indicated by their seniority within their organisations as they hold executive, senior manager, and manager (Junior and Senior) titles.

As a result of cancellation of interviews due to issues surrounding the participants personal and company circumstances because of the global pandemic (COVID-19), the research method initially involved purposive sampling however this was then combined with snowballing. The researcher ensured that the participant was not employed by the same organisations as the other participant. Thus, allowing for a varied perspective of how participants experience congestion and how their organisations address congestion issues internally. The sample of participants included individuals who are part of the recently formed decongestion task team for the Port of Durban. All the Participants in the research identified themselves and explained their experience of port congestion aligned to the main constructs of this study.

5.2.1. Analysis of Sample

All Participants have been exposed to port congestion and have experienced it or worked in organisation's that have experienced the effects of port congestion. The type of organisation that each Participant works in was represented in table 3 below.

Table 3: Participants

Participant	Position In organisation	Organisation Type
1	Executive Logistics	Stevedoring , Logistics and Cargo Operators
2	Transport Economist	Government(eThekwini Municipality)
3	Operations Director	Logistics and Freight Company
4	General Manager Africa	Government (Transnet)
5	Manager	Global transport and Logistics
6	Director	Trucking company
7	Operations Manager	Logistics and Distribution (Retail)
8	Manager Operations	Logistics and Distribution(Break bulk , Long Haul)
9	Manager Transport	Global Shipping and warehousing company
10	General Manger Operations	Intermodal (Container Depot Operations, Warehousing of General Cargo and Mining Minerals, Road and Rail Transport)
11	Senior Manager	Logistics and Distribution (Automotive)
12	Manager	Global Logistics and Distribution
13	Manager Logistics	Global Transportation and Shipping Company
14	National Maritime Consultant	Freight Forwarders Association

An overview of the maritime landscape is included in Appendix 6 to assist the reader in identifying the roles the participants play in the maritime sector. The sample consisted of a representation from various government bodies namely eThekwini Municipality (Participant 2) and Transnet (Participant 4). The participants have also contributed to research done within the Maritime sector of South Africa. Participant 14 is from the South African Association of Freight Forwarders (SAAFF) and has contributed to various reports on maritime specific issues. The participants from eThekwini and SAAFF are part of the new decongestion committee. They are regarded as the experts in the panel of participants chosen. The knowledge and experience that they have and contribution to research are the reason that they are experts within the industry.

The other eleven (11) participants' occupied positions in management, the reason for purposely choosing this participant is that they can make or influence decisions in an organisation, thus having the ability to affect how the respective employers behave towards port congestion. The sample consisted of participants that are from stevedoring companies, truck owners and managers in businesses relating to logistics (trucking), logistics distribution, clearing and forwarding companies in the retail, automotive sectors, bulk cargo haulers and a shipping line provided insight into how their operations are affected by congestion. Participant 6 provided insight from the perspective of a trucking company that once worked in the port but is currently operating his business outside the port due to losses incurred because of port congestion. The participant provided insight into the daily battles that was experienced within the port including bribery, incompetent staff managing processes and trucks that were not road worthy being on the bayhead roads. The participants interviewed had knowledge and have experienced port congestion in their organisations.

5.2.2. Distribution of the Population

The sample selected for participation in the interview were represented by individuals from three distinct population groups as shown in Table 3.

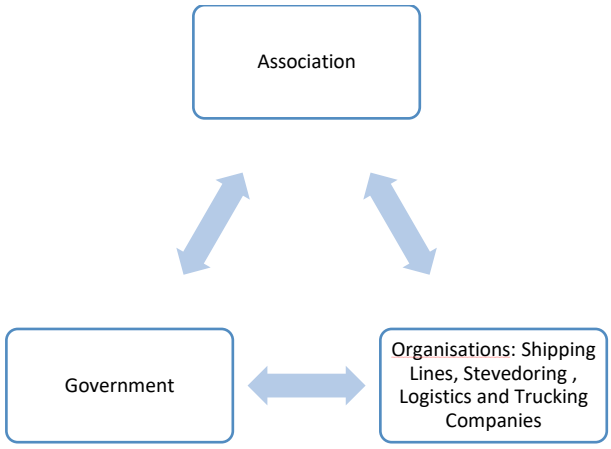

Figure 7: Population Distribution

The participants were from organisations within the public sector, associations, and private sector. The initial intention was to get an evenly distributed sample amongst all participants (Figure 7). However, the split of participants could not be evenly distributed as participants from associations as well as public sector had been affected by the global pandemic (COVID-19). The participants are represented in Figure 8 .

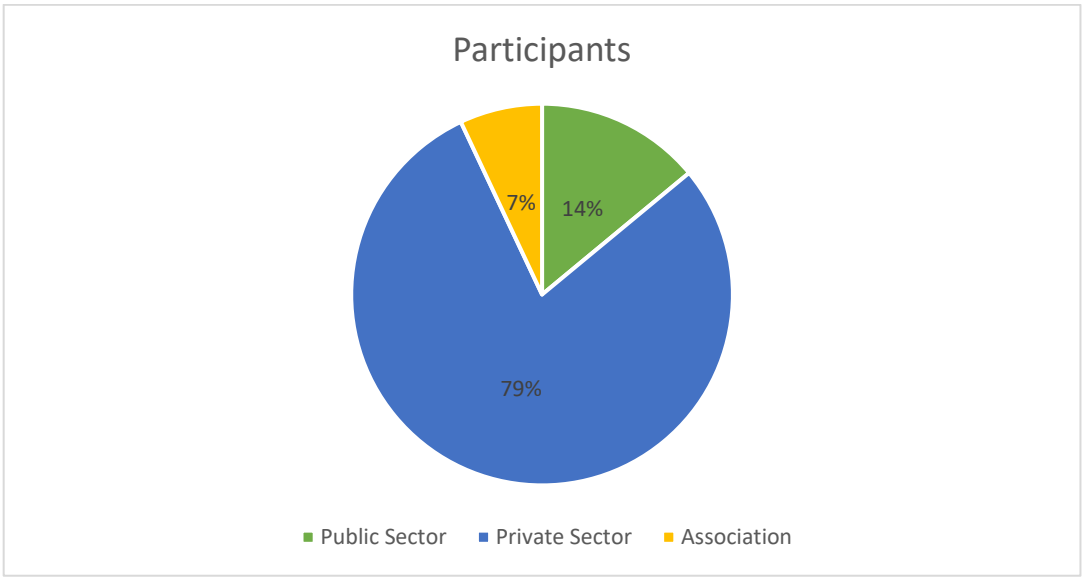

Figure 8: Participants Representation

All participants were either Supervisors (Junior Management), Senior Managers, Executives, or Owners of the organisation. The seniority within the organisation coupled with their experience with port congestion allowed us to evaluate their perspective on

port congestion from varying points of view, with participants that work with private, public as well as associations that represent a body of companies.

5.2.3. Word Frequency

The transcription of the semi-structured interviews that provided the researcher with a deeper insight on the individual opinions of the three (3) main objectives was evaluated for key themes that were common with the participants. The semi-structured interview questions were disseminated into themes or categories to ensure that the research objectives were met. The questions and answers by the respondents were extracted into excel and all common words based on the questions posed or similar words were highlighted, and a separate spread sheet used to account for the words that would form the basis for the themes. The words were assessed, and common words were extracted, similar words were categorised and aggregated, examples include expensive and costly. Each interview was reviewed manually and words that indicate theme within the answers were extracted into excel and counted in terms of frequency of use in the interview.

The total of all key words used by the participants in the interview was calculated and extracted into Figure 9 below.

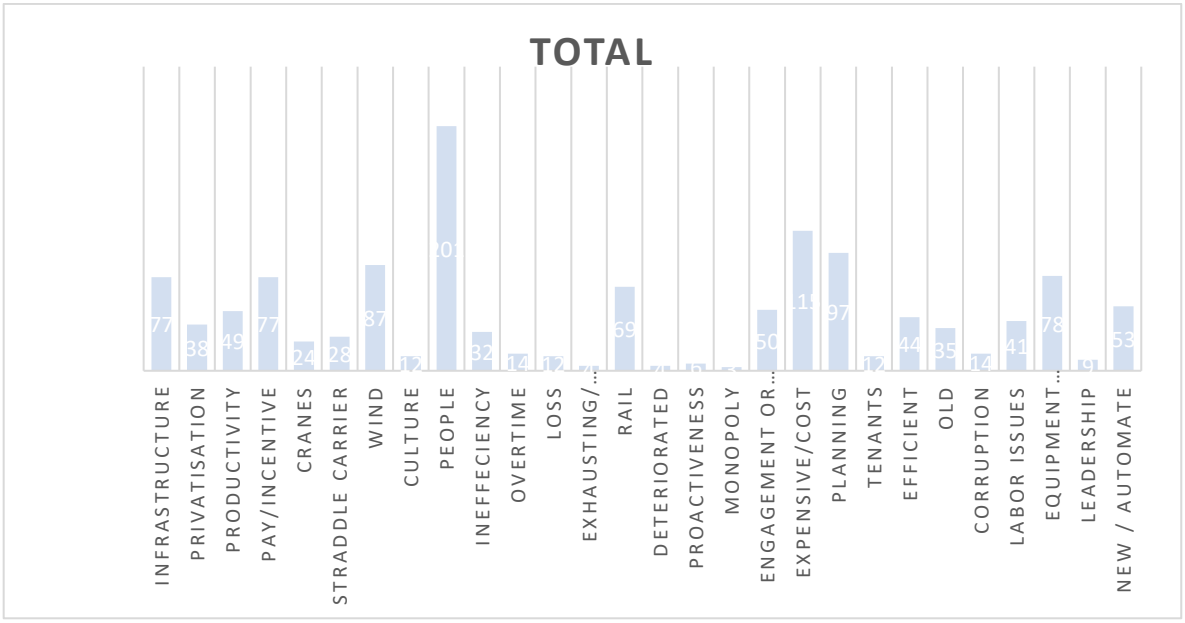

Figure 9: Key word count

From the questions posed to the participants and an analysis of the frequency figures above: people, expensive or costly, planning, equipment breakdown, infrastructure and rail was used frequently in the interview. This information was visually presented below in the form of a word cloud created by an application called ‘Word It Out’. It provides a visually appealing table, where people, planning, costs, infrastructure, incentives, and rail are the words used frequently by the participants indicating the importance to the participant and their organisations. The words are depicted from largest to smallest with the key words being shown in a larger font, aligned to the frequency count shown above in Figure 10.

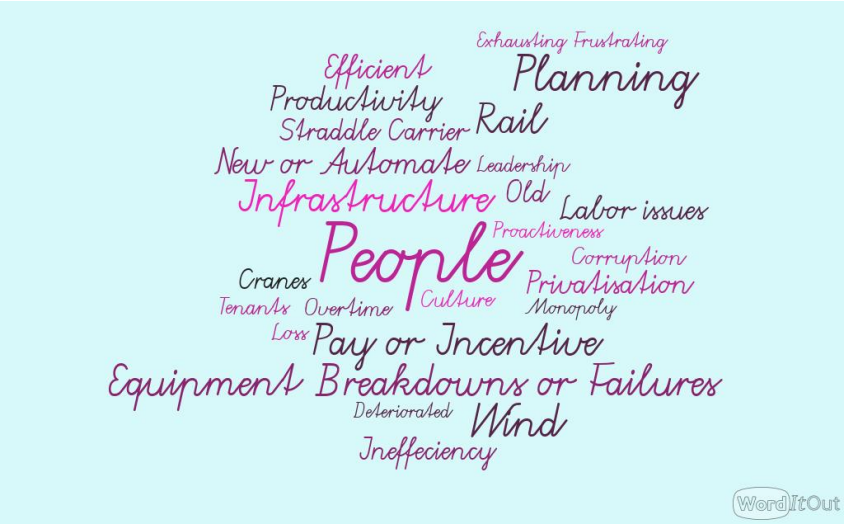

Figure 10: Word cloud

“Planning” was used to describe the organisations perspective on how they have learnt to deal with congestion. It is interesting to note that almost all the participants, except for participant 14, indicated that they plan their operations considering their experience with port congestion, this has assisted them in ensuring that ‘Expensive and Costly’ charges are minimised. This is expected from participant 14 as the participant represents a body of companies through the association. Participants have adopted various planning strategies within their organisations like scheduled operations, daily meetings, analytical data used to access containers entering port, GPS to identify if any congestion issues exist. The participants emphasised the importance of planning any

operation to minimise costs and ensure that the drivers of trucks that operate at the port are not caught in traffic without basic amenities like lavatories or access to food & water. They further explained the uncomfortable position the truck drivers must endure in terms of inclement weather conditions and sometimes having to sleep in the queue overnight, resulting in unsafe working conditions.

5.3. DATA SATUARTION

These words were then categorised into themes. Participants were asked to rank the causes of congestion, with '1' being the main cause, '2' being the second and '3' being the least important but a contributor to congestion. Based on the responses, the key words analysed below, and colour coded , as illustrated in Table 4.

Table 4: Ranking of congestion causes.

Themes	1	2	3
Participant 1	Cordination of tenants and Operations	Staging Area	Capacity-Space
Participant 2	Equipment	Infrastructure	Weather/ Wind
Participant 3	Staging Area	Equipment	Weather/ Wind
Participant 4	People/ Labour	Software Process	Equipment
Participant 5	Infrastructure	People/ Labour	Lack of planning
Participant 6	People/ Labour	Corruption	Road worthiness of trucks
Participant 7	Weather/ Wind	Systemic Problems	People/ Labour
Participant 8	Equipment	People/ Labour	Weather/ Wind
Participant 9	Weather/ Wind	Power outages	People/ Labour
Participant 10	Weather/ Wind	Infrastructure	People/ Labour
Participant 11	Infrastructure	People/ Labour	Leadership/ Decsion Making
Participant 12	Infrastructure	Outside influences (weather/ labour)	Communication Issues
Participant 13	Weather/ Wind	Equipment	People/ Labour
Participant 14	Weather/ Wind	Equipment	Staging Area

Colour Coding was used to identify themes, which is represented below:

Equipment
Weather/ Wind
Infrastructure
People/ Labour
Staging Area/Planning

The white indicates individual themes raised by the participants and could not be confirmed by other participants. The themes were analysed based on People, Process and Systems, Planet and Plant (Equipment and Infrastructure). This analysis was done to understand the main causes of congestion and the applicable solution that exists for the identified problem. The themes are depicted in figure 11 below.

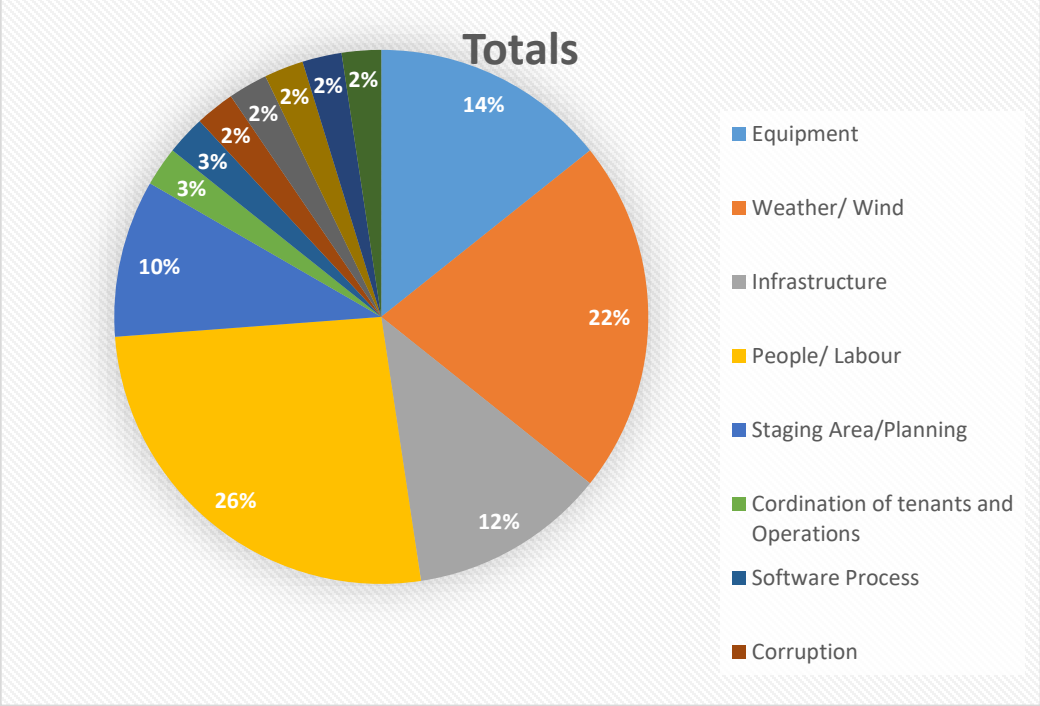

Figure 11: Percentage count of word frequency

The themes indicate that People and Labour issues have been ranked frequently with a 26% response rate, followed by Weather and Wind at 22%, Staging Area and Planning at 14% and Infrastructure at 12%. To assess the data for saturation across the sample of fourteen (14) interviews conducted, an evaluation was performed of all new themes generated after the interview was completed. Table 4 highlights the determination of data saturation using a colour-coded system to identify new themes. The colour white indicates new themes identified. From the data there has been no new themes identified after the twelfth participant's interview. Participant 13 and Participant 14 interviews indicated no new themes. The analysis and context of these words are depicted as the participants in the interview explained them.

5.4. Research Question 1: Understand the causes of port congestion from a land and sea perspective in the Port of Durban.

The objective was to understand how congestion in the Port of Durban was caused from the perspective of the participants and the way they have experienced it as well as how they rank the causes from highest, being the main cause, to lowest being the least. Table 5 below depicts the results from the participants interviewed. The ranking was based on frequency of causes of congestion as identified by the participants.

Table 5: Ranking of causes of congestion.

	1st		2nd		3rd		4th		5th	
Ranking	**Cause**	**Participants**	**Cause**	**Participants**	**Cause**	**Participants**	**Cause**	**Participants**	**Cause**	**Participants**
1	Wind	5	Infrastructure	3	Equipment	2	People	2	Staging Area	1
2	Equipment	3	People	3	Infrastructure	2	Staging Area	1		
3	People	5	Wind	3	Equipment	1	Staging Area	1		

The table above indicates the frequency of rankings by quadrants, with the first quadrant indicating the participants that ranked the causes of congestion the most in the ranking system used. It is interesting to note that Wind has been identified by five (5) participants of the fourteen (14) interviewed, as a main cause for congestion. Infrastructure had three (3) participants confirming it as a main cause, with People and Equipment having two (2) participants each declaring that it is the main cause, and one (1) participant confirmed the Staging Area to be a cause of congestion. The second quadrant confirmed, in terms of ranking, this is the second cause of congestion, Equipment and People had three (3) participants confirming this as a medium cause. This was followed by Infrastructure and Staging Area. The lowest causes of congestion had five (5) participants confirming this to be People, Wind had three (3) participants said it was Equipment and Staging with one (1) participant ranking this as a concern.

The overall top-ranking concerns as based on the participants' responses from the table above are as follows:

1. Wind (5)
2. Equipment(3) and People(3)
3. People (5)

Wind was raised as the main cause of congestion, one (1) participant stated that the port infrastructure was old and had not been designed to incorporate changing climate conditions. The interviews also reflected items that did not rank as frequently. This included coordination of tenants, software process issues, corruption, systemic problems, lack of planning, road worthiness of trucks, power outages, outside influences and communication issues. When one gets a large range of issues mentioned, this suggests that this 'other' grouping might reveal a situation where many factors are at play, although some are noted as more frequently having an impact. Tenants currently utilise the same roads as trucks, adding to the congestion. South Africa is constantly having power outages with traffic lights not working or port operations affected . Transnet has for several years battled claims of corruption by key individuals. Although the items raised are important, for the purpose of this research, they have the least impact based on frequency of ranking from the participants interviews. Participant 14 provided a different perspective on port congestion by stating:

> "I think it is really important to clarify what 'congestion' actually means. If it's simply to remove traffic jams on Bayhead Road stretching into the City then the booking system has largely done that, but the question then is where has the traffic gone, are we just not disguising inefficiencies and passing them on to trucking companies, many think that is indeed the case."

5.4.1. Weather Condition

The participants described the weather conditions as key factor affecting port congestion in Durban from a landside and seaside perspective. Most respondents shared a similar view in terms of wind and weather conditions and its impact on the port. Participant's 7, 9 and 10 are from the logistics and distribution sector and shared the same sentiments in terms of port congestion however it is interesting to note that the shipping lines as well as the freight forwarders association, which represent the voice of all freight

forwarders also felt that wind had a severe impact on port congestion. Participant 7 stated that :“My experience is that the port is wind bound. The downtime causes backlogs which then causes port congestion and so it not only the port, but it is vehicle congestion. …congestion port side is that one cannot offload the ships and then land side is they cannot load the trucks.”

Participant 9 added “ there's no movement or servicing trucks or vessels”. However, it was participant 13’s comment that brought about any interesting argument relating to wind conditions:

> “Cape Town is so prone to wind. But what happens is that you'll find that they'll have three days of wind. And within the next three days, they've recovered from that wind. And then you start to ask yourself how? why?”

Participant 13 added insight into other issues within the Port of Durban that prevents it from recovering as quickly as Cape Town because of weather conditions. Participant 14 added that Pier 1 is more sensitive to windy conditions with the RTG affecting both the landside and seaside operations. Participant 2 representing the government perspective summed up the current weather conditions experienced as “ I think we have got to bear in mind that we are living in an era of climate change … this is a reality … it has been reported in what we have seen in the reports coming from Transnet indicating that weather is impacting.”

Participant 13 further explained how Cape Town can recover from stoppages due to wind when “You look at the equipment that they're using in Cape Town, the exact same model and machine is being used in Cape Town and look at the frequency of breakdowns in Durban and Cape Town. There's a huge difference, so to me, you know there's a lot to do with culture.”

The changing weather conditions are certainly unavoidable, however the approach to recover from this disruption is important. Through proper planning and recovery process implemented the port could lessen the impact of the disruption caused by wind. Participant 13 raised a point of comparing Cape Town port operations to Durban, with

Cape Town experiencing more windy conditions than Durban further research into what operational factors differ within the ports, yet Transnet manages the Ports. The participants had shared communications from Transnet relating to stoppages because of windy conditions via email. Climate change has been affecting the Port of Durban substantially with approximately 79% of the participants referring to it, including participants from government, associations, and shipping lines. Changes in weather conditions have affected both seaside and landside operations. Participant's 1, 4, 5, 6 and 11 did not rank wind as a cause of congestion and Participant 4 and 6 did not mention wind throughout the interview. Participant 4 was concerned about labour and increasing productivity as a 'quick win' to alleviate congestion aligned to Participant 6 response.

5.4.2. Equipment

Participant 3, 8, 13 and 14 agree that new equipment replacing the old ones will assist with reducing time and alleviate the congestion experienced on Bayhead Road as well as seaside operations. Participant 14 indicated that there were approximately 17 breakdowns per shift, amounting to 14 hours of breakdown per shift. Participant 13 proclaimed that working culture affected how equipment is handled, aligned to the point raised with Cape Town's recovery being better than the Port of Durban, whilst Participant 3 explained that when Transnet has machines that are working properly, they might not have people who are trained properly to operate them.

There are varying factors associated to equipment held by Transnet. Participant 3 leaned towards training and culture, like participant 13 who referred to training and culture of people in Cape Town and their ability to turn around a vessel quickly, even though the weather conditions had delayed their operations. Participant 13 elaborated by saying that "You look at the equipment that they're using in Cape Town, the exact same model machine is being used in Cape Town and look at the frequency of breakdowns between Durban and Cape Town. There's a huge difference."

The 'people' element is clearly important in both climate change as well as equipment and must be considered together with these identified causes. Participant 5 claimed that

although Transnet had recently purchased new equipment, the ability of staff to manage the equipment is questionable, which raises a point of the process followed in training staff to operate equipment.

Participant 14 had a different view stating that the equipment is old, outdated, and constantly requiring maintenance, although Transnet is aware of this, their reaction to ordering new equipment is a slow and long-drawn-out process, the participant further stated that Transnet needed the following:

> "Review the entire procurement process for both equipment and maintenance parts is needed. Last minute decision making when the situation becomes desperate, (an example is the purchase of Mobile Cranes for Port Elizabeth early last year) is a symptom of a poorly managed equipment maintenance and replacement process".

Participant 14 added that Transnet should fast track the purchase of new equipment and implement a maintenance schedule with adequate qualified maintenance engineers.
Although Participant 2 stated Equipment as a problem, the participant did not elaborate on the issues along with Participant 4, who quickly stated that there has been a planned roll out of equipment purchase to alleviate the problem. It was interesting that the two (2) participants from the Government that shared similar comments. Participant 14 highlighted that the yard operations need investigation to see if inefficiencies can be reduced through a better layout also indicating that straddles operate extended driving distances and impacts on straddle useful life. The reason given for this by participants was that due to yard space constraints stacks at North Quay are too close to the berths making hauler operations impractical.

5.4.3. People and Culture

Participant 3 and 4 shared the same perspective that there is a significant shortfall in the skills gap due to the lack of experience. Although money has been spent on training employees, they are not motivated. They both concurred that the port should:

> "Employ attitude rather than skills rather than qualifications".

Participant 5, 6 and 9 further elaborated that as a country and employees of organisations, we constantly strive to meet legislation and codes (BBBEE) to satisfy shareholders and government at the expense of trying to salvage an organisations reputation or save costs incurred by the end consumer due to Transnet's employees.

Participant 8 stated that:

> "Currently, when you do call the port for assistance, it is difficult to get through. Lack of accountability, passing the buck, no stress and would not take initiative to go the extra mile or provide suggestions or alternatives to your problem. Also, staff are not adequately trained to use their own systems and provide details. The Port controls your destiny and work for the day. Should TPT not have sufficient capacity, example, staff on leave, absenteeism etc. On the day the number of truck appointments are reduced without notice thus causing financial impacts on our company."

People, culture, training, leadership, labour disputes, incentivised work force have been key words used by the participants in their interviews, with ten (10) out of the fourteen (14) participants ranking People and Labour as important contributors to congestion. Further emphasising the importance of the labour in addressing the port congestion issues faced in Durban. Interestingly to note is that only Participant 1 (Executive in Stevedoring), Participant 2 (Transport economist: Government) and Participant 14 (Maritime economist: Association) did not rank people as being a cause of congestion in the port. However, the participants did mention that further training and development is required by Transnet to better "equip" Transnet staff to handle different situations and for Transnet to embark on a recruitment strategy that emphasised on a transfer of knowledge and skills from people employed in ports that are more successful. An interesting point raised by one of the participants is that in the past staff were motivated by completing the task and leaving the job early, the participant believed that motivational factors do not always have to include a monetary element but could be intrinsic as well.

Participant 13 assisted the researcher in understanding what had gone wrong with the productivity of staff, the participant stated:

> "Some time ago they restructured the bonus system and I think from there onwards there was so much of disgruntled staff and that type of thing. Something has really gone into their minds to want to have negative attitude towards their work."

Participant 13 stated that the participants organisation, undertook a small research project to assess performance of a crane driver. The driver was monitored and was required to move a specific number of containers within a time frame and as soon as the monitors are withdrawn the staff members productivity drops indicating that they have the skills to perform but lack the motivation to do so.The varying results indicate that there is a serious problem with the performance management system, reward system, recruitment process as well as the training and development aspect of Transnet.

5.5. Research Question 2: Determine methods adopted by successful ports in addressing port congestion and their applicability to the Port of Durban.

Wind, Equipment and People are factors that affect the Port of Durban in terms of congestion, however wind and changing weather conditions are experienced globally. Understanding how other ports in the world address these issues adds insight into how Durban can approach the congestion issues identified and possible even break these down into quick wins and changes that are more radical that the port will have to implement. It was interesting to understand the participants perspective as well as experience with oversees ports yet very few participants could add input into benchmarking or how successful ports addressed congestion. The limited insight provided is listed below:

5.5.1. Equipment and Infrastructure

Participant 4 explained that Transnet had recently purchased four (4) straddle carriers for the Cape Town Port from Poland, which had the capability of withstanding a higher wind speed than the current equipment in the port.

5.5.2. Port Births

Participant 8 stated that that Durban has: “Too few berths available to berth vessels. Bigger vessels are redirected to New Pier because of the shallow waters at DCT. Deeper births at DCT would assist birthing of larger vessels.” This being a trend in the marine sector, as vessels become larger to carry more cargo.

5.5.3. Digitisation

Participant 8 further stated that: “For long lasting solutions, all parties in the supply chain needs to be part of the solution to avoid port congestion, e.g.: Shipping lines, truckers, rail operators, port authorities, logistics service providers, IT Specialists – all need to be involved. Digital cameras matching the truck with the assigned container. All activities at the port to be paperless reducing the time driver has to wait for processing”.

5.5.4. Labour

Participant 11 stated that he believed “training of this staff members” is essential and the best way to achieve this would be: “Investing in middle management technical skill where they can send employees and the second in charge on two-year sabbatical to like Singapore or one of the busier airports so they could learn from and transfer knowledge when they come back.” Participant 4 concurred with this and confirmed the success that has been had from these deployment initiatives. Participant 4 stated that Transnet had recruited “127 Sri Lankans, who were trained by the government*”,* this initiative entailed them being relocated to Durban and assist with increasing port productivity, which Participant 4 confirmed had happened. Participant 13 stated that Port Louis’s staff are “resilient” but delivery is key, there is no excuse for poor efficiency’s in the Port.

5.5.5. Truck appointment system

Participant 14 focused on the Truck appointment system and its ability to be flexible to accommodate the trucking companies. The participant further stated that: “To be turned away and told to re-book when arriving 30 minutes late for an appointment is unacceptable when the delay was clearly beyond the driver’s control.” Although Participant 14 stated the shortcomings of TAS, the participant also stated that the system is appearing to operate and serve its purpose of reduced congestion on the roads. This was a perception shared by many of the participants. The truck appointment system has been implemented by many other success ports in addressing the congestion issues that they had faced. Participant 14 further stated that the truck appointment system works well if it is tied to a penalty system as well. Interestingly to note was that one participant felt that the system was a “waste of time” and should be abolished as staff performed better prior to its implementation. The participant indicated that “As at November, Durban total TEU imports 2019 was 1,255,091 2020 and 2020 was 1,005,432 a drop of 20%”. This then brings about the questions of ,is the TAS system effective or has containers decreased to a stage that the port can handle? Is this the level the port should be operating at ? Chapter Six will investigate the alternatives that exist in other ports as raised in the literature review and add insight into the methods adopted by other ports as described by the participants.

5.6. Research Question 3: Proffer solutions to the congestion challenges faced at the port of Durban.

The aim of the research is to address the innovation lag in the port of Durban to alleviate congestion. In understanding the solutions and innovation required, a deeper understanding of the causes of congestion was essential as explained in research Question 1. The participants had varying elucidations that could proffer a solution.

5.6.1. Free days in port

Participant 8 suggested “Increasing the number of free days to pick up containers perhaps from 3 to 5 days, thus evenly spreading the workload”, interestingly ports globally introduced a penalty system against the port for long waiting time experienced by trucks rather than increasing free days.

5.6.2. Communication

The participants mentioned that if TPT engaged and communicated with all stakeholders for feedback and suggestions this will considerably improve the working conditions in and around the port. Participant’s complaints stemmed from the fact that TPT does not communicate its constraints timeously or engage in conversation with its stakeholders to understand their frustration as well as to determine if there is a more transmissible way of operating the port. Participant 1 stated that better communication channels should exist between the port and the stakeholders, 12 other participants concurred.

5.6.3. Procurement and Privatisation

Participant 14 stated a

> “Review the entire procurement process for both equipment and maintenance parts. Last minute decision making when the situation becomes desperate, (an example is the purchase of Mobile Cranes for Port Elizabeth early last year) is a symptom of a poorly managed equipment maintenance and replacement process. The requirement for Treasury to approve purchases in advance must also be reviewed. Proper management of equipment reaching half-life and end of useful life with clear forward plans will mean finance decisions and funds retained well in advance and not last minute.”

Participant 14 focused on the need for better procurement policies as well as privatisation or finding partners who can assist Transnet in their processes. This is a point of view shared by all the participants except 2, 4 and 12. This reiterated the

importance of privatisation within the port as well as a coordinated working relationship with private entities that could potentially be engaged in the future to assist or be part of any privatisation strategy. Participant 13 stated that with private ports “service delivery is key” and organisations are guaranteed quality service regardless of the circumstances that the port faces, a solution driven approach is taken. Participant 7 stated that “they should be partnering with businesses” to progress Durban as the hub port of choice for Africa.

5.6.4. Software, Automation and Equipment

Participant 7 brought to light the use of analytical software that would allow the port to analyse the data in terms of movements, issues or bottlenecks and potential solutions based on trends. An analytical tools and dashboards that could potentially allow them to analyse and indicate potential constraint.Participant 7 stated that in the long term more automation within the port is important like that of Netherlands, Shanghai and Singapore. The participant further stated that implementing a smart port would mean that we will be faced with the unemployment rates increasing and it would be difficult to develop a nation however if we keep looking for an excuse not to develop as a nation we will not move forward. The participant described this as “You either win it or lose it, but at least you know where you're going.” Participants views were distinctly different as most participants stated that unions will be “up in arms” and “our country is not yet ready for such a change”. However, Participant 7 exclaimed that we must start somewhere in developing our country and that with more automation, we can start to retrain and develop the skills we need in stages rather than leaps. Investing in high technology, digitisation, upskilling staff, and continuous training is crucial.

5.6.5. Rail and Infrastructure

The participants further stated that having a working rail infrastructure can directly alleviate the congestion experienced. The participants concurred that the rail infrastructure and improvements would be a low hanging fruit and should be on top of the priority list for Transnet. Moving the cargo to a less congested area like the Clairwood

Logistic area that has been identified would ensure that the port is more efficient as it would be moving congestion out of the city and into an area that can manage the cargo more effectively. However, Participant 13 raised an important point, stating that the port should negotiate with the tenants, to ensure better utilisation of port space to ensure that the economic benefits associated to Durban being a Hub is realised. Participant 13 further emphasised that, if this is impossible, then the port should look at ensuring that the export containers are stored at the port and imports are moved to an offsite facility, a similar process is followed in Keelung Taiwan.

5.6.6. Labour and Governance

Participant 11 stated that:

> " training and development is something that they should focus on very quickly to improve productivity levels…. I think it is a low hanging fruit which needs to be addressed."

The participant further pointed out that the governance issues surrounding Transnet also needs to be addressed urgently. Most participants found this to be an incremental change and something that the port can address rather urgently. Participant 8 raised bribery, corruption, and governance issues that the port faces and described these something the port could address easily.

5.6.7. Incremental and Radical Innovations

Participants were requested to identify the incremental or low hanging fruit and radical innovation that can assist the port in addressing the congestion of the port. The various responses were tabulated below and based on the 4 key areas identified to address congestion, being People, Equipment, and Infrastructure (Plant), Processes (Communication, Privatisation & Procurement) and Plant (Wind Conditions). The purpose of this is to categorise it to ensure that the solution fits the causes of congestion raised in Question 1. The participants' perspectives are tabularised in Table 6.

Table 6: Incremental Innovation

Description	Outcome
1. One participant stated that Transnet should "*Remove the transport management system , traffic will move faster, and people will work faster".* This transport management system has been found to be a globally effective transport management system, confirmed by participants in government as well as associations , however the underlying issue is that people worked according to the trucks that were outside the port and this required a greater deal of speed .	People
2. Participants described communication as a low hanging fruit by improve technology in terms of communication and engage with all stakeholders.	Process
3. Better recruitment process , hire for attitude and ability than aptitude Participant 8 elaborated that "incentivisation or motivate staff for quicker turnaround time to load a truck and process the necessary documentation." This point of view was held by twelve (12) participants and clearly is a factor that is affecting the port achieving the levels of productivity that is vital.	People
4. Handling of information , not a manual process but more automation . Bio matrix for drivers . Review of documentation before hand	Process
5. Truck Rollout Plan(replacing trucks after a period of time). Reduce emissions and breakdowns experienced.	Planet
6. Introduce proper change management processes.	Process
7. Training and Development of staff	People
8. Fast track purchase of new equipment and implement a maintenance schedule with enough qualified maintenance engineers.	Plant
9. Increase towers from 3 to 5 , Dual lift system for the port, off dock staging area for truck processing	Plant

The People context was emphasised quite strongly by the participants from incentivised working culture (monetary) to one participant even raising intrinsic rewards as a potential motivation for enhancing productivity. This was followed with training and development, which ties into the causes identified and the recruitment process. Interestingly to note was that the approach to a better recruitment process was identified as a solution by one participant and this was not the same participant who raised hiring process should be "about attitude and not aptitude". The same process was applied to all radical innovation identified by the participants as illustrated in Table 7.

Table 7: Radical Innovation

Description	Outcome
1. Rail network completed and in operation.	Plant
2. Cargo transported to another location for easy pick up and drop off , better use of technology to process trucks (Staging area).	Plant
3. Technology can work at wind speed of 80/90kmph.	Plant
4. Removal of tenants that are not related to port operations.	Process
5. Privatisation of the port and key operations.	Process
6. Automation of the port and a move to a smart port system , with less reliance on labour Automated stacking systems. Analytical data analysis.	People

5.7. CONCLUSION

Although wind and weather conditions were identified as a lead cause of congestion, the participants proffered no solution. Some Participants stipulated that they were not aware of any new developments in the port or other ports in the world to address the changing climate conditions. A participant suggested that the port investigate what windbreaker systems exist. The key themes that emerged from the research was extracted and placed in groups depending on key words used by the participants. People or Labour, Planet (Wind Conditions), Plant (Infrastructure and Equipment) and Process and Systems were identified as the key themes in understanding the causes of congestion. Labour issues have been raised by all the participants with key words like motivation, incentives, increased productivity, training, better recruitment raised as participants' perspectives. Although infrastructure is a key issue and has been raised in several meetings by the various forums addressing port congestion, the main issue identified is Wind. An analysis of the port design will allow for better understanding of how wind affects the port and contributes to congestion versus how staff react to an uncontrollable situation and how proactive they are in the recovering process proceeding such disturbances.

Privatisation of port operations as well as better communication from the port were identified as hindrances, with rail and equipment purchases playing another key role in addressing the issues surrounding the port along with a staging area outside of the port. Although communication was not identified as key issues causing congestion, the item remains a "low hanging fruit" for Transnet to achieve some success in ensuring stakeholder engagements. Better communication channels between all the stakeholders

can provide for a better opportunity to drive innovation forward as all stakeholders become part of the journey towards the solution. Privatisation and Rail were identified as radical innovations, despite the port already starting to implement its strategy in terms of these solutions. Although the rail network is in existence, enabling a speedier system will offer far greater advantages, in terms of cost savings as well ability to transfer more cargo in a quicker period.

The interesting point raised by all the participants, except Participant 14, was that planning is key in their organisation. Participant 13 stated that a “better planning systems” could address many of the port problems. The participants confirmed that their organisations have implemented various planned strategies to navigate the congestion issues surrounding the port, to minimise costs incurred.

As the barge operations is a key strategy applied in various ports in Europe, the participants were asked their view on the applicability of the barge to South Africa. Whilst some participants did not have much insight to share on this, one participant raised a valid concern. Would the barge operation move congestion around because all it does is move the containers, or bulk, from one congested point to another as space is a constraint within the port.

CHAPTER 6: DISCUSSION OF RESULTS

6.1. INTRODUCTION

In this chapter, a compilation of the interviews and themes from Chapter Five are tied to the literature review performed in Chapter Two aligned to theory as well as add to the theory of innovation. The results in this chapter focus on analysing the previous chapter in relation to any theory as an attempt is made to decipher potential contributions to theory and provide corroboration to the literature review. The deliberations provided in Chapter Five, were then combined into a summarised format according to the themes to highlight the dominance of a particular area of contribution in understanding the causes of congestion and possible solutions to alleviate this problem.

6.2. DISCUSSION OF RESULTS

The research question seeks to understand what the participants perceived to be the causes of port congestion in Durban. The participants were asked to rank the causes of congestion with one (1) being the main cause. Thirty six percent (36%) of the respondents declared Wind and Weather conditions to be the main cause of congestion. Followed by Infrastructure with 21% of the respondents proclaiming this to be a main cause and then 14% of the participants declared Equipment and People to be the main cause of congestion. The first question of what the causes of congestion are, as experienced in the Port of Durban, are discussed in item 6.3. Although some insight was provided into possible solutions when the problems were discussed and not raised during the discussion on incremental and radical innovation, this author chose to discuss the solutions with the problems identified. The second question related to benchmarking other ports is reflected upon in the results of items 6.3 and 6.4. The third question relating to the possible solutions that might exist are discussed in item 6.4 below.

6.3. CAUSES OF CONGESTION

The research question sought to understand why the Port of Durban has congestion, which ultimately affects the entire value chain.

6.3.1. Climate Change

6.3.1.1. Question1: Causes of congestion

From the literature review, Gidado (2015) declared that weather conditions are one of the causes of congestion that have halted ships and caused operations to stop however, the participants have confirmed through ranking the causes, that wind has been ranked the main cause for congestion in the port of Durban from a landside and seaside perspective rather than the seaside as mentioned by Gidado (2015). There has been limited literature that exists around weather conditions and ports with research focusing on seaside operations and the impact of climate change. Rosario (2020) confirmed what the participants were preluding to in terms of the effect of wind and the disruption in cargo operations due to bad weather. Rosario (2020) has stated that 300 days per annum are the actual working days for the ship to shore gantries, which has been cutting off at wind speeds exceeding 70kph.Which interestingly enough , the participants have also stated that there is an increasing number of windy days causing congestion.

Although the Environmental and Climate Protection Department within the eThekwini Municipality and Participant 2 shared the sentiments that changes in the weather conditions will affect the port operations (eThekwini Municipality, n.d.), the new plans to alleviate port congestion did not mention any infrastructural changes that the port could adopt to attend to the increasing windy conditions experienced. Durban has a coastline that is vulnerable to climate change because of poor planning, design and layout and climate variability (Mather and Roberts, 2015). This is a key point and was raised by the participant who indicated that ports were built in a time when climate change was something that people never considered at the planning stages, however, the Durban port did not adapt to the changes that followed and remained a port built in the early 1900’s. The results indicate that an incremental change in the climate can only serve to

intensify this exposure and result in further delays than currently experienced. High winds prevent crane operations and affects the safety when navigating causing delays and port closures, affect bulk gantry and container crane. The participants concurred with Rail (2015) stating that there is a need to develop robust designs for the quay gantry cranes that can tolerate wind speed that have usually caused port closure. In 2012, Becker, Inoue, Fischer, and Schwegler elaborated that planning for climate change will require ports to reconsider an array of paradigms, which include designing infrastructure that could withstand the elements of climate change beyond the average port administrator's career. Today this item still has not appeared on any of the agendas relating to port congestion.

Although various reports like the Integrated Development Plan (IDP) by 2030 included the climate change impact on eThekwini identifying sea level rises, our research suggest that government organisations have given little attention to the effects of changing climates on the Port of Durban and its economic impact. Delays experienced in the port are costly, with the end consumer ultimately paying the price for such inefficiencies that have a potential solution to reduce the costly impact that they endure. The research indicated that planned maintenance of equipment that is communicated with stakeholders is essential to reduce further delays, especially after closure of port operations.

Mbonambi (2018) stated that August until January is the windy season, however, this contrasts to the participants responses and Rosario, with reports on the Transnet Port Terminals website regarding terminal updates indicating changing patterns in terms of wind. On 10 March 2021, the Transnet port terminal – terminal updates website was accessed and data pertaining to the period from 1 February 2021 until 5 March 2021 was examined to review the windbound notices issued by the port. The data as presented in table is extracted from the notices issued as illustrated in Table 8.

Table 8: Transnet's correspondence relating to wind.

Date	Description	Wind speed
1 February 2021	DCT PIER1: Landside and Waterside on standby windbound from 04h15	75 kph
1 February 2021	DCT PIER1: Landside and waterside. Resumed at 21h00	
1 February 2021	DCT PIER1: Standby from 8h20	75 kph
1 February 2021	DCT PIER1: Resumed at 6h00	
8 February 2021	DCT Pier2: From 07/02/2021 at 12h00 windbound	80 kph
16 February 2021	DCT PIER1: Resumed at 7h00	
16 February 2021	DCTPier2: Land and Rail resumed at 6h30 but waterside still windbound	
16 February 2021	DCT Pier2: Windbound from 15/02/2021 (14h00) until 16/02/2021 at 7h00, however slots are frozen and will be reviewed at 12h00	
20 February 2021	DCT PIER1: Land and waterside disrupted from 19h00	74 kph
05 March 2021	PIER2: Land and rail resumed at 14h00	
05 March 2021	Windbound, resumed at 14h30	
08 March 2021	Pier1: Windbound from 20h30 till 23h10	

Source: Transnet Terminal Updates, 2021

At the time of doing the interview in December 2020 and January 2021, weather conditions were raised as the main cause of congestion aligned to the period as discussed in Mbonambi's (2018) research. However, the extracted data as shown in Table 8, from the terminal updates indicate that the windy conditions persisted into February and March, further research needs to be done on the changing weather conditions experienced in Durban and its effect on the port.

A review of the notices issued by the Customer Interaction Centre, Transnet Port Terminals, indicated that notices are not regular and consistent with information as to when the windbound conditions started, and port operations recommencement. With information being inconsistent and infrequent, it adds to the logistics operator's frustration as communication from the port is vague as raised by the participants and this is aligned to the data extracted from the updates for the wind conditions Equipment failure and breakdowns have not been included in the terminal updates despite the participants indicating receiving these communications. The participants further emphasised that the weather conditions result in equipment shut down at 70kph, whereas in the literature review it has stated that Cape Town experiences a shutdown

of equipment's at 80kph. Ports that are adaptable to change whilst building resilience to climate changes is now an imperative. Our research is not based on investigating the effects of climate change on the ports as this would involve utilising the skills of a meteorologist and would be an area for further study but to rather highlight what the causes are of port delays and to identify solutions through the participants' engagements and the review of literature around potential solutions.

Further investigations or research into the exact wind speed that machines could tolerate operating is required. Is Durban being cautious in stopping machines at 70kph or is there a tolerance on the machines to operate up to a wind speed of 80kmph? A question that requires machine operators and Original Equipment Manufacturers (OEM) to provide insight. Wind cannot be looked at in isolation but affects infrastructure and equipment.

6.3.1.2. Question 2 (Benchmarking) and Question 3 (Solutions)

Merging literature and the participants perspective, the results suggest that windy conditions are increasing, and more focus needs to be given to this. Although the Cape Town Container Terminal has implemented various strategies to address the weather conditions it experiences, Durban needs to adopt some of these strategies, namely the new straddle carriers that were purchased which can withstand wind at 90kph, the recovery plan undertaken to ensure quick turnaround of vessels. It is interesting to note that the TPT manages the ports, yet the operations appear to be managed differently, with the Cape Town Port appearing to be the port that the Port of Durban needs to be benchmarked against in terms of strategies applicable to weather conditions, recovery time and productivity. The straddle carriers purchased by Cape Town allows operations to continue at a wind speed of 90kph. Venter (2020) reported that the maritime sector advocates for the use of straddle carriers in windy conditions are experienced, however Transnet chose to move to the RTG model of operations.

The Port of San Diego (California) considered involving all stakeholders to the port in its Climate Mitigation and Adaptation Plan. This approach taken on this plan can be adapted to a South African context and will fulfil the rudiments of the participants who

mentioned the inclusion of stakeholders in decision-making and communication. The plan includes a risk evaluation framework that assesses the risk and identifies potential solutions. Climate and Infrastructure need to be evaluated together to assess if a reasonable solution exists that could ensure the possibility of adapting the ports infrastructure to have the ability to endure any climate change impacts.

Although TPT intends to investigate wind mitigation strategies like anti-sway technology that are on cranes as well as other technology (Transnet National Ports Authority, 2019), a participant mentioned that the port should look at implementing a simple windbreak system but could not offer any further detail. Windbreak systems are employed within the agricultural sector to reduce soil erosion (Hall, Sudmeyer, McLernon & Short ,2002). A similar process applied to the agricultural sector can be adapted using modern technology and equipment to assist in reducing wind speed.

6.3.2. Equipment

6.3.2.1. Question1: Causes of congestion

The participants named equipment failure and breakdowns as being the second cause of congestion. The research suggested that the equipment is old and outdated, maintenance of equipment is lacking, and training of staff in handling equipment is an issue. The results indicated that the procurement process for both equipment and maintenance parts needs to be re-examined as the equipment is purchased over a long period yet the need for the equipment is now. The process of procuring equipment is described as laborious and subject to budgetary constraints. Equipment purchases and maintenance are restricted based on budget allocations is detrimental to the economy as the port accounts for approximately 60% of the total number of containers handled at South African ports (Africa Ports and Ships, n.d.). Equipment that is not maintained and new equipment not purchased timeously affect port efficiency, confirmed by literature and participants . Port efficiency affects international transport costs and other scholars posit efficient ports add to a decreased transport costs and improved trade volumes. Gidado (2015) adds to these sentiments by stating that African ports should enhance planning, regulation, capacity, invest in basic infrastructure, modern equipment,

efficiency, or a combination of these. Terminal operations indictor is a key performance indicator that is utilised in assessing port efficiency, which measures the efficiency of equipment to meet the demand. An assessment of the efficiency indicators can identify the exact cause of the problem. Breaking down indicators to components and equipment will ensure that the port is able to identify the exact cause of delays and allow more innovative ways to address the congestion problem.

The research indicated that Transnet last-minute decision involving purchase and replacement is a sign of a reactive strategy rather than a proactive maintenance and replacement strategy, this will reduce downtime substantially rather than the port waiting for a situation to become desperate. This is described as a clear symptom of a poorly managed equipment maintenance and replacement process. The procurement process about equipment purchases needs to be reviewed, as a better understanding of the cost benefit analysis is required to understand the effects of late purchases and replacement is having on the port. Life cycle cost management planning and assessment will ensure that a forward plan in terms of asset purchases as well as replacement of spares and repairs will allow finance to be adequately advised by correct data. Allied to this advance ordering from suppliers will end last minute panics because of supply constraints.

6.3.2.2. Question 2 (Benchmarking) and Question 3 (Solutions)

Participants confirmed that a review of the internal yard processes is essential to identify the problems relating to equipment. Pier 1 operates with Rubber Tyre Gantry's (RTG) and hauler uplift and delivery to Gantry. Although new equipment was purchased, participants continued to raise equipment failure as a cause for congestion, also indicating that straddles operate extended driving distances and impacts on straddle useful life. The reason given for this by participants was that due to yard space constraints stacks at North Quay are too close to the berths making hauler operations impractical. Further research indicated that suggested implementing dual-cycling operation, this requires a synchronised operation of loading and unloading ships (Motau, 2015). A participant confirmed that this will allow for the productive use of quay cranes by ensuring quicker turnaround time. Planning the operations requires trial and error

before synchronisation of operation can occur with equipment availability and space management of the terminal.

The research indicated that DCT Pier 2 has three (3) operational towers as oppose to the original five (5). This clearly causes congestion and delays at towers during busy periods. There is a long term need for a review of future volumes and an assessment of how the port will handle increased traffic such review should include all port users not just Transnet. Participants viewed an ‘off dock’ handling of import containers to be a cheaper capital expenditure option than either Salisbury Island fill in or the ‘Dig Out Port’, which are part of the port development plans. Further literature review suggests ‘off dock’ handling refers to a multi-agent system, involving the sharing of data relating to cargo, cargo-related document screening system which allows for the carrier as well as logistic companies to ensure that all the data presented at time of collection or dispatch is correct (Motono, Furuichi, Kimoto, and Suzuki ,2014). Further elaboration by the participants emphasised that the ‘off dock’ site can be used as staging area for trucks before they enter the port allowing for an easier flow of traffic, as information is verified before port entry.

Rosario stated that port congestion will be a thing of the past if equipment was better utilised, indicating that spare capacity exists within the port this was further emphasised by Motau (2015), who also indicated that the port will need to look at a twin lift system which will allow the gantry to carry two 40-foot containers in a single lift and the quart capabilities allows for four 20-foot containers to be carried on or off the ship on a single lift. This was confirmed through the interviews with the participants who felt this would add value to the port through the increased capacity that the port can handle seamlessly. With the cranes, being utilised at full capacity efficiency can only be achieved if the stevedoring companies, port operators and the staff employed by the port are synchronised in their approach to operations. Staff will need to be highly skilled to ensure efficiency is achieved.

6.3.3. People

6.3.3.1. Question1: Causes of congestion

The research found that the staff productivity within the Port was affected by not being incentivised with one participant stating that productivity in the past was motivated by leaving early when the tasks were completed. Rosario (2020) argues that DCT need to reintroduce worker incentive schemes that linked performance to monetary incentives, as is the global norm.

The question of moving to greater automation and less reliance of employees was posed and brought about the discussion on the impact to the South African economy, which is currently faced with skills shortage. The country will not easily transition into a Smart Ports culture with highly skilled staff. South Africa also has the Unions which affect the behaviour of employees as well. Despite this, one participant strongly felt that as a country, we will need to start in the transition phase to an autonomous environment, resistance to change will not help the country become a competitive player on a global scale but will add to the shift the country has experienced with other ports in Africa gaining because of the Port of Durban's inefficiencies.

6.3.3.2. Question 2 (Benchmarking) and Question 3 (Solutions)

The results suggest that Transnet should employ people whose attitude towards work was better than their aptitude, for example, small incremental changes such as a change in worker attitude may have huge impact on productivity than huge capital investments in equipment and technology (Teece, Peteraf, & Leih, 2016). Having a strategy that allows employees to diverge their compensation or remuneration based on their individual needs can positively motivate an employee's behaviour in the organization and even aide in increasing the organisations competitive position. Rosario (2020) stated that Transnet management decided to transfer the additional revenue to the Transnet Group, worker performance declined, and the port lost its credibility in terms of efficiency. The research indicated that a better performance management system needs to be considered , coupled with a recruitment and training policy.

6.3.3.3. Framing the Problem

Although the study aimed at addressing the innovation lag, the research found other controllable and uncontrollable forces that affected port congestion. The uncontrollable force is the changing climate condition, and the controllable force is the labour issues that the Port is experiencing. To understand how innovation can assist, the responses from the participants categorised into themes. This is depicted in figure 12.

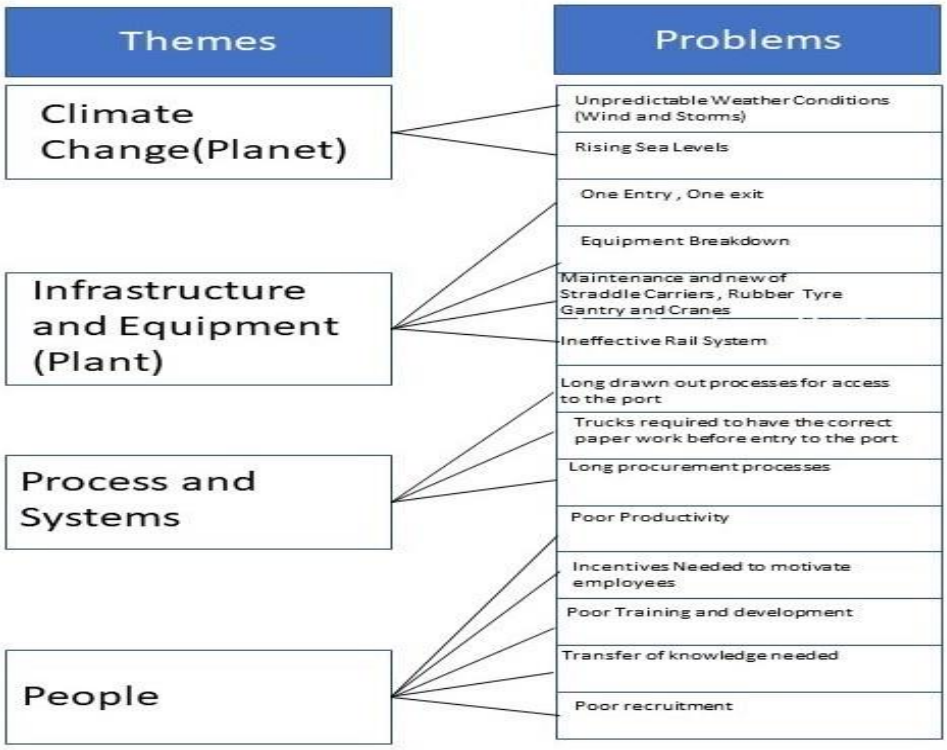

Figure 12: Causes of congestion.

The figure categorised the problems based on the effect to People, Planet, Process and Plant. The outcome that the research aims to achieve understands the innovation lag through a review of the type of innovation that is required. By affecting an incremental change, the port can move to stage of efficiency. An addition to the innovation model presented by Kahn would be a consideration to the environmental factors at play combined with incremental and radical innovative solutions that can ensure the desired outcome is attained.

6.4. SOLUTIONS TOWARDS PORT CONGESTION

The last stage in a value creation process is the smart port, which involves the digital integration into the operations of the port that will make the seaport smart through integrating all actors of the ports to ensure a stage of efficiency in the seaport operations. With the growing use of IOT and the needs for analytical and digitisation, aspects of the smart port system are slowly incorporated into the daily operations of the port, this was confirmed by participants who are also stakeholders within the port system. For a port to move to a smart port collaboration with all stakeholders is essential and addressing the quick wins will make for a more sustainable avenue to reaching a smart port status (Berns, Dickson, Vonck & Dragt, 2017). Whilst the research indicated that the Port of Durban is not ready to be a Smart Port, it is important that they incorporate certain elements of the Smart Port structure considering the digitisation era that we are currently exposed to that has seen businesses streamline their operations. The research indicated that, smart ports are a well-known term amongst the maritime community. The research confirmed that maintaining a seamless operation is always a challenge and involves communication between many parties and a collaborative approach.

The literature review provided description of what innovation entails. The application of incremental and radical innovation becomes applicable as ports reinvent the way they operate, with participants stating the low hanging fruit might be the quick wins the port needs. The solution to the problem will allow the Port of Durban to compete successfully as a major contributor to the GVC. Problem driven or outcome driven (Kahn, 2018) innovation with incremental and radical solutions assist in ensuring competitiveness within the value chain (Coccia, 2017). Differentiating between radical and incremental innovation is essential. Their main objective should be to simplify the business processes. The research used Kahn 2018 model of outcome, process, and mindset. The outcome is to address the innovation lag in addressing port congestion. Kahns (2018) innovation model describes innovation as an outcome as a process innovation that requires a change in a process to achieve efficiency, which is an outcome that the port currently seeks to achieve.

Kahn (2018), process model for innovation portrays three phases: discover, develop, and deliver. The discovery phase involves the organisation identifying potential opportunities and investigating these opportunities .In the case of the research this is taken from the main causes of congestion. In understanding what the participants believe to be the main causes, the researcher can look at ways in developing solutions by identifying opportunities. It is at this stage that the technical specifications are delivered and before the item is ready to be delivered in the port or marketplace.

The breakdown of incremental and radical innovation is a key area. It is through incremental changes the port can start to achieve efficiencies and prepare the stakeholders for a stage of radical innovation. Using the key themes as identified in the research Climate Change (Planet), Infrastructure and Equipment (Plant), Process and Systems and Labour (People), the responses from the participants as shown in Table 6 (from Chapter 5) were compared with the literature review, the analysis is shown below and is based on the incremental innovation identified, as shown in Table 9.

Table 9: Incremental Innovation

Description	**Outcome**
1. Although a participant stated that Transnet should remove the transport management system, traffic will move faster, and people will work faster, TAS has been found to be a globally effective transport management system, confirmed by participants in government as well as associations, however the underlying issue is that people worked according to the trucks that were outside the port and this required a greater deal of speed. This is then again pointing to incentivising the work force , who will process more trucks than the allotted trucks from TAS , alternatively , the number of trucks being processed daily needs to be reviewed and staff motivated to process more trucks per day. Scholars posit that design of a successful TAS needs an intertwined approach that examines the problem from all perspectives, including that of ocean carriers affected by the TAS, because inland transport is part of their service offerings. Results confirmed that for the TAS to create an efficient operational structure synergy should exit in the operations by ensuring that with changing technology the system is applied to all operations and that different versions or approaches should be eliminated and a single process followed to avoid making a system ineffective.	People
2. Participants stated that improving technology in terms of communication and engage with all stakeholders confirmed with literature that stated the Port of San Diego (California) has the Climate Mitigation and Adaptation Plan which includes all stakeholders that are involved directly or indirectly to the maritime sector. As stakeholders are co-creators of value it is essential that proper engagement with them occur.	Process

3. The results conclude that incentivised employees would increase productivity adding better recruitment process is also to be considered. Similarly, Snelgar, Renard and Venter (2013) argue that for organisations to remain efficient and profitable, budgets should be allocated to deliver higher levels of value to the employees through the development of effective reward strategies. It must be noted that understanding that everyone is different is an essential component in developing an effective reward system.	People
4. Participants comments of handling of information, not a manual process but more automation, use of bio matrix for drivers, review of documentation beforehand are aligned to Gidado (2015) who stated that port congestion in Africa is caused by either capacity constraints or procedural delays, and moving to a stage of digitalisation can relieve some of the congestion issues faced.	Process
5. Participants stated that the Truck Rollout Plan (replacing trucks after a period) would result in a reduction of emissions and breakdowns experienced. Although wind recovery plans were not mentioned by the participants as being an incremental change, Kleyn (2019) described the strategy applied in Cape Town in terms of addressing wind issues as focusing on quick recovery with gangs operating on night shift and a diversion of vessels as well, could be viewed as an incremental change. This is certainly an option that Transnet should apply to all Ports.	Planet
6. Participants indicated that Transnet should introduce proper change management processes, the literature review concurred with this as the TAS system whilst viewed as being a “change maker” by associations and Transnet, and it was viewed as a hindrance to stakeholders. An inference can be made to how the port communicates to the stakeholders as a possible cause of the problem based on the communication seen on wind delays.	Process
7. Participants viewed Training and Development of staff as being a low hanging fruit , similarly, (Hoa, 2017) also argues that the key to port efficiency could also lie in improving human resource competence, education, and training.	People
8. Participants stated that fast tracking the purchase of new equipment and implement a maintenance schedule with enough qualified maintenance engineers is needed. This concurs with Rosario (2020), who stated that port should consider a deployment of nine straddles per tower, twenty-seven in total, road congestion will be a thing of the past (Rosario, 2020) and by ensuring proper training of equipment, utilisation of equipment could be maximised.	Plant
9. The Research indicated that increase towers from 3 to 5, dual lift systems and off dock staging area for truck processing can alleviate congestion.	Plant

This study revealed that planning plays a key role in any organisation, poor planning often results in failed execution. All the participants, except Participant 14, ensured that they have minimised the exposure of port congestion through better planning and implementation, with Becker, Inoue, Fischer, and Schwegler (2012); Gidado (2015); Mather and Roberts (2015); and Hancock(2020) having emphasised the importance of planning. The first stage of applying any innovation is to plan and consider the following:

why is it implemented, what is being implemented and how will it be implemented? At the planning stage, it is important to involve stakeholders or representatives of the stakeholders as their contribution enables them to feel that they are also part of the solution. The discover stage involves identifying opportunities , by looking at the causes of congestion and categorising them into simple themes , with the solutions provided by the participants and literature review can be categorised into these themes .This will assist in ensuring that at the develop stage , the technology is identified to address the problem and deliver the outcome(Kahn, 2018).

The planning stage has commenced with the decongestion task team identifying the stakeholders of the port to address port congestion issues. Although the committee was formed in 2019, the participants still raised communication with the port as an issue and involving the stakeholder in the decision-making process is important, which brings to question, the way communication is rolled out to stakeholders or Transnet is engaging the stakeholders. The research was the start of the ‘discover’ process with participants contributing to the solution and literature review added a perspective of what other ports have successfully implemented. By involving the stakeholders of the port, a breakdown of incremental changes can be identified, the various changes however were not ranked according to importance or frequency but with improved stakeholder engagement, these changes can be prioritised, and quick wins identified to improve morale of internal and external stakeholders as the port moves to a more radical change. Figure 13 is a visual representation of the identified process to be followed in applying incremental innovation.

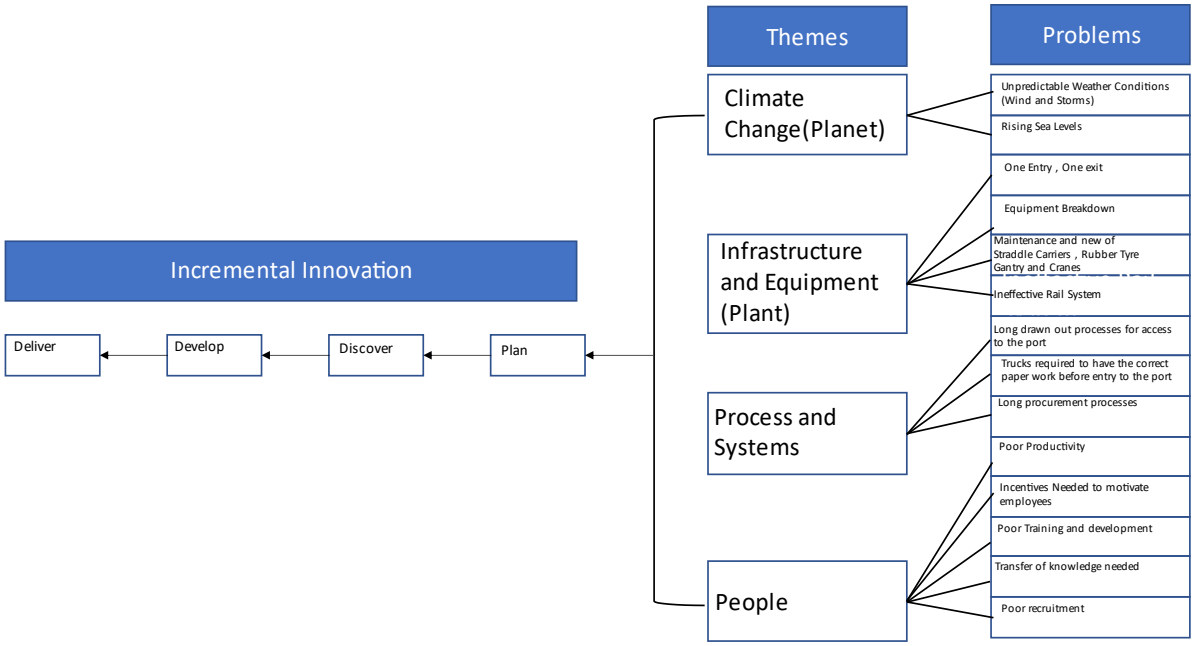

Figure 13: Incremental Innovation

A participant stated, “radical change generally has just caused chaos”. Kahn (2018) states that innovation does not always have to be something totally new or radical in nature, but minor incremental innovation does count, and that radical innovation is particularly challenging, risky and may require significant number of resources (Kahn, 2018). This has been confirmed by the participants who placed worker attitude and changes as having a bigger impact rather than the rail infrastructure (Teece, Peteraf, & Leih, 2016), similar to what the participants claimed in this research. Radical innovation becomes difficult to implement when internal cultures drive employees toward more low risk, immediate reward project (McDermott & O’Connor, 2002). Interestingly to note is that McDermott and O’Connor (2002) research found that informal networks of individuals within a company or outside the company, could help the company as the move through the development process, this was confirmed by the participants in the research. The research found that better stakeholder engagement can allow the port to transition through the different phases of innovation and this was highlighted by the participants as being an incremental change that is required by the port. The People element of the study is important to address as proper stakeholder engagement as well

as motivated employees can assist as the port moves though the various stages of innovation.

The responses from the participants as shown in Table 7 (from Chapter Five) were compared with the literature review, the analysis is shown below and the radical innovation identified, as shown in Table 10:

Table 10: Radical Innovation

Description	**Outcome**
1. The Participants stated that rail network should be completed concurring with Guan (2009) who noted that an increase in cargo volume, with an increase in the use of rail for the distribution of container distribution in the USA resulting in efficient ports. In this way, increased use of rail can have a positive effect on terminal performance.	Plant
2. Participants raised staging area as incremental and radical innovation scholars concur especially when land availability around the port is scarce.	Plant
3. Participants stated that technology or equipment is needed that can withstand wind speed of 80/90kph is needed, contrasted to Becker, Inoue, Fischer, and Schwegler (2012), who stated that planning for climate change will require ports to reconsider an array of paradigms, which include designing infrastructure that could withstand the elements of climate change beyond the average port administrator's career.	Plant
4. Participants stated that removal of tenants that are not related to port operations will free up space for port operation expansion, this can be seen as a long-term event as most tenants' leases are long term, scholars have concurred that land availability in the port is scarce therefore port players will want to hold onto the land that they have.	Process
5. Participants stated that privatisation of the port and key operations is essential at this stage with Hoa and Haasis (2017) confirming this in their research, elaborating that the upgrade and investment of port infrastructure in Vietnam through public private partnerships reduced capital pressure on government budgets, this would allow money to be allocated to other pressing issues.	Process
6. Participants stated that greater automation of the port and a move to a smart port system, with less reliance on labour is needed, this concurs with the findings of Deloitte's and Clay who stated that smart ports and use new technologies to maximise efficiency and productivity by making better use of their space, time, energy, and resources better (Deloitte Port Services, 2017; Clay, n.d.).	People

Radical innovation should be broken into smaller increments, through the planning process the increments can be divided into smaller projects. This will ensure that 'havoc' is not created. For this reason, applying incremental innovation can reach the desired

outcome however, if it does not result in the desired outcome, the radical change required can be broken into the increments as shown in Figure 14 as R1, R2 and R3, however each stage involves planning, discovery, development, and deployment.

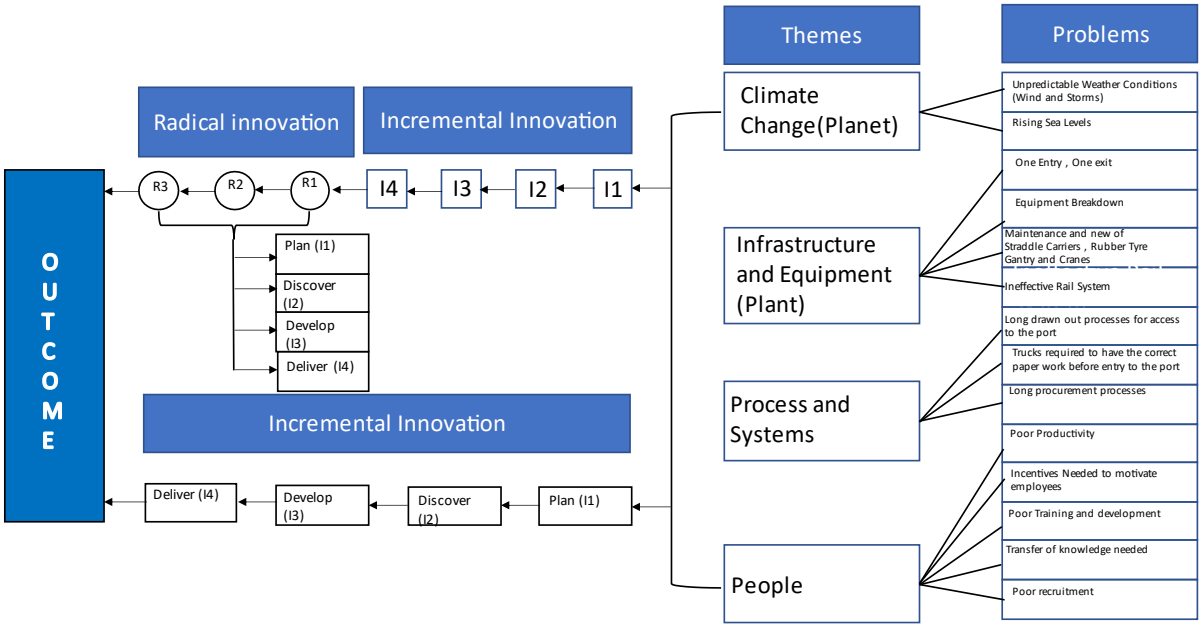

Figure 14: Radical Innovation

Kahn's final stage involved innovation as a mindset that addresses the internalisation of innovation by individual members of the organisation and advancement of a supportive culture throughout the organisation. Innovation has the propensity to flourish when employees and the organization instil and ingrain innovation, which in turn predicates the emergence of favourable innovation characteristics. By using the approach taken in Figure 14 Transnet can move closer to a stage of being a smart port.

6.5. CONCLUSION

By better stakeholder engagement, the port can identify the "quick wins" in alleviating congestion. Although not all the factors raised by the participants are new innovations, they are important for the port to move to a state of automation. Through employee engagement and motivating employees, there attitude towards their tasks will change resulting in greater efficiencies. By improving communication with stakeholders, the port

can ensure that the stakeholders are part of the “journey” and through inclusivity, the stakeholders become part of the solution and not the problem.

The factors that have contributed to congestion being weather conditions caused through climate change, labour issues, breakdown of processes and systems and maintenance and replacement of equipment and updating infrastructure, not all factors that can assist in reducing congestion are innovative, some can even be classified as simple housekeeping issues or an organisational structure that should have existed. Although the participants have identified the rail network as a key infrastructure area, the innovation has existed for years however, the port has not upgraded or expanded the rail network despite the growing need for it with globalization and increased trade, instead the port has already allowed for the increasing number of trucks to plague the roads. Whilst this has allowed for increased employment and quicker turnaround, the measurements for such turnaround are only based on hearsay evidence and a detailed study of road versus rail needs to be undertaken to evaluate turnaround as well as the number of people employed to ensure that jobs can still be maintained.

Understanding what innovation exist that could proffer a solution is important. Using Kahn (2018) process of innovation, the research adapted the model to include planning which includes stakeholder engagement at this point and breaking the stages of innovation into increments rather than a radical innovation which will cause havoc and prevent successful implementation at each stage. Using the identified incremental (Table 9) and radical innovation(Table 10), and through the process identified in Figure 14 ,the port can start at the planning and engagement stage and determine the approach that it could utilise to achieve the desired outcome.

CHAPTER 7: CONCLUSION

7.1. INTRODUCTION

The impact of congestion on the port of Durban has not been researched except for the research by Raballand, G., Refas, S., Beuran, M., and Isik, G. (2012) on why does cargo spend weeks in Sub Saharan African Ports? This included the Port of Durban in the study, the limitation on this study was that the comparison was made of ports within Africa rather than benchmarking the ports to global ports. With limited literature about Congestion in the Port of Durban, the research focused on assessing information on research done about the Port of Durban to understand the system adopted by the port as well as relying on global practices. As port congestion is a debate that has existed for decades, the Port of Durban and its congestion issues have been trending in newspapers, news reports, maritime forums, and magazines because of the negative impact it has had on the sector. The reason of the study was to address the innovation lag, the understanding of what is defined, as innovation is important. This chapter amalgamated the results and literature review of the study undertaken. The limitations of the study and further research that can be undertaken to add more insight into the findings are presented in this chapter.

7.2. PRINCIPAL FINDINGS

The aim of this study was to understand what the causes of congestion are in the Port of Durban and to proffer solutions to address the innovation lag. The key points raised by participants were wind disruption, incentivisation for employees is needed to motivate them to increase productivity, proper equipment purchasing processes and proactive maintenance. The literature review concurred with what the participants had raised as issues however wind as a deterrence was a factor that stood out against the literature review, with scholars only citing it as a possible cause but not considering the effects of climate change on port efficiency. This fact suggests that further research into climate change is essential, as it is a factor that has shown to be affecting the port, even in periods that are not considered the windy season, this has been confirmed through the

analysis of the communication from the port. The current plans to address climate change need to include the port in terms of changing weather patterns and the effect on the various operations of the port. Although it is essential to address plans and policies regarding climate change, risk management factors need to be considered and mitigating controls identified.

The literature review began with the infrastructural layout of the port to draw a visual understanding in the mind of the reader of the current structure the current port landscape, structure, and possible congestion routes. The research then focused on port inefficiency to understand what the possible causes of congestion are to assess global trends against what is currently happening in the port of Durban. Rosario, (2020), provided key insight into congestion causes naming weather conditions and the prevailing delay that exists for ports to become effective again after such an occurrence. Further to this, the research found that infrastructure and equipment breakdowns was implied, along with underutilised equipment. Rosario (2020) also brought to light the people factor with un-incentivised workforce that are not motivated to perform at their peak. Limited literature exists on the Port of Durban and the congestion issues hence the reliance on current and trending news reports. Participants echoed the sentiments shared by Rosario (2020) confirming that Windy conditions, Equipment and People (labour) remain an issue for the port and are the main reasons for congestion.

Despite scholar's research into windy season in South Africa being October to January, the research indicated that windy conditions continue into February and March, affecting the port and resulting in further delays. Indicating that windy conditions are beyond the time identified by Mbonambi. Different strategies exist to alleviate the congestion conditions with Cape Town implementing a wind strategy and purchasing straddle carriers that can withstand wind speed of up to 90kph (Bulbulia, 2020) thus increasing port efficiency. Although purchasing new assets would appear to be a quick solution, Transnet like other parastatals have long drawn-out procurement processes, budgetary constraints and staff that then needs to be 'properly' trained to handle the equipment.

The research indicated that a reintroduction of the worker incentive schemes is needed, that links performance to monetary incentives as is the global norm. Productivity in the

port has been declining with staff not being motivated, with the research supported existing literature that indicated that employees seek a better reward system as a motivator to increase productivity (Nujjoo & Meyer, 2012). This study firther supported the scholars that proclaimed equipment breakdown as another cause of congestion. However in the Port of Durban maintenance and upkeep of equipmnet is one factor and the other is the manner in which the assets are procured. A deploymnet of more straddle carriers and an effecinectly operated gantry crane can adequately increase the operational capacity (Rosario, 2020). It is clear that there is a link between all the factors and one factor can not be looked as in isolation from the other identified causes.

The research then focused on the Truck Appointment System (TAS) as the latest implementation to ease congestion in the Port of Durban. The Port of Durban uses the TAS system for containerised cargo at present and another TAS system for Fruit Terminal and Bulk operations (Dass, 2020). Scholars have indicated that this system does not work effectively and have benchmarked operations that have utilised different TAS systems within the same port, adding that the varying operations have not synchronised the flow of traffic. Although reports indicate that the TAS system has been operating successfully, an interesting observation is that the system went live during the global pandemic when the lockdown restrictions globally affected cargo movement, with UNCTAD (2020) reporting a 4.1% decline in global trade in 2020, with a participant concurring that there was a decrease in containerised cargo with data releaving, “as at November, Durban total TEU imports: 2019 was 1,255,091; 2020 was 1,005,432 indicating a drop of 20%”. Reports have indicated that the TAS is operating efectvely however, this is based on a decreased cargo operations model to what it normally experiences. This will have to be assessed as operations normalise and trade increases. Introducing TAS at a point when cargo operations was at its lowest might be the first sign of an incremental shift by the port to addressing port congestion using what is termed a radical innovation.

Through the innovative lenses, the research explored how other ports enhanced their capabilities using innovation, with ports shifting to a stage of smart ports. However, the research did not focus solely on smart ports but rather what the Port of Durban can do to alleviate the congestion experienced to move closer to a SMART port status. This

paper focuses on identifying the causes of congestion in the Port of Durban and the incremental and radical innovative strategies that can assist to alleviate the current congested ports. The research found that innovation theory is the most appropriate theory applicable as innovation can either build on what is already there with slight modifications or incremental changes, whilst some innovations change the entire order of things and result in a radical shift (Koberg, Detienne & Heppard, 2003). By utilising the incremental and radical innovation subsets, the port can reinvent the way it operates. Using an outcome or problem-based innovation, competitiveness can be assured as the Port of Durban is losing cargo to other African Ports.

As the port is a complex system, their main objective should be to simplify the business processes. Adopting any form of radical innovation at the outset can create havoc and cause companies to abandon strategies that if planned correctly could result in the desired outcome. Although the implementation of the TAS system can be seen as being a radical innovation, the implementation during the pandemic allowed for ease of operations and adoption of the process more smoothly as restrictions within South Africa curtailed normalised operations. Using Kahn (2018) model, innovation as an outcome underlines the output that is sought, which in this case is a reduction of port congestion.

The process of addressing the innovation lag of port congestion, involved engaging with stakeholders to understand their perspective of port congestion and innovation. The process entailed conducting interviews with fourteen (14) participants in the maritime sector to understand the causes of congestion; saturation was achieved by the twelfth (12^{th}) participant indicating no new themes. The participants' process of addressing port congestion within their own environment involved an immense amount of planning, this assisted in re-approaching the Kahn model differently. It was through engaging with the participants that the researcher understood the importance of communication from port authorities and their engagement with the stakeholders, hence the reiteration of stakeholder engagement at the planning phase. An understanding of what incremental innovation and radical innovation from the perspective of the stakeholders, assisted during the 'discover' phase, with the innovations stated in Table 9 (incremental innovation) and Table 10 (radical innovation). Utilising the steps identified in the model as shown in Figure 14, will assist the port in increasing efficiency and decreasing

congestion. The first step after problem identification would be a process of planning what needs to be done to alleviate the problem to achieve a desired outcome. Involving key stakeholders is essential as they form part of the solution. Aakhus and Bzdak (2015), argues that the shift to value creating networks which centralises the main problem shared by the actors or stakeholders, will allow these stakeholders to create value by jointly solving the problem at hand.

The discover stage involves identifying opportunities, by looking at the causes of congestion and categorising them into simple themes, stakeholders can sort the various areas and identify potential opportunities to address the problem. At the develop stage, the technology is identified to address the problem and deliver the outcome of reduced congestion in the port. Although this appears to be a simple model for addressing innovation, the problem lies in dividing the radical innovation into increments, which requires an immense amount of planning. Radical innovation should be broken into smaller increments, through the planning process, the increments can be sequentially divided into smaller projects (R1, R2, and R3). To avoid “Havoc” of introducing a radical innovation at once, even though the impact might be larger, a system of applying incremental innovation can reach the desired outcome whilst still allowing for an easier transition by all stakeholders and provided it be implemented correctly can ensure the desired outcome is achieved.

Although the literature review included the suggestion of a barge to alleviate congestion, the results of this study indicate that better progress can be achieved through the identified incremental and radical innovation. The study infers that the barge operations means that congestion is being moved around the port and the actual problem of congestion is not being addressed.

7.3. CONTRIBUTION TO THEORY

This study contributes to the understanding of the causes of congestion in the Port of Durban. A factor often overlooked by ports and committees is Climate Change, namely wind conditions, and the effect it has on port operations. Although the study did not go

into the detail on Climate Change, it introduced it as factor that needs to be considered when addressing port congestion issues.

The Innovation Model was constructed as illustrated in Figure 14 from the themes and constructs of the causes of congestion and solutions that have been identified through the literature review and engagement with participant, the figure then interconnected the approach taken to address the innovation lag. An outcome can be achieved quicker if it is split into incremental and radical factors or innovations, and then the radical innovation divided into smaller increments. This however involves a process of planning, discovery, development, and deployment. The process undertaken involved stakeholders in the port, who for the purpose of this research are the participants. By involving stakeholders throughout the process, the desired outcome can be achieved through value creation.

7.4. IMPLICATION FOR STAKEHOLDERS

Given the implication of port congestion on the entire value chain, the study has served to contribute towards the field of maritime studies and innovation. This study specifically focused on understanding the causes of Port congestion in Durban. Through the findings of this study, the stakeholders within the port and government departments can understand the causes of congestion from the perspective of the stakeholders within the maritime sector and look at the identified solutions within this study(Table 9 and 10). The decongestion task team can utilise the findings of the research, to address issues that have not been identified as causes or solutions to addressing port congestion and the innovation lag. For the port and the decongestion task team this research proposes a framework to achieve the desired outcome using the process illustrated in Figure 14.

7.5. LIMITATION OF THE RESEARCH

This research was a qualitative research that was inductive in nature. This meant that this research followed the constructivism / interpretivism research paradigm (Ponterotto, 2005). The constructivist paradigm allows the researcher to unveil or uncover hidden meaning through conversing with the people who have gone through a particular

situation (Ponterotto, 2005). The results from this research may be criticised as being biased in that the respondents were all white-collar employees who are arguably out of touch with the reality on the ground.

Data from TPT regarding the wind conditions and communications issued, although at some point was in the public domain, could not be accessed as the waiting period for the release of such information is between 60 to 90 days as confirmed with the CSIR and TPT. This limited an analysis to identify the extent to which wind provides a hindrance to port operations as well as at what wind speed machines stop operating.

The study sought to gain insight on the causes of port congestion in Durban at a time when the global pandemic, COVID-19 had disrupted global supply chains including the maritime transport and logistics. This somewhat may have clouded the thinking and responses of some of the respondents' responses as some of them were speaking to the current port congestion situation. This could give a misleading picture on the state of port congestion in Durban as global supply chains have been negatively disrupted due to the travel restrictions placed on the movement of goods and people among countries of the world. This was noted when participants were asked about the TAS system. Many believed the system was successful however, with limited cargo leaving and entering the port and restrictions on movement placed by government on Ports, the inference of a successful system is predisposed.

On the other hand, one of the limitations of this study was that the global pandemic (COVID-19), denied the researcher the chance of meeting physically with the respondents. This had a potential impact of denying the researcher a chance to interpret nonverbal cues often easily visible in a relaxed natural physical interview setting as both verbal and nonverbal communication can be key in a social research of this nature that seek to understand people's thoughts and behaviours. A further limitation has been the load shedding that we had experienced during December and January at the time the interviews were conducted. This affected two (2) interviews that was conducted during the stages of load shedding (Participant 13 and Participant 14). The interviews were 'cut off' because of the varying load shedding times and the participant agreed to answer the questions telephonically and via emails.

As the research is currently a trending issue within the maritime sector, the researcher looked to current newspaper and articles in magazines to understand what stakeholders have emphasised as possible causes and if any solutions have been offered.

7.6. SUGGESTION FOR FUTURE RESEARCH

Further research into the tolerance of the machines operating at the Port of Durban, to wind, needs to be conducted Changing weather conditions and its effect on the port need to be studied. Participant 13 raised a point of comparing Cape Town port operations to Durban, with Cape Town experiencing more windy conditions than Durban further research into what operational factors differ within the ports, yet Transnet manages both the ports.

Although the research indicated that the TAS system is operating efficiently, further studies involving container movement in 2020 vs expected container movement aligned with the expected increase in trade would provide a better analysis to assess the efficiency contribution of TAS. However, the research limitation identified by Guan (2009) must be considered. Guan (2009) recommends that future research that seeks to tender solutions to port congestion should not only rely on statistical queuing theory as this method is prone to errors in calculating truck waiting time and the quantifying of such waiting time costs on truckers (Guan, 2009). Moreover, the data collection method used which is the limited field observations done by the researcher may not have covered all situations regarding hourly truck arrival rates as truck arrival times may be by vessel delays, holidays, and many other factors (Guan, 2009). Further research into assessing the effectiveness of the various TAS systems applied at the port is needed, as research have indicated that this has not worked in Ports.

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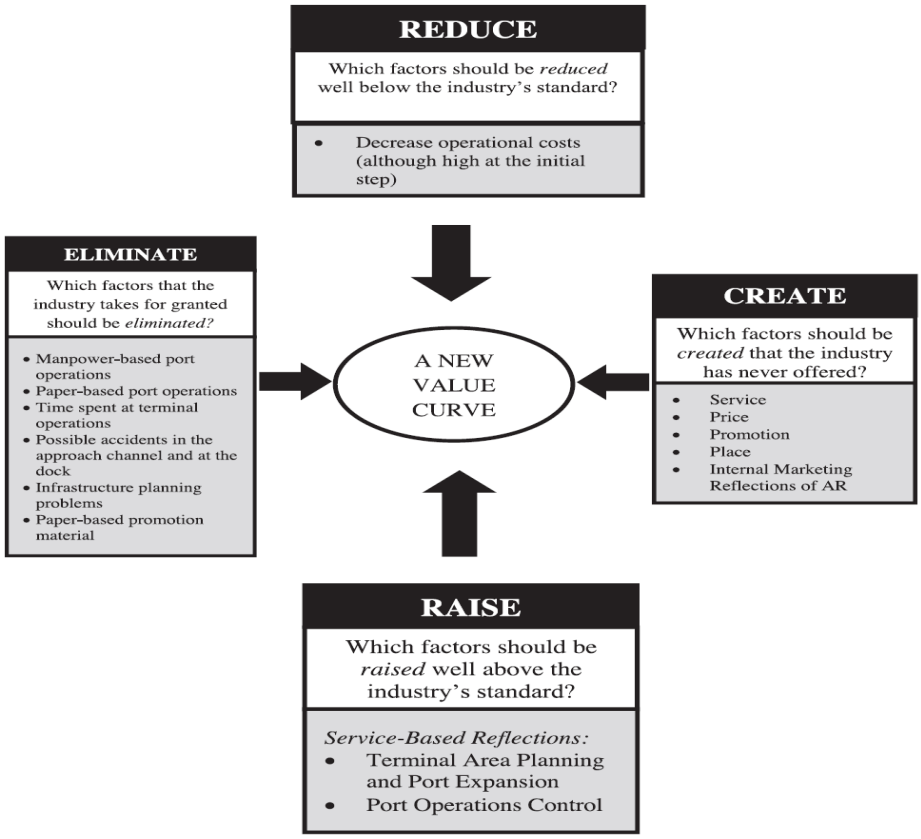
Appendices

Appendix 1: Creating new value



Source: Şakar & Surucu, 2018

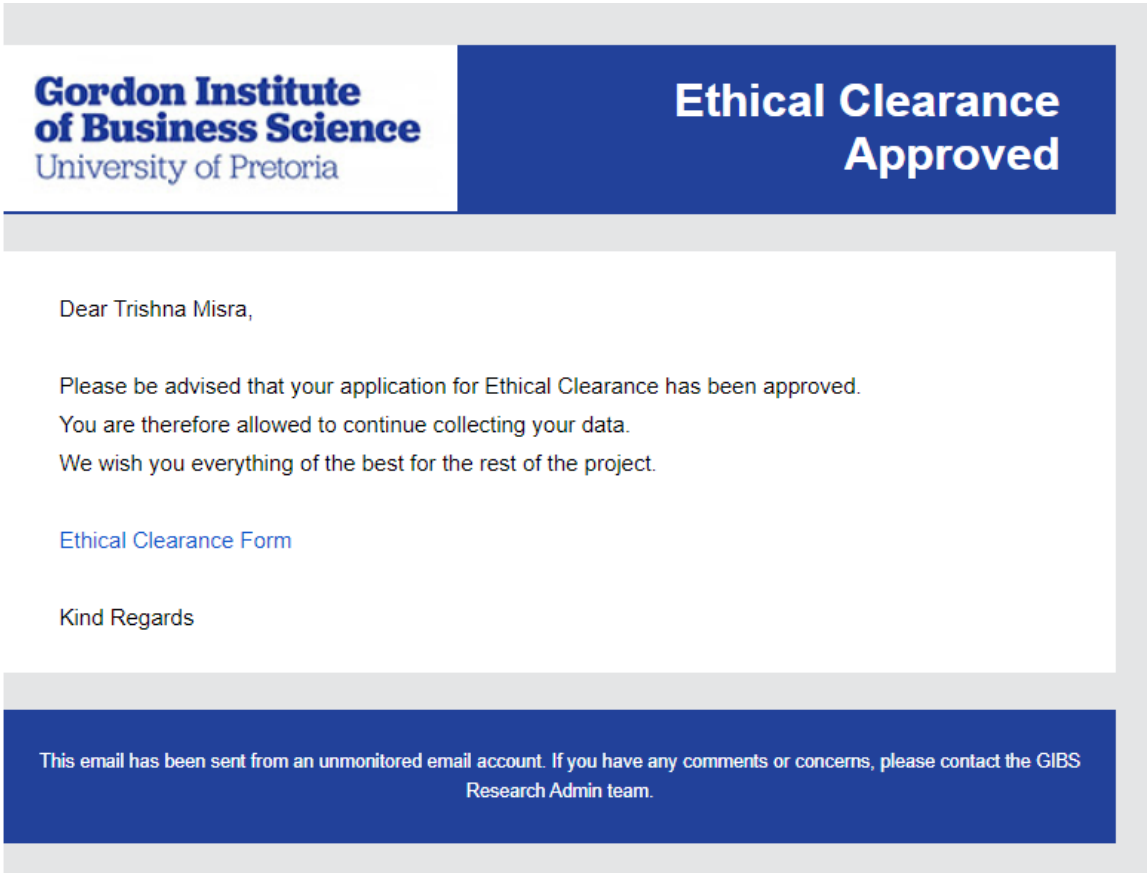
Appendix 2: Categories for research questions

Port Congestion	Innovation	Incremental and Radical

• Causes
• Effect
• Costs associated (estimates / data)
• Other factors to reduce or eliminate port congestion
• What should be raised above industry standards ?
	• Current Innovations
	• Classification of innovation
	  • Infrastructure
	  • IT
	  • Equipment
	  • Other
	• What should be created that the sector does not have?
		• Current innovations in the Port
		• TAS and ability to alleviate congestion
		• Current and future plans for the port to increase efficiency
		• Ability of the port feeder barge to alleviate congestion in the waterways

Source: Own Construct

Appendix 3: Ethical Clearance Approval



Gordon Institute of Business Science
University of Pretoria

Ethical Clearance Approved

Dear Trishna Misra,

Please be advised that your application for Ethical Clearance has been approved.
You are therefore allowed to continue collecting your data.
We wish you everything of the best for the rest of the project.

Ethical Clearance Form

Kind Regards

This email has been sent from an unmonitored email account. If you have any comments or concerns, please contact the GIBS Research Admin team.

Appendix 4: Interview Guide

Date of interview: _____

Name: _____

Job Title: _____

Organisation: _____

Start Time: _____ End Time: _____

Thank you for agreeing to participate in the research study.

The Research that I am conducting is to understand what are the causes of congestion as perceived from the port actors and how can incremental or radical innovation alleviate the problem?

The objectives of the research are:

1. To understand the port congestion issues from a land and sea perspective in the Port of Durban.
2. To determine current innovation adopted by successful ports and their applicability to the Port of Durban because of global pressure to innovate in terms of the port's current configuration and management (Global Value Chain).
3. To identify incremental and radical innovative methods, processes, and technologies that the Port of Durban can adopt.

This research will seek to identify what are the causes of congestion in the Port of Durban, what incremental and radical innovative processes and technologies will benefit in reducing port congestion and decreasing costs in the global value chain. Identifying key characteristics of innovative solutions to solve a wider range of challenges across the land and sea while creating value for the customer who is the end user is the main objective of the research.

The interview will be treated with confidentiality and I hope that you will feel free to provide me with as much information as possible.

The Consent Letter must be signed before we can proceed. The interview is recorded for transcribing purposes and as part of my research we will need to provide the recordings which will always remain confidential.

Questionnaire: Semi Structured Interview

Objective: To understand the port congestion issues from a land and sea perspective in the Port of Durban.

1. How do you experience congestion in the work that you do in the port?
2. Port Congestion: Cause and Effect
    a. What do you believe are the main causes for port congestion and how would you rank the causes from highest being the main cause to lowest being the least and provide reason for the given rankings?

Causes	Ranking	Reasons

    b. What has been the effect of port congestion on the global supply chain and the time delay experienced by companies?
    c. What steps has your organisation taken to reducing the impact of congestion?

3. Innovation

    Objective: To determine current innovation adopted by successful ports and their applicability to the Port of Durban because of global pressure to innovate in terms of the port's current configuration and management (Global Value Chain).

    I am now interested in understanding what new approaches have been taken and the characteristics associated with those.

    a. What do you believe are the main innovation introduced in your environment?

b. Are there any seaside/landside innovations that could reduce congestion and what are they?
c. From your experience in working with the port, what do you believe are the potential innovations that are justified and can add value?

4. Incremental and Radical Innovation

   Objective: To identify incremental and radical innovative methods, processes, and technologies that the Port of Durban can adopt.

   a. What do you believe are the incremental or radical changes that the port can adopt?
   b. What is your view on the Truck appointment system that has been introduced?
   c. What are the plans to alleviate congestion and make the port of Durban more efficient?

Appendix 5: Consent Form

Dear ……..

Re: Informed Consent Letter

I am currently a student at the University of Pretoria's Gordon Institute of Business Science and completing my research in partial fulfilment of an MBA.

I am conducting research on "Addressing the innovation lag of port congestion in the value chain within the Port of Durban". Our interview is expected to last about an hour and will help us understand how the Port is dealing with congestion on the roads in Durban.

Your participation is voluntary, and you can withdraw at any time without penalty. All data will be reported without identifiers. If you have any concerns, please contact my supervisor or me. Our details are provided below.

Researcher name: Trishna Misra	Research Supervisor: Glen Robins
Email:	Email:
Phone：	Phone:

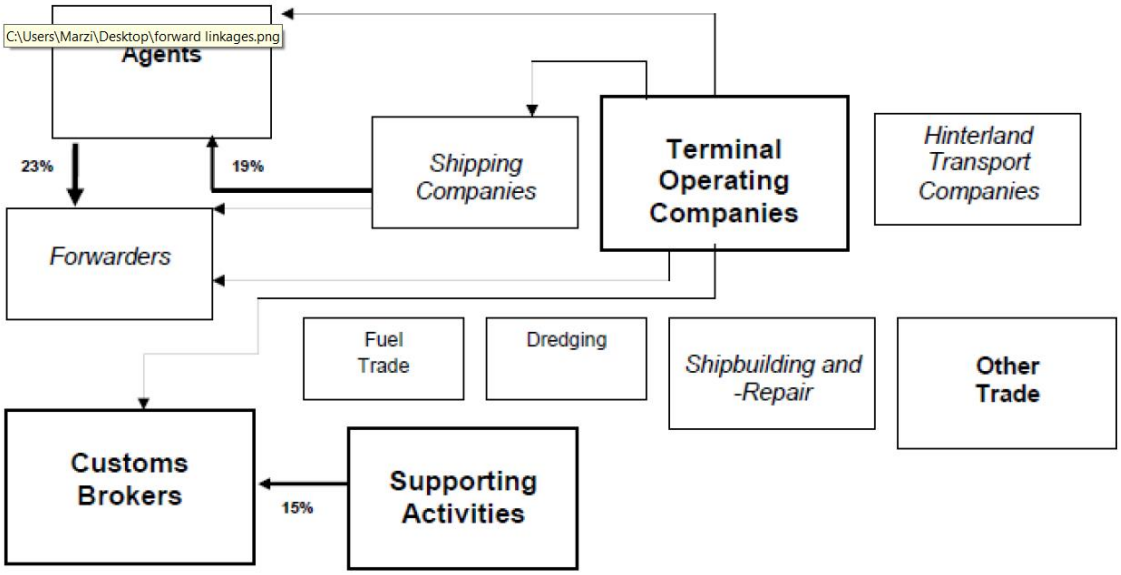
Signature of participant: _____

Date: _____

Signature of researcher: _____

Date: _____

Appendix 6: Port Structure



Source: Nazemzadeh (2016).