Application of a Critical Systems Approach

to understanding Ship Turnaround in the Port of Durban.

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This dissertation is submitted in partial fulfillment of the requirements for the degree of Masters of Commerce in Leadership Studies at the University of KwaZulu Natal, Durban.

November, 2012

DECLARATION

I Eugene Alec Rappetti declare that

(i) The research reported in this dissertation, except where otherwise indicated, is my original research.

(ii) This dissertation has not been submitted for any degree or examination at any other university.

(iii) This dissertation does not contain other persons' data, pictures, graphs or other information, unless specifically acknowledged as being sourced from other persons.

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a) their words have been re-written but the general information attributed to them has been referenced:
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ABSTRACT

Seaborne container shipping plays a major and important role in the world transportation system and the global supply chain. Shipping lines have designed their product offering to shippers around providing regular calls at designated ports. This works well for most firms that operate on a just-in-time philosophy.

The real costs of trade – the transport and other costs of doing business internationally – are important determinants of a country's ability to participate fully in the world economy. This is an important indicator for port performance in a globalised economy; therefore, any inefficiency that increases costs must be addressed. This means that ports have to ensure very high productivity and efficiency levels so that ships have a quick turnaround. Clark et al., (2002) conclude that a 50% improvement in port efficiency can reduce shipping costs by about 12%.

The general question that is studied in this research is: How can the Marine Services within the Port of Durban assist in reducing ship turnaround times? This study seeks to determine what role the marine services plays in ship turnaround. The analysis in this study will be to determine the source of delays and ways to improve on efficiency. The resultant improvement in efficiency should lead to a possible reduction in shipping costs.

The Market Demand Strategy employed by Transnet in 2012 must be implemented in such a manner that it must not only address the current infrastructural backlogs but it must also endeavour to alleviate several logistic chain bottlenecks that tend to constrain the economy.

When analysing 2010-2011 a worrying trend emerges that the average waiting times for ships at anchor has increased significantly and the time on the berth has also increased significantly despite a reduction in the number of ships calling to the port. This is partly due to the fact that much larger ships now arriving at the port and more crucially are working a larger number of containers per port call. However, there is still concern about the operational efficiency of the terminals in the port (Pier One and Durban Container Terminal). The Marine Operations service times have also increased marginally 1.23% (0.98 hours) but this is due to longer time required for berthing and sailing of larger ships.

This study has clearly shown that the Marine Operations within the Port of Durban do not significantly impact on overall ship turnaround time. However, there are areas of improvement that can be implemented to ensure high service levels within the port. By increasing the tug fleet and ensuring adequate human resources, the service offering can immediately be improved. Extremely lengthy anchorage waiting times and high berth occupancy impact negatively on ship-owners, shippers, and the economy at large. The Port Authority must interrogate these areas to understand clearly what is driving these extended times and determine strategies and performance measures to mitigate these.

ACKNOWLEDGEMENTS

I thank my God and Saviour Jesus Christ for giving me knowledge and understanding in completing this dissertation.

My gratitude to my wife Lulu and my children Wendle, Marcel and Kyle for all your tolerance and understanding during the writing of this dissertation.

I would like to thank Professor Trevor Jones for kindly agreeing to supervise my dissertation and all the advice and guidance given to me. You are a true mentor and teacher.

A special word of thanks to Nic van Rijsbergen for all your assistance and guidance in compiling and analyzing the data. Your time and effort is truly appreciated and for the copious amounts of coffee consumed.

TABLE OF CONTENTS

TITLE **PAGE NUMBER**

LIST OF FIGURES

TITLE	**PAGE NUMBER**

LIST OF TABLES

LIST OF ANNEXURES

<u>CHAPTER ONE</u>

INTRODUCTION

1.1. BACKGROUND AND RATIONALE

Seaborne container shipping plays a major and important role in the world transportation system and the global supply chain (Imai et al., 2007). Containerisation is thus a major and increasingly important sector of not only maritime activity, but also of world trade and the entire global industrial structure (Peters, 2001). The container transport system is structured by time-tight schedules (Notteboom, 2006). Shipping lines have designed their product offering to shippers around providing regular calls at designated ports. This works well for most firms that operate on a just-in-time philosophy. It also provides for other firms to utilise this service offering to get their goods to specific markets within a reasonable and predictable time.

Carriers design the networks they find convenient to offer, but at the same time, they have to provide the services their customers want in terms of frequency, direct accessibility and transit times (Notteboom, 2006). A major contemporary trend in liner shipping strategy is vertical integration and diversification into inland transport, terminal operation and logistics (Panayides and Cullinane, 2002). Shipping lines are now offering shippers end-to-end product solutions in order to effect control over the whole logistics chain. This gives the shipper greater confidence that the goods transported will reach the desired destination at the desired time.

There was a time when shippers used an array of freight forwarders, truckers, clearance agents, shipping companies, railway services, etc., and various financial, freight insurance and other institutions. Today major customers demand and get one-window, integrated, just-in-time and efficient all-inclusive door-to-door service at a predetermined price. This is what the market demands now (Frankel, 1999).

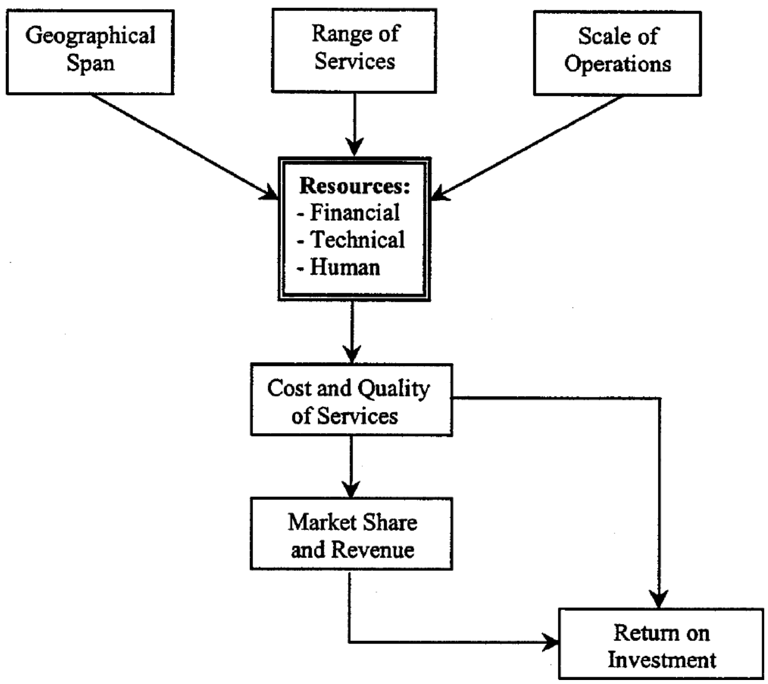


Figure 1.1: A framework for the strategies of liner shipping companies

SOURCE: Heaver, TD. (2001): The Evolving Roles of Shipping Lines in International Logistics. International Journal of Maritime Economics 4: 210-230

Some of the areas that the container shipping lines have had to focus on in order to remain competitive and profitable are outlined in figure 1.1. Shipping lines have had to adapt to a changing economic, technological and legislative framework. In addition, some of the operational arrangements such as Conference Agreements have had to be redefined. Liner Conference Agreements are generally defined as agreements between two or more shipping companies to provide scheduled cargo and/or passenger services on a particular trade route under uniform rates and common terms.

In the European Union and in certain other major jurisdictions, there have been policy changes, which have influenced the extent to which carriers may collaborate with others in Conferences or other co-operative arrangements (horizontal relationships) and the extent to which carrying lines may integrate vertically with landside activities. Some of these aspects are set out as follows in the Guidelines on the Application of Article 81 of the EC Treaty to Maritime Transport Services of 2008:

“Section 3. Horizontal Agreements in the Maritime Transport Sector

35. Cooperation agreements are a common feature of maritime transport markets. Considering that these agreements may be entered into by actual or potential competitors and may adversely affect the parameters of competition, undertakings must take special care to ensure that they comply with the competition rules. In service markets, such as maritime transport, the following elements are particularly relevant for the assessment of the effect an agreement may have in the relevant market: prices, costs, quality, frequency and differentiation of the service provided, innovation, marketing and commercialization of the service.

36. Three issues are of particular relevance to the services covered by these guidelines: technical agreements, exchanges of information and pools.” (Commission of the European Communities, 2008, p.7) This provides guidelines to forming shipping consortia and regulating conference arrangements.

This legislative framework could spark other economies to also regulate conference arrangements thus making it more difficult for shipping lines to dominate certain markets and routes. The co-existence of alliances and mergers, the fact that only in some cases the companies merging are partners in the same alliances (often, they belong to different alliances operating in distinct geographical areas) and the survival of the more traditional forms of co-operative agreement raises questions of whether these processes are linked and, given that there still is a continuous drive towards the extension of service coverage, whether an optimal level of horizontal integration in the shipping industry might be reached (Bergantino and Veenstra; 2002). Liner shipping today is different after a watershed decision taken within the EU on 13 September 2006; the Council unanimously repealed the liner conference block exemption from the application of conventional competition legislation - Article 1 of Regulation (EC) No 1419/2006.

Liner shipping carriers now enter into various forms of co-operative agreements, but without fixing or setting prices or liner freight rates. The following broad categories exist namely:
a] A Vessel Sharing Agreement is a contract between two or more vessel operators agreeing to provide a certain number of vessels for common use of all parties in order to set up a joint liner service.
b] A Swap Agreement is a reciprocal contract between two or more parties that agree to exchange space on the ships they operate.
c] A Slot Charter Agreement is a contract between two or more parties whereby the vessel-operating party sells slots on its vessels to the other party (Commission of the European Communities, 2008, p10).The highly regulated liner industry means that liner companies need to ensure optimal efficiency of their ships. Inefficient ports can add significantly to the performance of liner companies both financially (cost of delays) and with regard to frequency of schedules (high turnaround times).

The economic slump in 2008 has forced many lines to rethink their overall strategies. Some strategies have involved laying-up ships in order to balance excess capacity against demand. The introduction of extra slow steaming of ships and the introduction of additional ships into existing trade loops to reduce fuel costs, have helped shipping lines reduce overall running costs. Ships are no longer travelling speeds of 26 knots but rather at speeds of 14 knots while still being able to maintain their very tight schedules. This reduction in speed has significantly reduced fuel consumption and a bludgeoning fuel bill while also reducing the amount of harmful emissions into the atmosphere[1].

Unproductive routes and inefficient ports have also been targeted as part of a means of minimizing financial losses. This process has highlighted some of the inefficiencies that still exist in ports and the need for ports and port terminals to counter unproductive activities in earnest. One positive spin-off of the economic downtown is that it has forced several of the shipping lines to scrap their older units within their fleets thus reducing the number of old, unseaworthy ships that traverse the world's oceans, and thereby reducing excess fleet capacity.

A port is a cluster of economic activities (De Langen, 2004) where a number of port users and operators offer different products and services, which ultimately define the ports' overall product and service offering. All these interactions between the various stakeholders within the port influence overall port performance and the inefficiencies that exist. The cargo transfer product is the backbone of the port: the port only functions if it is an efficient node in transport networks (De Langen et al., 2007). Congestion in container terminals, fierce terminal competition, the ever-increasing role of the time factor in liner shipping (Notteboom, 2006) and the pressure by liner shipping operators for increased effectiveness and punctuality of service (berthing and vessel loading/unloading operations) reinforce the need for improved container terminal seaward operations (Golias et al., 2009). The advent of slow steaming has meant

[1] Rethink on fast ship speeds – Lloyds List (19 November 2009) no.60.055. www.maersk.com/.../Slow%20Steaming%20-%20the%20full%

that the shipping lines have increased the number of ships in their trading loops to maintain their schedules.

The real costs of trade – the transport and other costs of doing business internationally – are important determinants of a country's ability to participate fully in the world economy (Limao and Venables, 2001). This is an important indicator for port performance in a globalised economy; therefore, any inefficiency that increases costs must be addressed. While Clark et al., (2002) focus on the cost implications of inefficiencies in maritime transport, they do not focus on the cost implications of inefficiencies of not providing adequate port services e.g. the delay experienced by a ship. While this study looks at the source of these delays, the costs associated with this will not be quantified in financial terms. This study will focus on one aspect of inefficiency namely vessel turnaround time. Any delay to a ship is equated to a potential loss in earnings. Clark et al., (2002) conclude that a 50% improvement in port efficiency can reduce shipping costs by about 12%. The analysis will be to determine the source of delays and ways to improve on efficiency. The resultant improvement in efficiency should lead to a possible reduction in shipping costs.

This study will limit its focus to the Port of Durban but will also use international case studies. The study will, however, not be limited to the role of vessel turnaround times in a port only. It will also deal with the inefficiencies arising from the aberrant behaviour of shipping lines, which may themselves lead to greater vessel turnaround times.

1.2. OVERALL RESEARCH OBJECTIVE

The general question that is studied in this research is:

How can the marine services within the Port of Durban assist in reducing ship turnaround times?

For the purpose of the research, the focus on ship turnaround (for container ships) will mainly be on the marine services provision component. The efficient provision of pilotage, towage and mooring services facilitates quicker turnaround times. The main area of concern is around the co-ordination for the provision of these services. For this reason, the analysis will include the Vessel Traffic Services (VTS). A VTS service is provided by the Port of Durban to monitor the shipping and aid the management of traffic within the Port itself and within designated port limits, including port approaches and the roadstead/anchorage. The same would apply for the departure process. This study seeks to also understand the ship turnaround measurement.

1.3. LIMITATIONS AND OVERVIEW OF THE STUDY

1. This study will be limited to container ships using the Port of Durban Container Terminal (DCT) operated by Transnet Port Terminals (TPT).
2. This study will only focus on the vessel movements over two three-month periods in which the data will be analysed. This includes analysing approximately 1600 vessel movements over this period.
3. Turnaround time will be measured on arrival from the time the service is required until the vessel is safely alongside (agreed time-pilot on board-last line on bollard), or on departure from the time the marine services are ordered until the vessel clears the port (agreed time-pilot on board-vessel passes the breakwater outbound).

4. There are also vessel-related problems, particularly arising from non-adherence to schedules that need to be identified and where information is not always reliable.

Ports and shipping lines have varying priorities that often leads to conflict. Chapter two will focus on what is meant by ship turnaround time and how the marine services in the Port of Durban is part of this process. There will also be a brief explanation of how a typical container terminal functions. Chapter three will focus on the research methodology and soft systems theory. Chapter four will detail the analysis of the data of shipping movements during the two three-month periods in 2010-2011. Chapter five will conclude the research and the overall impact of Marine Operations within the Port of Durban.

CHAPTER TWO: UNDERSTANDING VESSEL TURNAROUND TIME

2.1. INTRODUCTION

“Like large commercial jet aircraft, large ships like mega-containerships have an overall cost structure (fixed plus variable) that requires them to be intensively utilized. In order to maintain the compelling economic arguments for utilizing larger ships, operations will have to be undertaken that result in higher levels of utilization at sea and lower amounts of time in port” (Harrison et al., 2000, p10). This means that ports have to ensure very high productivity and efficiency levels so that ships have a quick turnaround. These fine objectives may, however, be difficult to achieve, not only because of limitations in physical port capacity, but also because of the limitation associated with other actors namely road and rail that make up the hinterland connections. In addition, the provision of sufficient marine services to ensure that ships are able to navigate safely within the ports is crucial.

De Monie (1987) outlines the arrival and departure of a vessel (see Figure 2.1) to a port and the important interactions that take place during this period. It is clear that when a ship arrives at a port, it does not go straight to the berth but a number of intermediate steps have to take place before the ship is finally alongside a berth for cargo operations. Particularly in a context where the carrying lines deploy larger, more capable and more expensive ships, the overriding imperative is to shorten this entire process so that the ship’s time in port is minimized. It is therefore important to unpack all the various stages before berthing/sailing a ship and to understand how each stage works in order to determine ways to shorten these times. This process is, however, a complex and interconnected one - hence a holistic view must be taken in order not to oversimplify the process.

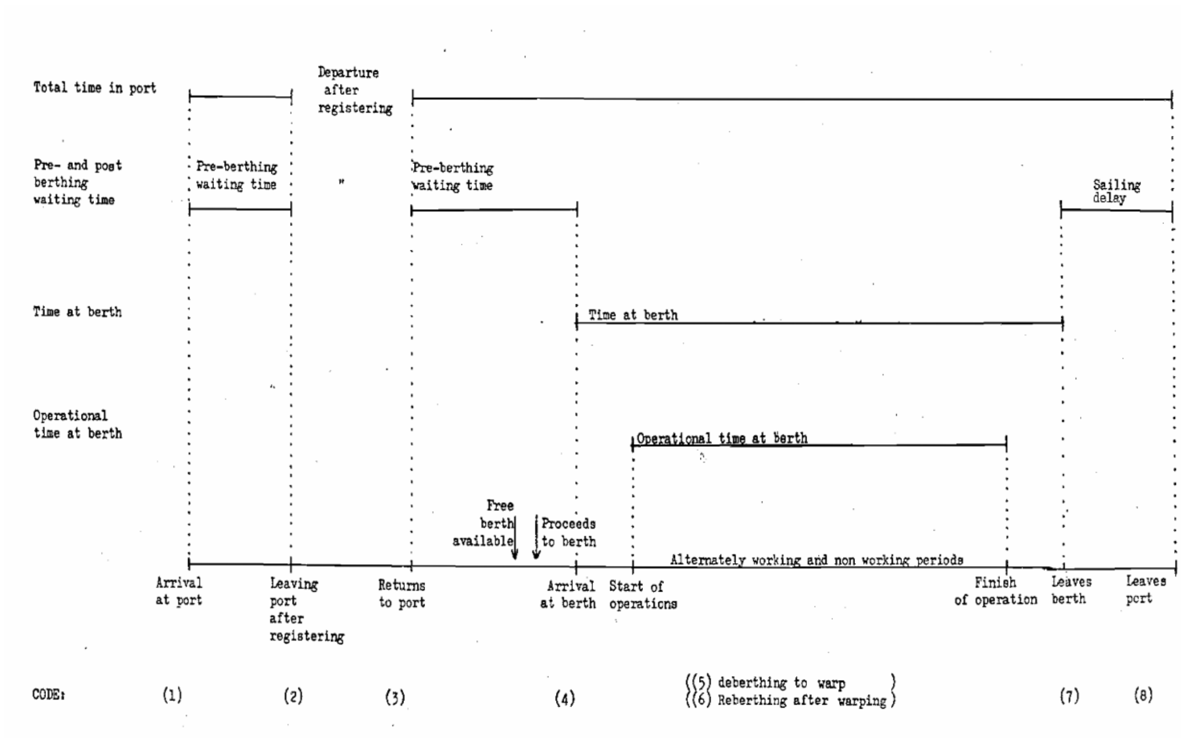


Figure 2.1: Breakdown of ship's time in port.

SOURCE: De Monie, G. (1987): Measuring and Evaluating Port Performance and Productivity, UNCTAD Publication, Monograph

The ship has to give notification to the port and the terminal of its arrival/departure. Normally the ship would wait at anchor when arriving at the port and then be given orders to weigh anchor and for the pilot and marine services to berth the ship. Once alongside the berth, the terminal would commence cargo operations provided all the necessary port arrival documentation is completed. The efficiency of the port would be measured by the total ship turnaround i.e. the time from when the ship arrived at the port limit till the time the ship crosses the breakwater on its onward voyage.

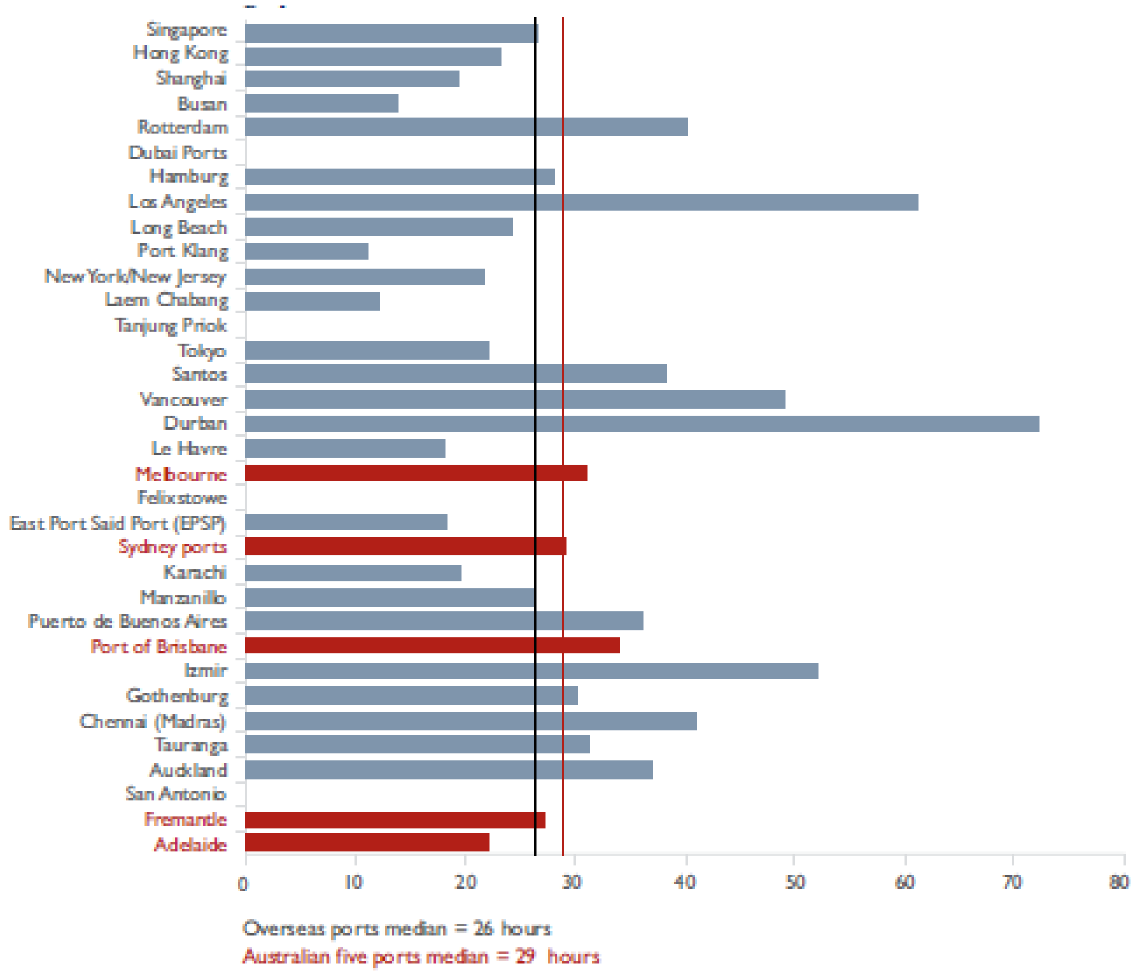


Figure 2.2: Vessel turnaround times for selected ports for 2006-2007

a. The black line represents the median for overseas ports while the red line is the median for Australia's five container ports.

Source: Bureau of Infrastructure, Transport and Regional Economics [BITRE]; (2009), Australian Container ports in an international context, Information Paper 65, BITRE, Canberra ACT.

It can be seen from figure 2.2 that the Port of Durban displayed very high vessel turnaround time of over 70 hours compared with the overseas port average of 26 hours during 2006-2007. It must also be noted that in 2002 the container lines imposed a surcharge on all containers going through the Port of Durban due to the lengthy ship waiting times experienced.

This prompted the then mayor of Ethekwini, Obed Mlaba, to convene a meeting with port authorities to try to resolve what was perceived as a potential crisis for the port community and to attempt to stave off the R875 per box surcharge. (*The Mercury,* 17 January 2002). Again in 2006, the carrying lines threatened to impose a surcharge unless the vessel waiting times of between 60-70 hours were reduced. The cost of high vessel waiting times can be detrimental to the economy and a reduction in these waiting times, together with an overall improvement in terminal efficiencies (e.g. gantry crane productivity), must be high-priority aims for port management.

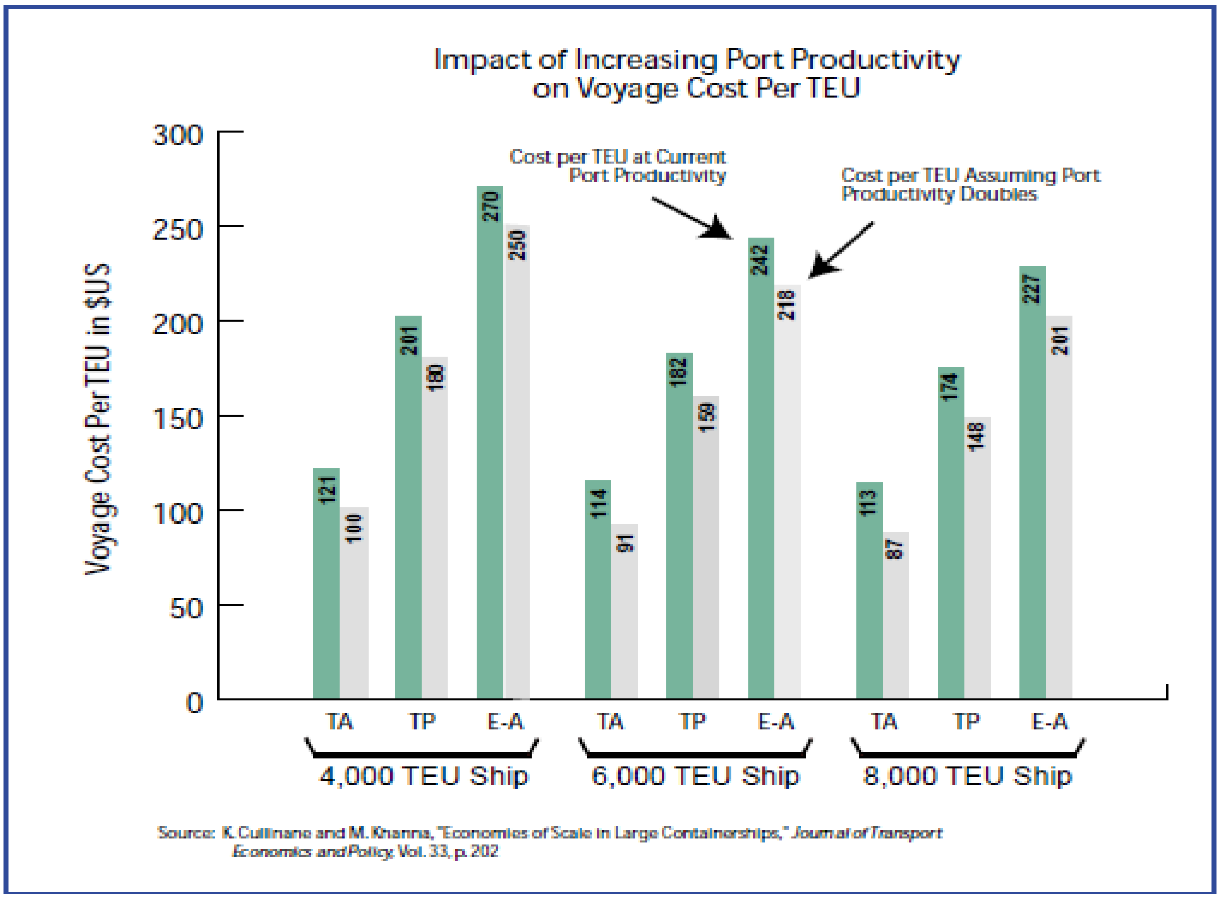


Figure 2.3: Increasing port productivity and the effect on voyage costs per TEU

SOURCE: Cullinane, K. and Khanna, M. (1999) Economies of scale in large containerships:. Journal of Transport Economics and Policy, Vol.33, p202

Note: TEU-twenty foot equivalent (container length)

By increasing a terminal's handling capacity and efficiency (see figure 2.3), the overall net effect is a reduction in the voyage cost per TEU. Cullinane and Khanna, (1999) show that a cargo-handling rate double that of the current rate will significantly reduce the unit cost, as the ship will be able to carry more containers in a given time period. If a terminal for example has a handling rate of 15 moves per hour as opposed to a terminal with a handling rate of 30 moves per hour for the same size of ship using similar equipment, the turnaround time for the ship will be halved *ceteris paribus*. This means that the ship spends more time at sea earning revenue than alongside a berth. Therefore, one can conclude that higher port productivity leads to reduced vessel turnaround times and improved overall vessel performance.

2.2. NOTICE OF ARRIVAL AT A PORT.

During January to March 2010, 1068 ships (see Annexure 1) arrived at the Port of Durban. The total number of vessel movements (total movements are arrivals + departures + vessels shifting berth) for the same period equaled 2308 (extracted from the Vessel Traffic Services – VTS – log). The analysis of the data indicates that 409 container ships arrived at the port. Before analysing the data further, the process of a ship's pre-arrival and arrival will be explained (see figure 2.4 and 2.5). International regulations (International Ship and Port Facility Security Code (ISPS Code) - 2002) require that all ships arriving at a port must give notification prior to arrival for security clearance.

As a signatory to the ISPS Code, South Africa ensures compliance by ensuring that all ships entering South African ports are security cleared for entry. In a 14-day window before the ship's arrival, all the relevant documentation required by the South African security department to clear the ship for entry has to be received via the ship's agent and is verified together with the terminal at which the ship is to berth. This is done to prevent rogue ships from entering South African ports. This pre-vessel arrival process is shown schematically in figure 2.4.

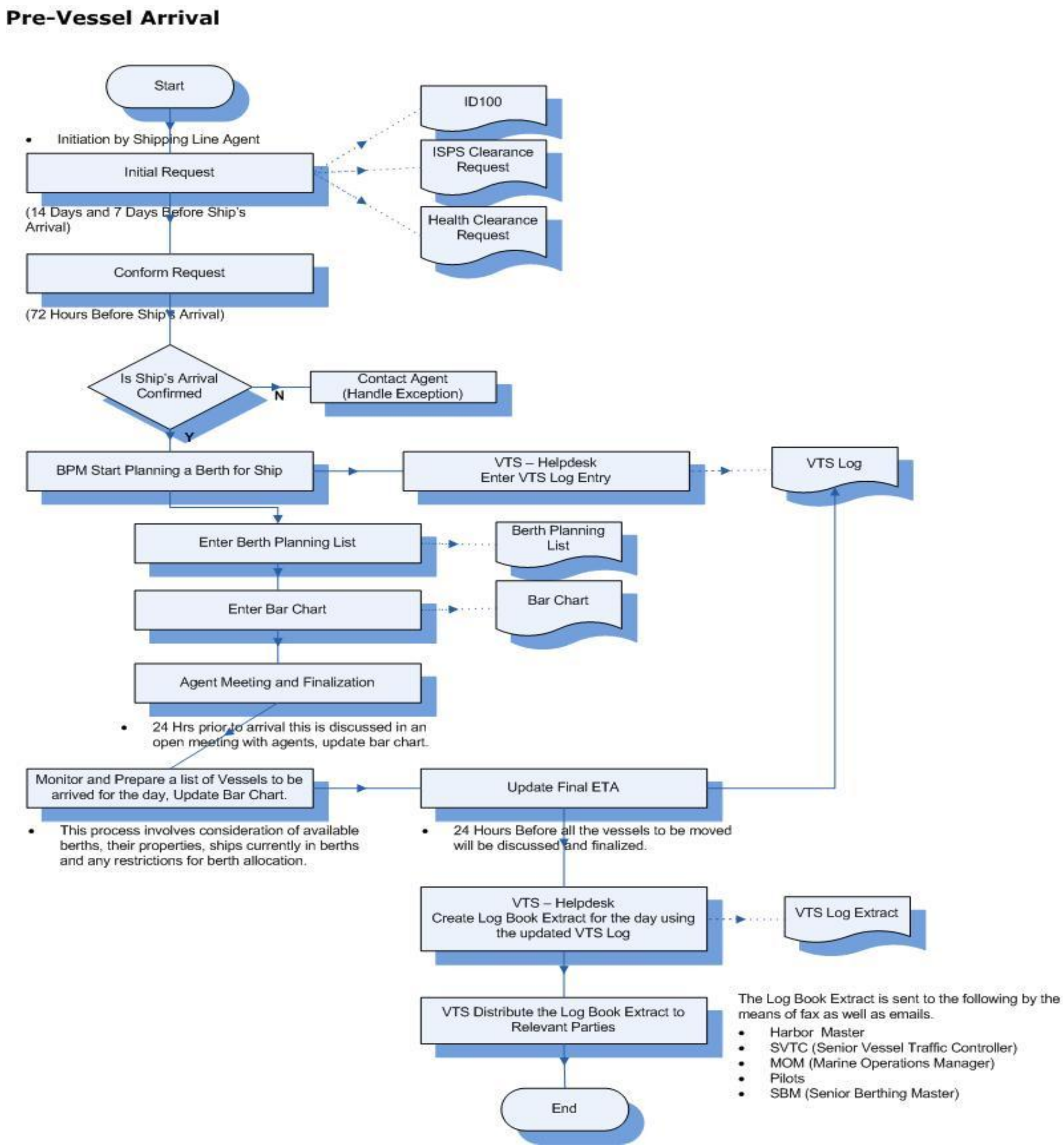


Figure 2.4: Pre vessel arrival process to port entry into the Port of Durban

Source: Drawn from Aitken Spence One Alpha Report (2008) and Vessel Traffic Service (VTS) System 2011

From the pre-arrival processes (see figure 2.4) a 14 day / 7 day Estimated Time of Arrival (ETA) is also given to allow to sufficient planning and preparation of the vessel's arrival. The very beginning of the process starts at the point the shipping agent sends a request for an allocation of a berth on a specified date.

Once this request is received, various events are triggered and numbers of sub-processes evolve. Upon receipt of an ID100 (Initial Request Document), the Berth Planning Manager plans for a berth for the vessel. Various preparation tasks will also be initiated at this point. Updates are sent by shipping agents to the port in a sequence of 14 days, 7 days and to confirm 72 hours before the arrival of the vessel. Within the South African port system, a ship only needs security clearance at the first port of entry.

On arrival at the port depending on the berth allocation and berth availability the ship follows the process outlined in figure 2.5. The ship will make a request for service and the VTS centre will allocate the necessary resources to ensure the safe berthing of the vessel. The port has limitations in that it is only able to operate four vessel movements in a two-hour slot/window. Therefore, ships arriving at the port are allocated within a slot for appropriate service.

Vessel Arrival Process

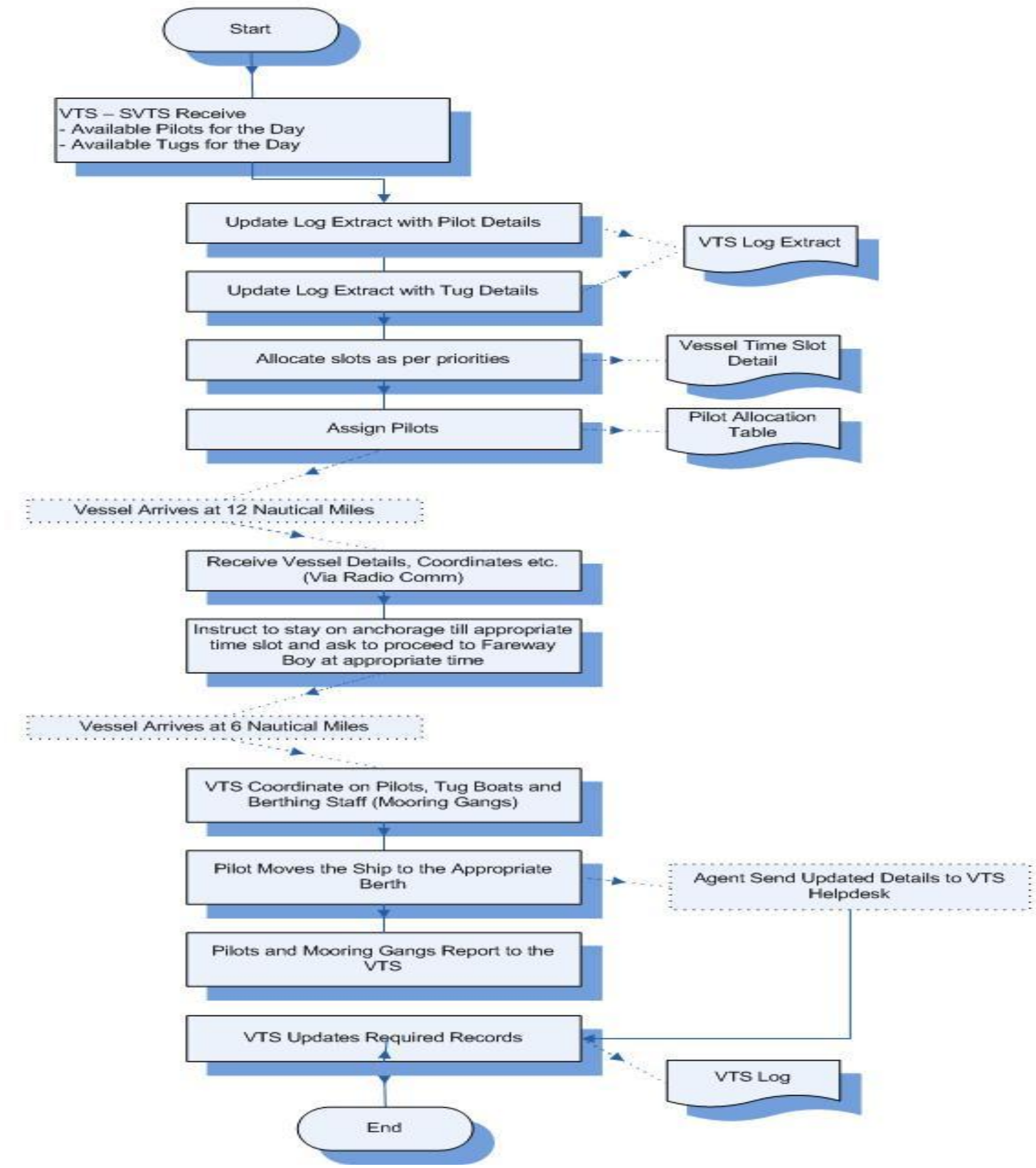


Figure 2.5: Vessel arrival process at the Port of Durban.

Source: Drawn from Aitken Spence One Alpha Report (2008) and Vessel Traffic Service (VTS) System 2011

2.3. NOTICE OF DEPARTURE

The departure process (see figure 2.6) is almost same as the arrival except the terminal operator provides departure information four hours prior to sailing and must confirm within two hours of request for marine services (see Port Rules Part D Section 31 – Annexure 2).

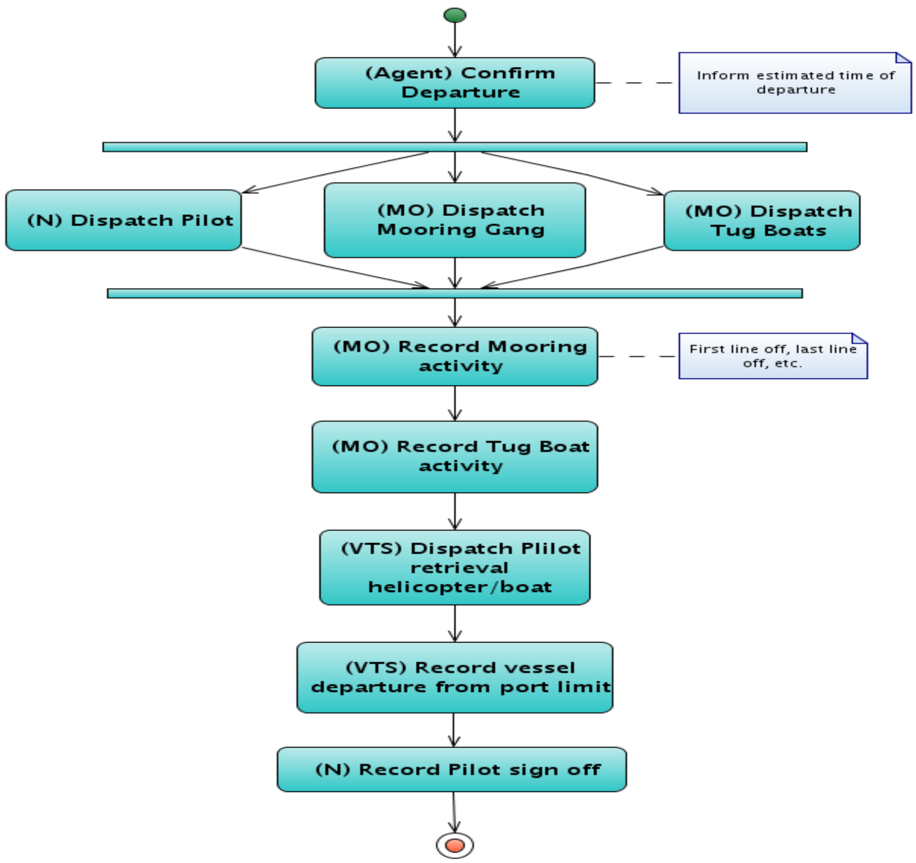


Figure 2.6: Vessel departure process for the Port of Durban

Source: Drawn from Aitken Spence One Alpha Report (2008) and Vessel Traffic Service (VTS) System 2011

2.4. OPERATION OF A CONTAINER TERMINAL

Seaport container terminals are an important part of the logistics systems in international trades (Wong and Kozan, 2010). Container terminals are not only simple connections between transportation modes; they also represent the site where several market players, who act around maritime transportation, trade for their business (Vacca et al., 2008). This can be evidenced by figure 2.7 showing the typical process flow of a container terminal.

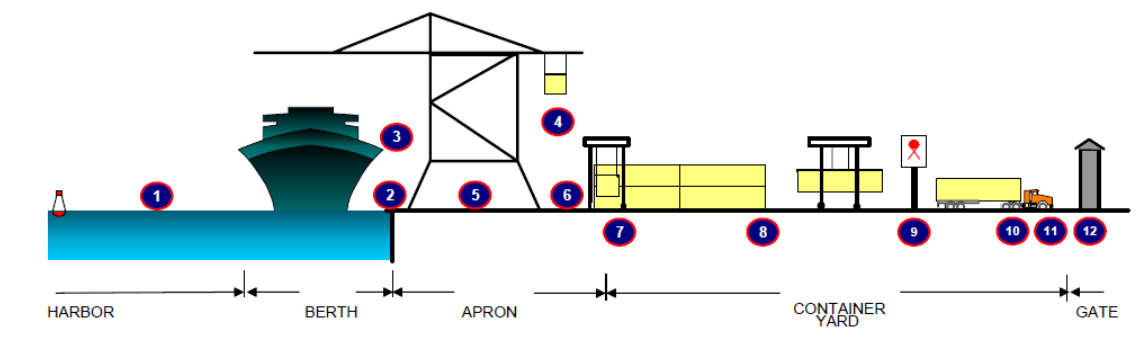


Figure 2.7: Typical operation of a container terminal.

Source: Londono-Kent.M and Kent.P; (2003) Tale of two ports. The costs of inefficiency. World Bank

Londono-Kent and Kent, (2003) outline the process from 1 to 6 and also explain the charges incurred during this time:

1. At the fairway buoy, a pilot boards the vessel (usually by pilot boat) and guides the captain through the navigation channel. If no berth is available, the ship is assigned an anchorage area. The ship is assisted to the berth by one or two tugs, depending on ship size and port regulations. Berthing gangs help tie the ships lines to the bollards. In some ports, navigation, pilotage, and tug assistance may be combined into a single charge. These charges all apply to the carrier via the vessel agent.
2. Once on the berth, the vessel pays berth dues but not so in South Africa. Here berth dues as such are only attracted by non-cargo working ships. For working ships, berth

dues are bundled into port dues. Time on the berth also determines the berth occupancy rate.

3. Ships are cleared on the berth by immigration, customs and other government agencies. The ship must also comply with ISPS (International Ship and Port Security Code) requirements.
4. The terminal personnel together with the stevedores then discharge/ load the ship. International Benchmark Productivity rates for gantry cranes (See figure 2.8) are about 50+ moves per hour. Productivity rate for Durban is around 23 moves per hour.
5. The terminal's efficiency is measured by the time it takes to load and discharge a ship as well as the dwell time of containers (export/import) in the terminal.
6. The charges allocated for moving/storing containers are laid out in the terminal tariff book.

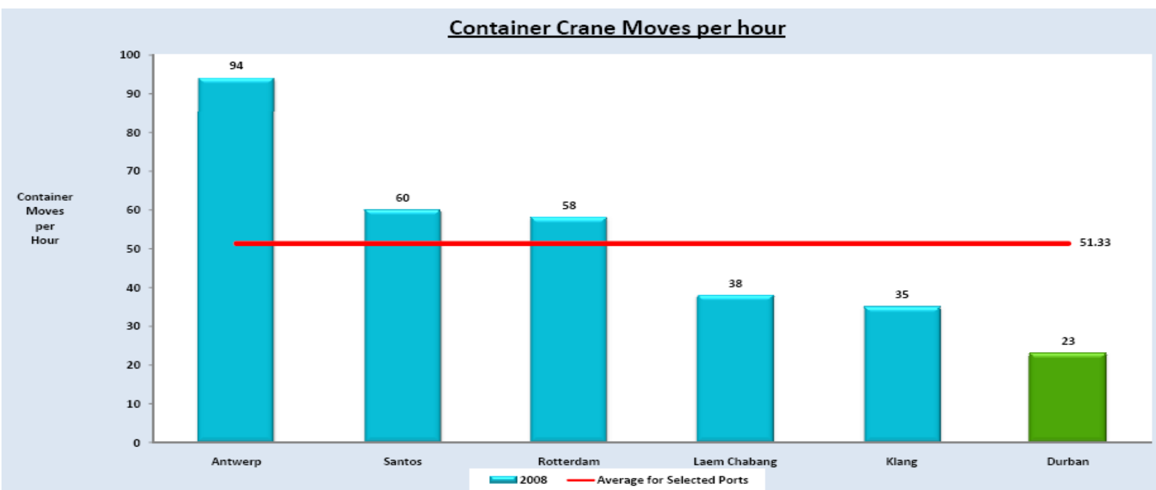


Figure 2.8: Container crane moves per hour[2]

Source: South African Port Regulator (2010)

Figure 2.8 shows the productivity levels at a range of ports. Currently, it would appear that the productivity at the Port of Durban is low compared with other ports around the world.

[2] The figure of 94 in the case of Antwerp has been questioned, but it is based on the use of double spreaders each capable of handling two 12-metre containers, hence one operation equals four TEUs.

However, this benchmark is often not a fair reflection of the ports performance as well as some of the challenges that it encounters. Terminal design (see figure 2.9) and equipment, together with the level of skill of the terminal management and workforce, can determine the efficiency of a terminal. It is evident that the South African ports are often affected by labour work stoppages; poor infrastructure (including hinterland connections); maintenance and issues regarding terminal management. Figure 2.9 also shows how a relatively substantial terminal complex and container stacking area compresses into quite constricted distribution channels. These constricted landside connections may affect yard-gate-distribution efficiency adversely.

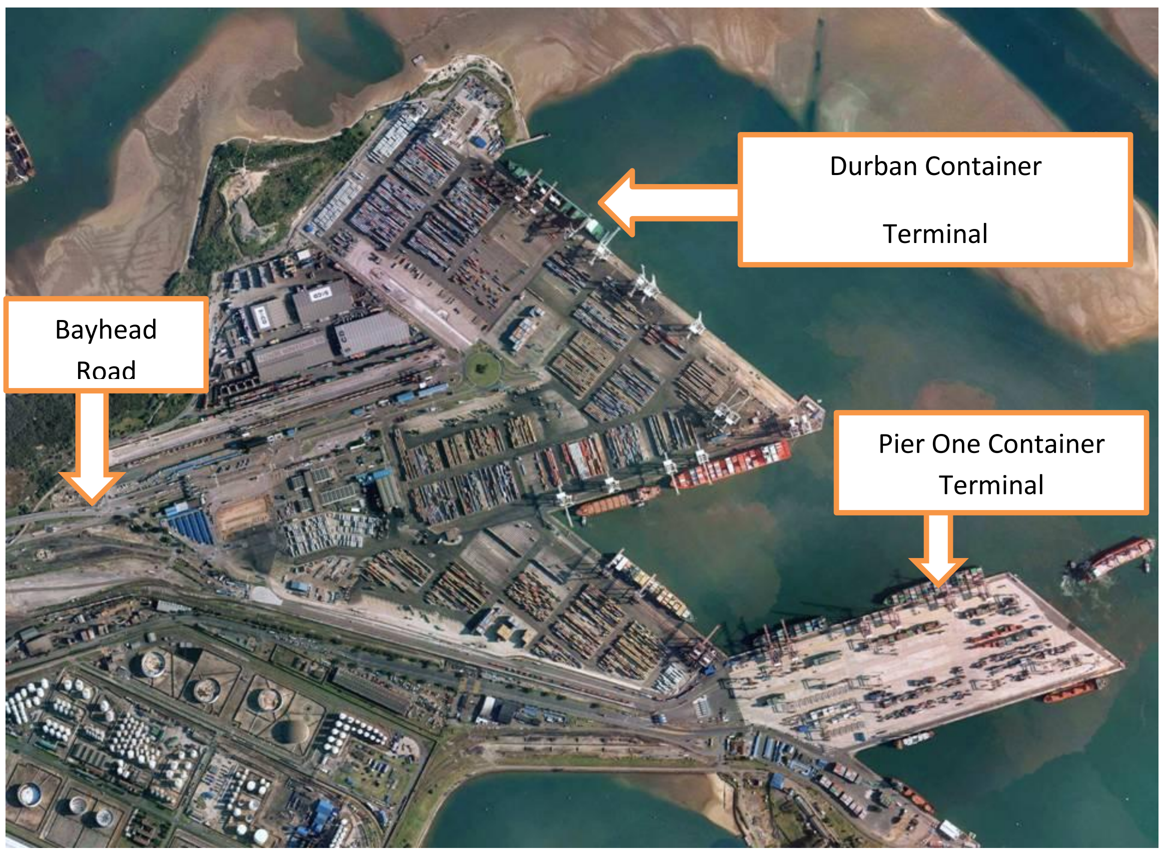


Figure 2.9: Layout of the container terminals in the Port of Durban

SOURCE: Photo is courtesy of the Planning and Development Department in Port of Durban 2010

Container terminal productivity not only contributes to a higher saving in voyage cost per TEU but also contributes to significantly reducing any delays to ships awaiting berths and thereby also to enhancing the earning capacity of these vessels. Annexure 3 highlights two pillars from the Global Enabling Trade Report 2012. It shows that the productivity of South Africa in relation to 132 countries studied. The number of days to import/export containers and the costs associated with this is very high in relation to the top performing countries. South Africa also ranks poorly overall which shows the need to drastically improve our terminal performance in relation to the total logistics chain and minimize bottlenecks that exist.

In this chapter, ship turnaround time has been explained. It can be seen that there are a number of processes involved leading up to the time a ship arrives alongside a berth, commences and completes cargo operations, and then sails. The efficiency of the cargo handling of the terminal impacts on the overall ship turnaround time as well as the costs of handling the cargo. Ship owners are constantly trying to achieve greater economies of scale, minimising idle time and delays to a ship that affect the revenue earning capacity of the ship.

In chapter 3 the soft systems complexity model for explaining the data will be discussed.

CHAPTER THREE: USING A COMPLEXITY MODEL TO UNDERSTAND THE IMPACT OF MARINE SERVICES ON SHIP TURNAROUND

3.1 INTRODUCTION

Globalisation of manufacturing has placed pressure on to the shipping lines to deliver the freight "just-in-time". That is "just-in-time" to allow the manufacturer's production line to continue operating without the need for a significant inventory of parts in storage. This is often a huge cost saving initiative on the part of the manufacturer. Therefore, the transportation system becomes the warehouse. For many importers, it is more important to know when their goods will arrive rather than how fast they can be delivered. This gives them sufficient time to plan their operations (Francou and Whitaker, 2004).

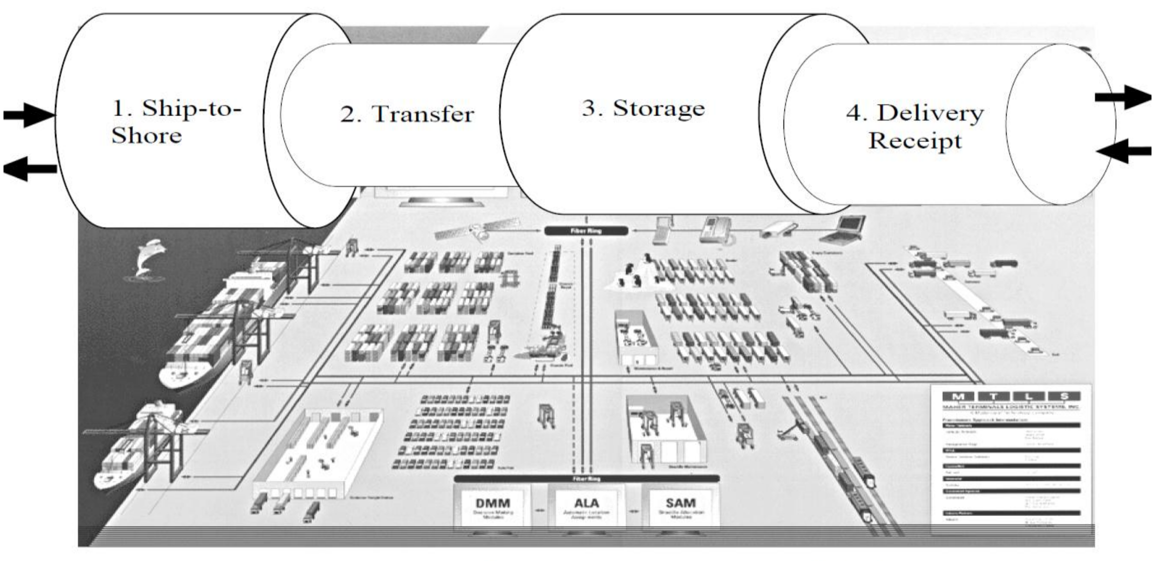


Figure 3.1: Configuration of a typical container terminal

SOURCE: Henesey, L.E., (2004) Enhancing Container Terminal Performance: A Multi Agent Systems Approach, Department of Systems and Software Engineering School of Engineering, Blekinge Institute of Technology, Karlshamn, Sweden

The flow of containers through the container terminal (see Figure 3.1) is determined by the capacity of the bottlenecks, whether realised or unrealised (Hennessey, 2004). The diameter of each subsystem shows its capacity, which in turn determines the capacity of the entire container terminal. The focus of this research will be to determine the ship-to-shore interface. This would include waiting time from last line secured to first container moved.

A faster turnaround time in a container terminal translates to a shipping line spending less time in port and more time at sea earning revenue. Container terminals use some of these as measurements to indicate performance i.e. (UNCTAD, 1976):

- Service time: Period of time which a ship is berthed whether it is worked or not. This includes working and non-working periods.
- Container Terminal Capacity: Maximum output that is generated from the input of production factors.
- Berth Utilization: Utilized service time in relation to available service time.
- Waiting time: Time the ship has to wait for an available berth. This "waiting time" also potentially includes the "dead" time a vessel spends on the berth after completion of cargo operations but prior to departure. It may be tricky to deal with as it could be attributed to terminal delays, but it might also have a marine services dimension, if tugs/pilots are not available on demand. In this research, the specific focus is on marine services efficiency.
- Dwell time: Time spent by the container (export/import) in the terminal.

Ship turnaround is greatly affected by these factors. Waiting time is an area that the study will focus on. This will be combined with the time to dock/undock a vessel upon notification. These performance indicators serve to influence strategic decisions made by port authorities with regard to capacity. They are also useful when benchmarking against other ports with similar characteristics and communicating with stakeholders.

The transfer of cargo is the backbone of the port. Therefore, the port only functions if this important transportation node links with other modes. This transfer from ship to other modes requires terminals, pilotage, towage, mooring operations, customs and other activities to make it work efficiently (De Langen et al., 2007). While there is a lot of literature on port turnaround, there is no measurement for turnaround that determines the performance of the port. This study seeks to also understand ship turnaround measurement. A lot of attention has been given to an adequate literature review, including the work of Wiegmans et al., (2004) and De Monie, (1987), in understanding ship turnaround and berth allocation and occupancy while conducting this research.

Ports have also evolved over time in a dynamic and path dependent manner as a result of complex interactions amongst shippers, ship-owners, port users and other stakeholders. This is evident in the evolution of ports over time as shown in figure 3.2.

A. First generation	Prior to 1950	Sea approach, transfer of goods, temporary storage, delivery.
B. Second generation		Includes A plus industrial and commercial activities which give added value to the goods. The port is a handling and services centre.
C. Third generation	Since 1980	Includes A plus B plus structuring of the port community, plus strengthening links between town and port and between port-users, plus extension of the range of services offered beyond the port boundary, plus an integrated system of data collection and processing. The port has become a logistics platform for trade.
D. Fourth generation	Since 2000	Network of physically separated ports (terminals) linked through common operators or through a common administration.

Source: UNCTAD 1992; 1999

Figure 3.2 Evolution of ports

SOURCE: UNCTAD (1999). Technical note: Fourth generation port. UNCTAD Ports Newsletter 19, pp9-12 and UNCTAD (1992), Development and improvement of ports: the principles of modern port management and organisation, UNCTAD, Geneva and Verhoeven, (2009), p4.

3.2. RESEARCH DESIGN.

3.2.1. RESEARCH APPROACH

Ports are complex systems. In order to understand the nature of the complex interactions between the port and its various stakeholders, the appropriate methodology used provides a means at problem solving (Levy, 2000). Traditional methodologies include looking at the organisation from a strategic level. However, using a critical systems approach means understanding the nature of the problem and then looking at all the factors influencing the problem, letting an appropriate solution (or solutions) emerge as the analysis unfolds. Critical systems' thinking is divided into three phases namely:

1. Creativity phase - the organization is described in terms of an appropriate metaphor.
2. Looking at the system of systems methodology (SOSM) grid, a suitable methodology is chosen to the problem situation. Sometimes this could involve a combination of methodologies.
3. Implementation phase – the methodology is applied to the situation with specific results then tabled.

On the surface, it would appear that a hard systems approach would be more appropriate due to the process flows involved. However, a soft systems methodology would prove as the more dominant method to be employed with the hard systems approach being subservient. Hard systems approaches assume that the objective reality of systems in the world present themselves as relatively well-defined problems in which technical factors are paramount, and therefore where technical solutions are accessible. They are more suited to engineering type problem solving, whereas the soft systems approach here will address an operational problem that is regarded as 'messy'. Table 1 below outlines the differences between the two systems and provides general pointers to situations where one or the other of the approaches is likely to be more appropriate in application.

ATTRIBUTES	HARD SYSTEMS METHODOLOGY	SOFT SYSTEMS METHODOLOGY
Orientation	Systematic goal seeking	Systematic learning
Roots	Simplicity paradigm	Complexity paradigm
Belief	Systems can be “engineered”	Systems can be explored
Belief	Model of the world (ontologies)	Models of intellectual constructs (epistemologies)
Belief	“Closure” is necessary	“Inquiry” is never-ending
Belief	“Finding” solutions to problems	“Finding” accommodation to issues
Human content	Nonexistent	High
Question(s)	How?	What and how?
Suitability	Well-structured problems	Ill-structured problems

Table 1: Differences in application between a hard and soft system approaches

SOURCE: Khisty; 1995, p97

A soft systems methodology has emerged as a much more appropriate approach to use because of the limitations of a hard systems approach in contexts where several interactions are involved.

Since there are several stakeholders involved who have their own views and perspectives to the problem of high ship turnaround times in the Port of Durban, a soft systems approach is adopted in this study, as it takes into account all the human factors that are involved in complex problem solving situations.

Emergence of a possible solution from the analysis of data is a cornerstone of a soft systems approach (Checkland, 1985). As the system is interrogated, new learning and knowledge emerge for possible solutions.

This study has opted to use the brain metaphor in this scenario because of the role the VTS centre plays in managing the co-ordination of traffic flow within the port. The systems methodology employed will be Checkland's SSM (Soft Systems Methodology) (Checkland, 1987) approach because of the wide range of stakeholders involved and their specific interests concerning ship turnaround.

3.2.2 RESEARCH METHODOLOGY

Using the system of systems methodology approach would mean that Checkland's SSM would be the dominant methodology employed. SSM is an action research approach to problem or 'puzzle' situations in which people with different or conflicting views are involved. In contrast to typical action research methodology, however, SSM places the priority on processes of enquiry, in particular, learning about the worldview, and sense of values, of all the people concerned with a given situation (Tajino and Smith, 2005).

A model using the seven-stage model of SSM as a base, (in Figure 3.3) will be constructed to outline the problem situation that exists in turnaround times of ships – mainly container ships – in the Port of Durban.

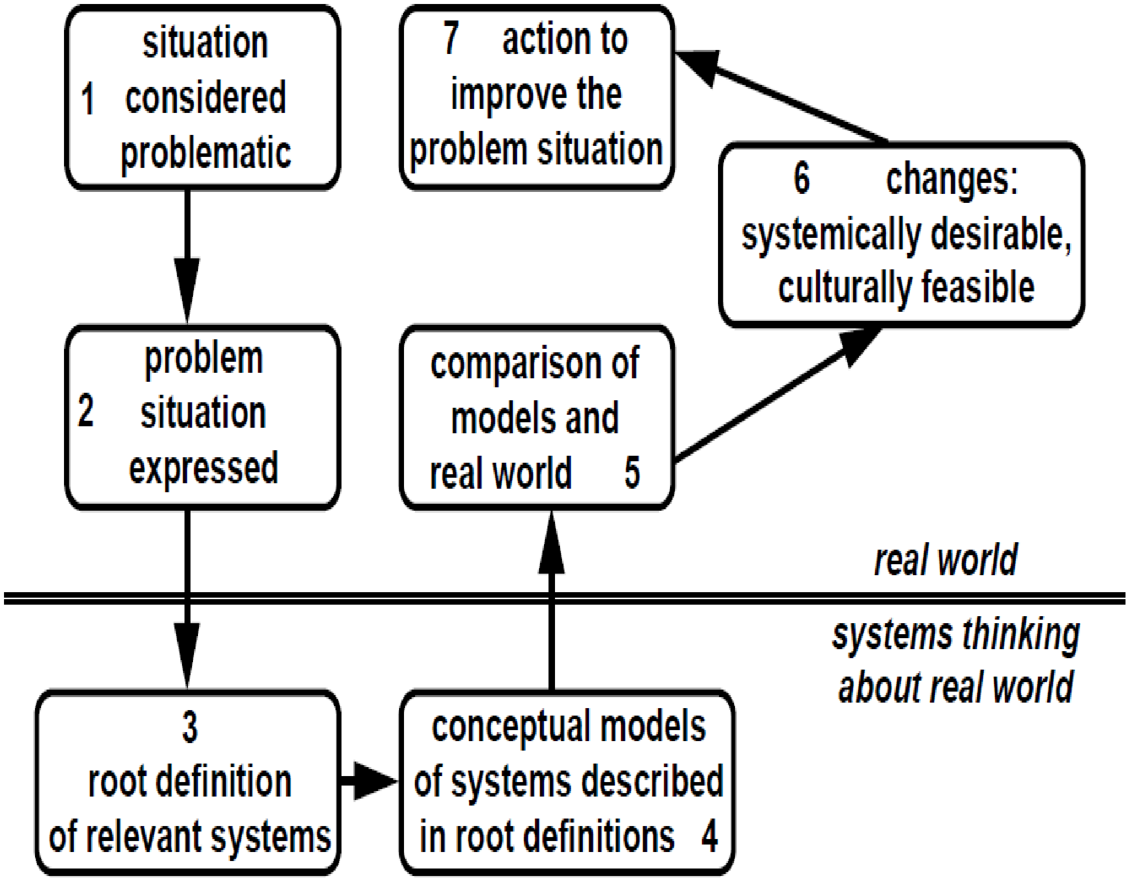


Figure 3.3: The conventional seven-stage model of SSM

Source: Checkland and Scholes, (1990, p 27)

The model has seven steps that are used to unpack the problem situation. While the methodology itself is "soft" meaning that it can accommodate imprecision, uncertainty and alternative points of view the conceptual models are abstract entities which may be subjected to rigorous analysis. This chapter has presented briefly the basic conceptual and theoretical framework outline for this study.

In chapter four the study will focus on the analysis of the data using this framework - Checkland's seven-stage model - to understand the complexities of ship turnaround in the Port of Durban.

CHAPTER FOUR: ANALYSIS AND INTERPRETATION OF DATA

4.1 INTRODUCTION

It is understood that a port's performance indicators are simple measures of a port's operation. An analysis has been conducted on the actual number of ships that have visited the port during two three-month periods of July to September 2010 and July to September 2011. It is important to utilise actual data in order to get a true reflection of how the port is functioning. The Port of Durban VTS, using the completed movements register, has supplied the data. For the purpose of this study, we will only concentrate on the movements involving container ships as this has been considered a priority for the port. The Marine Resource Allocation Policy of the Port of Durban [although still a draft document] determines that container ships be given priority berthing as can be seen in annexure four.

4.2 THE STAGES OF THE CONVENTIONAL SEVEN-STAGE MODEL OF SSM

4.2.1 STAGE 1

It is deemed that the ship turnaround times in the Port of Durban are considered fairly long by the operators and port users (see earlier in figure 2.2). The Port Authority and the terminal operator do acknowledge that there is room for improvement with regard to ship turnaround times; however, no-one is willing to pinpoint the exact source for the delays experienced by ships using the port. Figure 2.3 earlier showed the breakdown of a ship's time in port and established that there are a number of steps that are undergone by a vessel upon arrival and departure and a number of important interactions between the terminal and the other modes of transportation. This study seeks to determine what role the marine services plays in ship turnaround.

4.2.2 STAGE 2

Using the research question as a guide: "*How can the Marine Services within the Port of Durban assist in reducing ship turnaround times?*", it will be assumed that the main reason for ship delays or higher turnaround times is that there is an inefficient marine service offering in the Port of Durban. This may also serve as the null hypothesis in this work.

The marine services within the port are made up of the pilotage service, towage, and berthing. This function of marine services is coordinated by the Vessel Traffic Services (VTS) as can be seen by figure 4.1. This has also been previously discussed under notification of arrival and departure. The VTS function is important in ensuring that there is optimal usage of the resources available at their disposal. The jobs (sailings/arrivals/movements within the port) must be planned well in order to properly dispatch resources appropriately. There have been instances where the pilot is dispatched to a vessel only to discover that the tugs are preoccupied on another job thus causing a delay that could have been avoided.

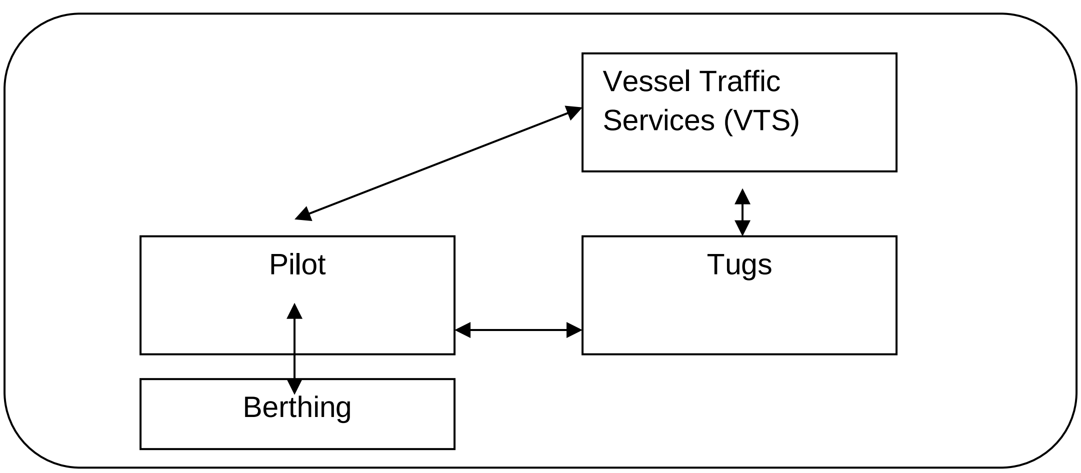
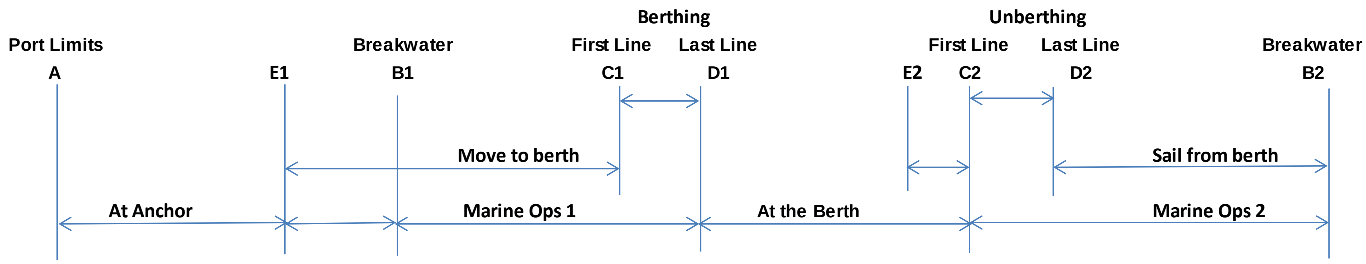


Figure 4.1: Coordination of the Marine Services for sailing/berthing of ships

SOURCE: Author's own representation

4.2.3 STAGE 3

In order to understand the extent of the problem relating to very high ship turnaround times experienced in the Port of Durban, it would be important to evaluate the vessel arrival/departure to and from the port and try to understand the flow/process of the ship.



E1 – Pilot on Board

C1 – First line onto the bollard

D1 – Last line onto the bollard

E2 – Pilot on Board

C2 – Fist line off the bollard

D2 – Last line off the bollard

Figure 4.2: Revised breakdown of a ship's time in port

SOURCE: This timeline is similar to figure 2.1 but reconstructed from the VTS data analyzed. Author's own representation

It must be noted that not all ships arriving at the port limits of the Port of Durban and anchoring at the anchorage enter the port. Some ships might be awaiting further orders or seeking a secure/safe anchorage.

This study is also only focused on the container ships entering the Port of Durban. The critical parts of the study are mainly the delays caused by the Marine Ops 1 (arrival) and Marine Ops 2 (departure) of container ships and the significance of these delays in terms of overall ship turnaround times.

Table 2: Analysis of July-September 2010 Arrival/Departure Statistics for Container Ships to the Port of Durban (figures expressed in hours)

	At Anchor	Pilot to B/Water	Moving to Berth	Tie up	Let Go	Sailing from Berth	Stay	In Port	Arrival Tugs Used	Depart Tugs Used	Ships Sampled
	B1-A	B1-E1	C1-B1	D1-C1	D2-C2	B2-D2	B2-A	B2-B1			
JULY	85.2	0.42	0.65	0.31	0.20	0.59	135.4	50.1	1.6	1.3	91
AUG	72.4	0.39	0.65	0.30	0.20	0.56	114.9	42.5	1.7	1.4	119
SEP	34.8	0.41	0.65	0.29	0.18	0.58	79.0	44.2	1.5	1.4	112
Average	64.1	0.41	0.65	0.30	0.19	0.58	109.8	45.6	1.6	1.4	107

	At Anchor	Marine Ops 1	At the Berth	Marine Ops 2	B1 to B2	A to B2	Anchor /A to B2	Berth / A to B2	OPS / A to B2
JULY	85.2	0.96	48.4	0.79	50.14	135.4	63.0%	35.7%	1.29%
AUG	72.4	0.94	40.8	0.76	42.53	114.9	63.0%	35.5%	1.48%
SEP	34.8	0.94	42.5	0.75	44.23	79.0	44.0%	53.8%	2.14%
Average	64.1	0.95	43.9	0.77	45.63	109.8	58.4%	40.0%	1.56%

SOURCE: Author's own analysis and representation

When analysing table 2, it must be read in conjunction with figure 4.2. For the period under review from table 2 - July-September 2010 - there were 322 container ships that arrived at the Port of Durban. The time spent at the port is reflected in hours and it can clearly be established that the ships arriving at the port spend most of their time at anchor – 58.4% (64.1

hours) on average for the period. A further 40% (43.9 hours) of the ship's time is spent alongside the berth. The Marine Operations component is 1.56% (0.95 hours).

Table 3: Analysis of July-September 2011 Arrival/Departure Statistics for Container Ships to the Port of Durban (figures expressed in hours)

	At Anchor	Pilot to B/Water	Moving to Berth	Tie up	Let Go	Sailin g from Berth	Stay	In Port	Arrival Tugs Used	Depart Tugs Used	Ship Sampled
	B1-A	B1-E1	C1-B1	D1-C1	D2-C2	B2-D2	B2-A	B2-B1			
JULY	57.9	0.42	0.69	0.30	0.18	0.53	114.3	56.4	1.7	1.4	82
AUG	84.9	0.39	0.69	0.31	0.20	0.58	143.2	58.4	1.8	1.5	77
SEP	87.9	0.38	0.64	0.31	0.20	0.52	161.8	73.9	1.6	1.4	75
Average	76.9	0.39	0.67	0.30	0.20	0.54	139.8	62.9	1.7	1.4	78

	At Anchor	Marine Ops 1	At the Berth	Marine Ops 2	B1 to B2	A to B2	Anchor /A to B2	Berth / A to B2	OPS / A to B2
JULY	57.9	0.99	54.8	0.71	56.45	114.3	50.6%	47.9%	1.48%
AUG	84.9	1.00	56.6	0.78	58.36	143.2	59.3%	39.5%	1.24%
SEP	87.9	0.95	72.2	0.72	73.92	161.8	54.3%	44.6%	1.03%
Average	76.9	0.98	61.2	0.74	62.91	139.8	55.0%	43.8%	1.23%

SOURCE: Author's own analysis and representation

For the period under review from table 3 - July-September 2011 - there were 234 container ships that arrived at the Port of Durban. The time spent at the port is reflected in hours and it can clearly be established that the ships arriving at the port spend most of their time at anchor – 55.0% (76.9 hours) on average for the period. A further 43.8% (61.2 hours) of the ship's time is spent alongside the berth. The Marine Operations component is 1.23% (0.98 hours).

When analysing 2010-2011 a worrying trend emerges that the average waiting times for ships at anchor has increased significantly and the time on the berth has also increased significantly despite a reduction in the number of ships calling to the port. This is partly due to the fact that much larger ships now arriving at the port (see figure 4.3) and more crucially are working a larger number of containers per port call. Also see annexure five and six. However, there is still concern about the operational efficiency of the terminals in the port (Pier One and Durban Container Terminal). The Marine Operations service times have also increased marginally 1.23% (0.98 hours) but this is due to longer time required for berthing and sailing of larger ships.

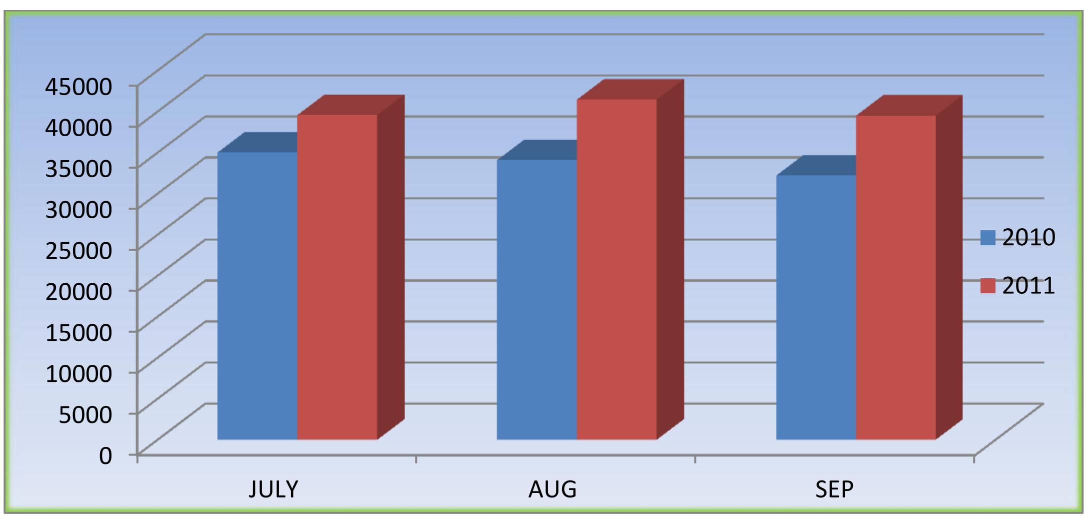


Figure 4.3: Average Incoming Gross Tonnage Handled for the period

SOURCE:Author's own analysis and representation

The turnaround time of the container ships expressed in hours is deemed as high in relation to other overseas container ports (see figure 2.2). The data collected clearly supports the information and highlights the need for greater port efficiency at the terminal and or port and possibly the need for additional berths and terminals.

4.2.4 STAGE 4

In analysing the delays experienced at the port, there are several contributing factors that impact on the delays. This study will focus on delays for 2010 as these are similar to delays experienced in 2011 (see table 4).

Table 4: Delays (in hours) experienced July-September 2010

	DELAYS 2010									
	a	b	c	d	e	f	g	h	i	Total
JULY	6	1	1	2	4	1	1	2	1	19
AUG	5	1	0	0	0	0	0	0	0	6
SEP	5	0	0	0	1	1	0	0	1	8
Average	5.3	0.7	0.3	0.7	1.7	0.7	0.3	0.7	0.7	11
JULY	31.6%	5.3%	5.3%	10.5%	21.1%	5.3%	5.3%	10.5%	5.3%	
AUG	83.3%	16.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
SEP	62.5%	0.0%	0.0%	0.0%	12.5%	12.5%	0.0%	0.0%	12.5%	
Average	48.5%	6.1%	3.0%	6.1%	15.2%	6.1%	3.0%	6.1%	6.1%	

a. TUGS OCCUPIED

b. TUG OUT OF COMMISION [O.O.C.]

c. BERTHING STAFF OCCUPIED

d. CHANGE OF SHIFT

e. PILOTS OCCUPIED

f. OVER BOOKING OF SLOTS

g. SHIPPING MOVEMENTS

h. BACKLOG OF SHIPPING

i. ADVERSE WEATHER

SOURCE: Author's own analysis and representation

From table 4 it can be seen that a high proportion of the delays are as a result of the tugs occupied (48.5%) followed by the pilots occupied (15.2%).

Table 5: Delays (in hours) experienced July-September 2011

	DELAYS 2011									
	a	b	c	d	e	f	g	h	i	Total
JULY	7	2	1	0	3	0	4	0	0	17
AUG	8	3	0	0	8	0	2	0	0	21
SEP	7	0	3	1	6	0	4	1	0	22
Average	7.3	1.7	1.3	0.3	5.7	0.0	3.3	0.3	0.0	20.0
JULY	41.2%	11.8%	5.9%	0.0%	17.6%	0.0%	23.5%	0.0%	0.0%	
AUG	38.1%	14.3%	0.0%	0.0%	38.1%	0.0%	9.5%	0.0%	0.0%	
SEP	31.8%	0.0%	13.6%	4.5%	27.3%	0.0%	18.2%	4.5%	0.0%	
Average	36.7%	8.3%	6.7%	1.7%	28.3%	0.0%	16.7%	1.7%	0.0%	

a. TUGS OCCUPIED

b. TUG OUT OF COMMISION [O.O.C.]

c. BERTHING STAFF OCCUPIED

d. CHANGE OF SHIFT

e. PILOTS OCCUPIED

f. OVER BOOKING OF SLOTS

g. SHIPPING MOVEMENTS

h. BACKLOG OF SHIPPING

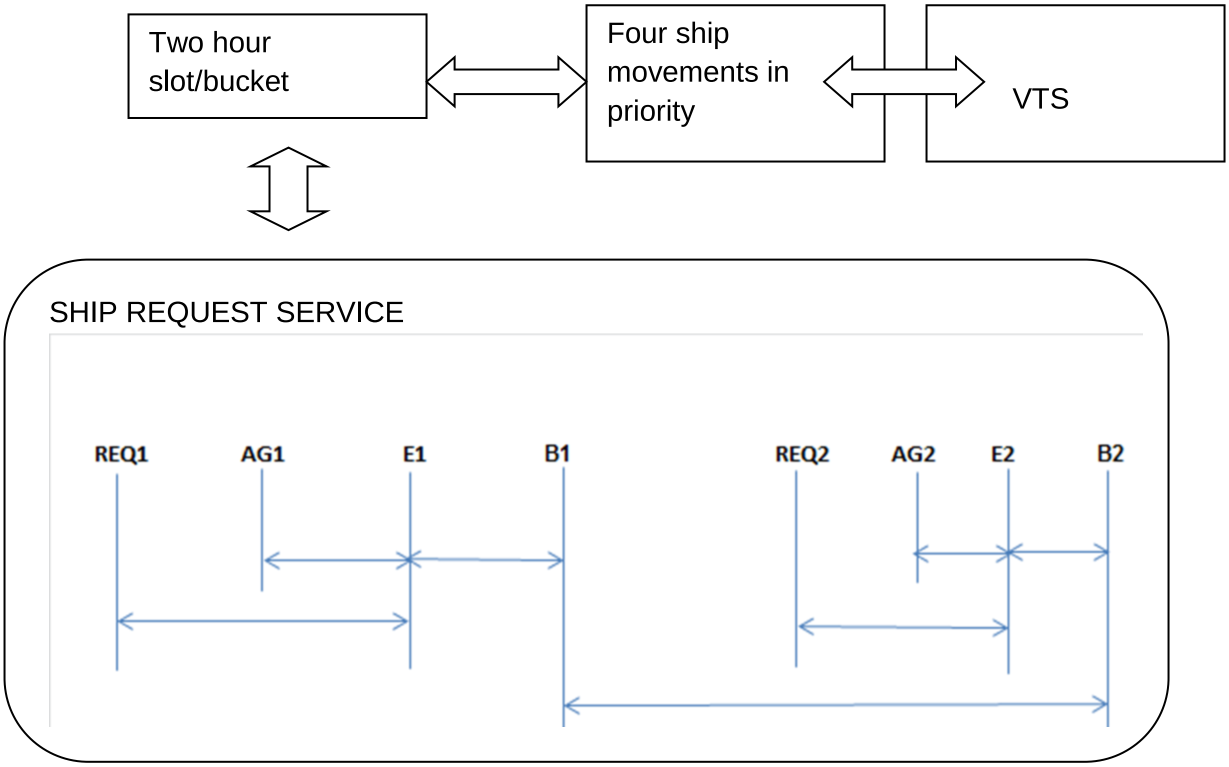
i. ADVERSE WEATHER

<u>Table 5: Delays experienced July-September 2011</u>

From table 5 it can be seen that a high proportion of the delays are as a result of the tugs occupied (36.7%) followed by the pilots occupied (28.3%). Another interesting statistic is that the percentage of overbooking of slots has decreased significantly compared to 2010. This clearly indicates poor planning in 2010 as well as several requests for service within the same window (see slot system). Also, the number of adverse weather delays for the same period is zero. There has been much debate around the effects of global warming and changing weather patterns that have impacted on global shipping and terminal performance but none conclusive as different scientists have differing views on the subject; there is, however, no compelling evidence to indicate that changing weather patterns have impacted materially on vessel operations in the Port of Durban.

The Port of Durban manages a slot system to determine service delivery. Normally it is on a first come first served basis. However, with the introduction of the Marine Resource Allocation Policy (Annexure 3), within the spectrum of cargo carrying vessels, priority is given to container ships then car carriers followed by other shipping classes e.g. tankers, general cargo ships etc. The slot system is divided into two hours with four ship movements anticipated.

From figure 4.4 it can be seen that all ships request a time for service either by contacting the VTS or through the ship's agent or terminal. This time is referred to as the Requested Time. The VTS will then determine a time booking within the slot and both the ship and the VTS will agree on a time of service. This is referred to as the Agreed Time. The delay to the ship will be measured between the Agreed Time and the Pilot on Board Time. The negative difference in time is recorded as a ship delay.



REQ1/2 – Requested time of service for incoming/sailing ship

AG1/2 – Agreed time to service incoming/sailing ship

E1/2 – Pilot on board time – also called Served Time

B1/2 – Ship passing the breakwater

Figure 4.4: diagrammatic representation of the slot system

SOURCE: Author's own analysis and representation

The slot system needs to incorporate the resources available over a 24 hour period.

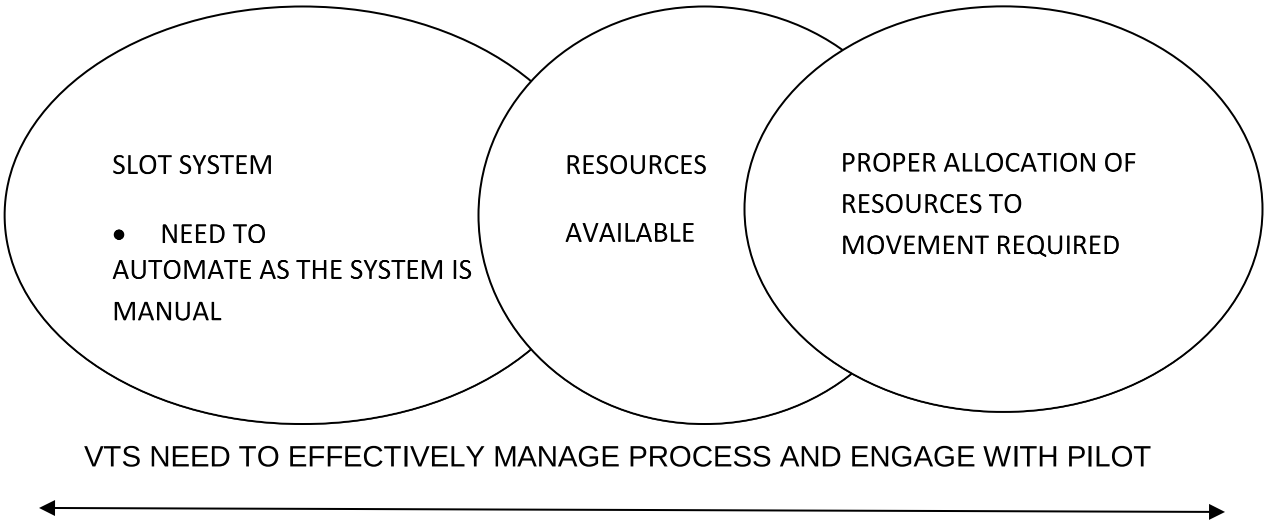
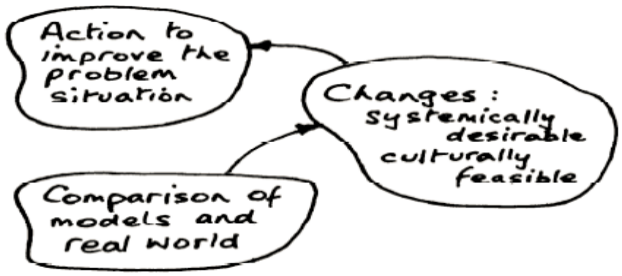


Figure 4.5: Model - VTS resource allocation in conjunction with marine pilot

SOURCE: Author's own model

The VTS function in the port needs to engage effectively with the marine pilots (see figure 4.5) when resources are allocated to facilitate ship movements (sailing/incoming). Often service items such as tugs and pilots are not homogeneous, undifferentiated inputs, but may indeed be differentiated by, say, tug bollard pull or pilot license size. The ideal is to achieve a match not a mis-match of resources required per ship movement. Prior engagement of the VTS with the marine pilot can lead to much better allocation of resources needed. The allocation of the correct marine pilot for the required movement (sailing/incoming) can also be determined in advance. Sometimes a marine pilot with a license limitation is allocated to the incorrect ship. The current method of phoning/faxing/emailing a request needs greater refining into an electronic system that is also web based to allow users the ability to access and input information online. Transparency of the system means users can also view the slots and their usage.

4.2.5 STAGE5



Step 5   Compare Model And Real World. Gain Insights

Figure 4.6: Examining the model [see figure 4.4] to real world

Source: Soft Systems Methodology – Bob Williams (Kellogg Foundation – 2009)

The real problem here is to identify the overall delay impact of Marine Operations to ship turnaround times. In figure 4.6 we see that we need to find ways to improve the delay impact on ship turnaround. However, the anchorage times are so large in this analysis that any tug delays would have a minor impact on the extended time the ship would spend at the berth. Until anchorage times have been significantly reduced and berth times are reduced significantly, any delays caused by marine services (i.e. tugs arrive late at the berth to sail the vessel) will have no appreciable impact on the overall stay of the ship at the Port of Durban [see figure 4.7].

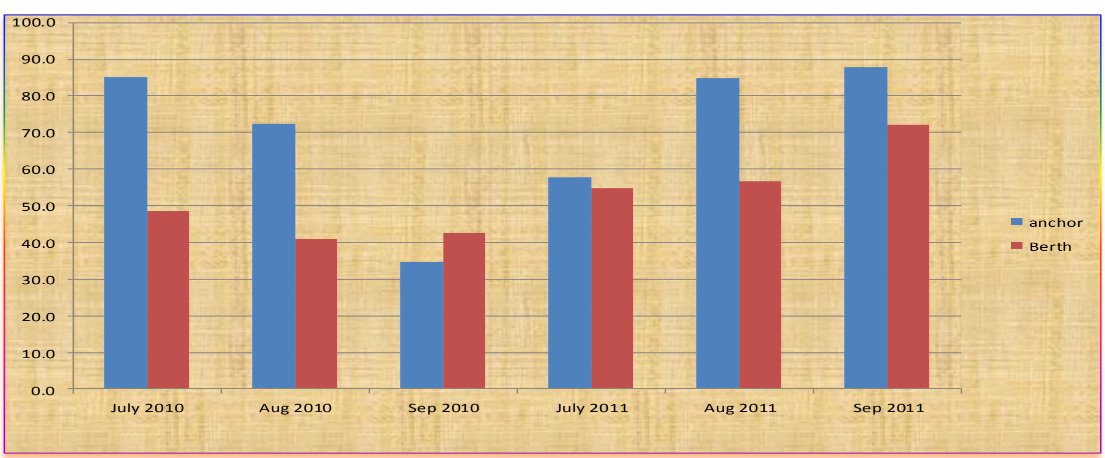


Figure 4.7: Comparison of berth time against anchorage time in hours

SOURCE: Author's own analysis and representation

Extremely lengthy anchorage waiting times and high berth occupancy impact negatively on ship-owners, shippers, and the economy at large in the following ways:

1. Increased costs in operating a ship (especially those on charter where charter rates are determined on a per day rate).
2. Increased costs in importing/exporting goods as the higher costs incurred by the ship-owner and shipper are usually passed on to the buyers and ultimately the consumers of those goods. This has a broader economic impact on the South African economy (especially since the Port of Durban handles roughly 60% of all containerized exports/imports) as it means higher costs in doing business.
3. Leads to congestion at a port where several ships await a berth. This has an impact on the queue of ships and the order of priority in providing service to ships (refer to Draft Berth Allocation Policy – Annexure 4).
4. Insufficient berth capacity at the Port of Durban. This has been identified as a problem hence Transnet has embarked upon the possibility of converting the old airport site into a dugout port (see annexure 7).
5. Greater efficiency along the entire logistics chain including rail/road; third and fourth party logistics providers. A more in-depth study needs to be undertaken in this regard.
6. Inefficiency within the terminal operations. Appropriate benchmarks need to be set to measure the efficiency of both Pier One and the Durban Container Terminal. This must also include the terminal configuration and the deployment of adequate resources (both capital and human).

"Benchmarking is a continuous systematic process for evaluating the products, services and work processes of organisations that are recognised as representing best practices for the purpose of organisational improvement."(Spendolini, (1992), p.2) or "Benchmarking is a performance measurement tool used in conjunction with improvement initiatives; it measures comparative operating performance of companies and identifies the ‘best practices.’

Benchmarking creates value by:

· Focusing on key performance gaps;

· Identifying ideas from other companies;

· Creating a consensus to move an organization forward;

· Making better decisions from a larger base of facts.”(Mission Statement for The Procurement and Supply-chain Benchmarking Association (PASBA™))

4.2.6 STAGE 6 AND 7

It has been clearly demonstrated by the analysis undertaken that the overall delays caused by Marine Operations are rather insignificant with regard to total ship turnaround time in the Port of Durban. However, there is room for improvement in enhancing service delivery and minimizing ship time spent in the port. The following are a series of initiatives that may be contemplated:

1. Older Schottel tugs (over 30 years old) need to be replaced due to higher breakdown frequencies and unreliability leading to lower overall availability of tugs in the port.

2. The number of tugs employed over a twenty four hour period need to be increased from the current deployment strategy. Currently five tugs are used in a twenty four hour period this needs to be increased to six to match the number of pilots per shift. The port can easily accommodate three simultaneous movements depending on where they are required.

3. Fleet configuration needs to be spread between 50-70 Tonne Bollard pull tractor tugs to accommodate all ship type and sizes to the port.

4. The fleet size must incorporate the maintenance regime that will be employed to ensure optimal fleet availability.

5. The port needs to ensure sufficient personnel to operate the tugs as well as adequate training programmes to enhance operator efficiency e.g. better handling techniques, fuel saving techniques etc.

6. Adequate scheduling of work by VTS (see figure 4.1).

7. Pilot allocation and scheduling (see figure 4.5). Note that the pilot shift system must be in line with tug operations and berthing services. All work a common quadruple shift.

8. Berthing operations. Increase in number of gangs and gang sizes to match operations.

The Market Demand Strategy employed by Transnet in 2012 must be implemented in such a manner that it must not only address the current infrastructural backlogs but it must also endeavour to alleviate several logistic chain bottlenecks that tend to constrain the economy. If South Africa intends to be competitive internationally then it must lower the cost of doing business which is often seen as an impediment. The Port Regulator needs to regulate the Transnet National Ports Authority (TNPA) not only on its tariff regime but start to regulate its business activities so as to enhance the performance of the TNPA. More needs to be done in ensuring that the skills required within the maritime sector are not only enhanced but that they are adequate in measuring up to world class standards.

CHAPTER FIVE

CONCLUSION

International commerce relies on the fast, low-cost movement of goods through global value chains. Maritime transportation systems are the most cost-effective ways to ship freight over long-distances but they rely on effective and efficient ports to load and unload cargo. Combined with other transportation infrastructure, access to high-quality port infrastructure helps determine a country's integration with international trade flows.

But ports have to maintain high levels of efficiencies in order to ensure that their services are competitive. In figure 5.1 it is evident that port uses will opt for other ports providing better service and efficiency.

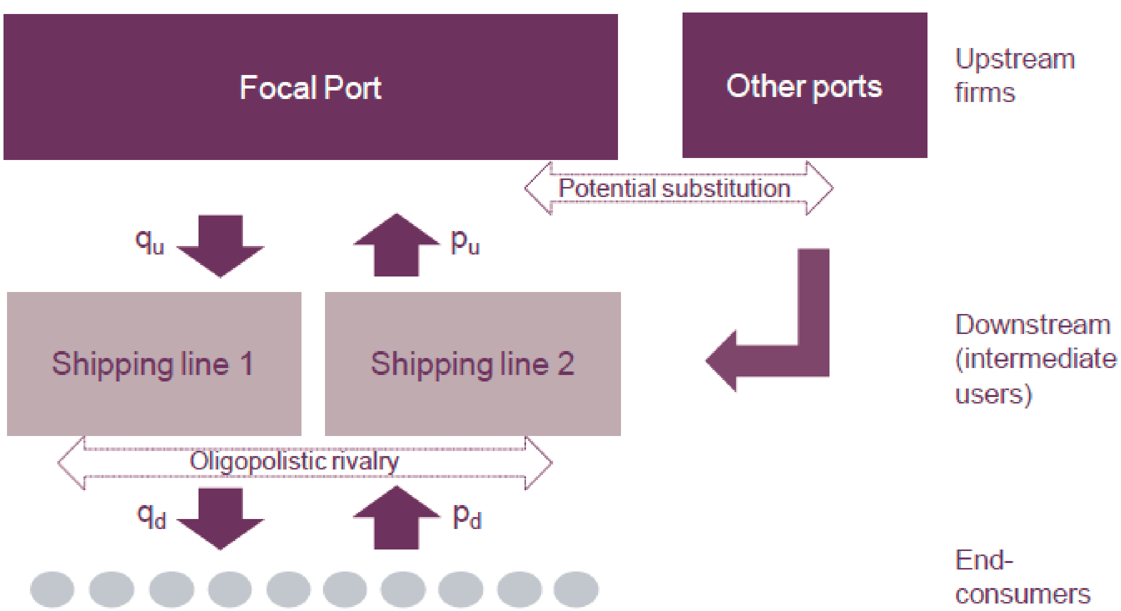


Figure 5.1 Countervailing buying power

SOURCE: Competition Committee (2011) Competition in ports and port services. Organisation for Economic Co-operation and Development

The shipping lines and the end consumers can influence the performance and service offering of a port depending on their individual and or collective bargaining power in the port. This means poor performing ports can experience loss of users to other ports. Therefore, the port needs to be relevant in providing a range of service offerings on par with the users expectations and requirements. For the Port of Durban this could mean the potential loss of users to other ports like the Port of Maputo or the Port of Walvis Bay.

Moreover, ports can host a range of value added services and thus provide significant direct economic benefits to host countries. Despite their importance, ports in many developing countries are characterized by underinvestment, low productivity, and inefficient use of resources, high user prices, long delays, and ineffective services (UNCTAD (2011)). This however, is not the case in South Africa. The commitment by Transnet to spend R300 billion on infrastructure development between 2012-2019 is a clear sign that the country is determined to invest in infrastructure to drive economic growth over the long term (Transnet, 2012).

The purpose of this study was to determine the impact of marine services on overall ship turnaround time and whether it contributed to delays to ships to the Port of Durban. This study has clearly shown that the Marine Operations within the Port of Durban does not have a significant impact on overall ship turnaround time. Using Checkland’s soft systems methodology, the study was able to establish that the marines services in the Port of Durban was only one part in a series of processes in total ship turnaround with little influence on turnaround time. The main results of the findings show that the time spent at anchor and the time spent on the berth are more dominant areas of concern that would require further analysis and research.

However, there are areas of improvement that can be implemented to ensure high service levels within the port. By increasing the tug fleet capacity (as well as increasing tug bollard capacity) and ensuring adequate human resources (there are skills shortages amongst the marine staff – especially the chief marine engineers), the service offering can immediately be improved.

Extremely lengthy anchorage waiting times and high berth occupancy impact negatively on ship-owners, shippers, and the economy at large as was discussed earlier. The Port Authority must interrogate these areas to understand clearly what is driving these extended times and determine strategies and performance measures to mitigate these.

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ANNEXURES

ANNEXURE 1

SAMPLE OF VESSEL ARRIVALS/DEPARTURES FOR THE PERIOD JULY 2010

Type	Vessel	Berth 2	Port Limits	Breakwater	First Line	Last Line	Pilot On / Off
Arrival	AFRICA STAR	204	17-Jul-10 21:45	19-Jul-10 12:05	19-Jul-10 12:42	19-Jul-10 13:00	19-Jul-10 11:50
Departure	AFRICA STAR	204	17-Jul-10 21:45	21-Jul-10 0:21	20-Jul-10 23:48	20-Jul-10 23:54	21-Jul-10 0:15
Arrival	ALIANCA MAUA	107	3-Jul-10 5:35	3-Jul-10 14:15	3-Jul-10 14:48	3-Jul-10 15:15	3-Jul-10 13:42
Departure	ALIANCA MAUA	107	3-Jul-10 5:35	4-Jul-10 17:00	4-Jul-10 16:00	4-Jul-10 16:18	4-Jul-10 16:55
Arrival	APHRODITE 1	105	6-Jul-10 3:00	8-Jul-10 7:00	8-Jul-10 7:36	8-Jul-10 8:00	8-Jul-10 6:40
Departure	APHRODITE 1	105	6-Jul-10 3:00	11-Jul-10 2:27	11-Jul-10 1:36	11-Jul-10 1:48	11-Jul-10 2:22
Arrival	ARNIS	200	22-Jun-10 10:44	28-Jun-10 4:25	28-Jun-10 4:50	28-Jun-10 5:06	28-Jun-10 3:30
Departure	ARNIS	200	22-Jun-10 10:44	29-Jun-10 23:45	29-Jun-10 22:55	29-Jun-10 23:12	29-Jun-10 23:40
Arrival	AS SCANDIA	202	1-Jul-10 15:10	7-Jul-10 20:50	7-Jul-10 21:18	7-Jul-10 21:42	7-Jul-10 20:30
Departure	AS SCANDIA	107	1-Jul-10 15:10	10-Jul-10 7:25	10-Jul-10 6:42	10-Jul-10 7:00	10-Jul-10 7:25
Arrival	BARRIER	203	1-Jul-10 17:30	7-Jul-10 19:50	7-Jul-10 20:48	7-Jul-10 21:00	7-Jul-10 18:50
Departure	BARRIER	203	1-Jul-10 17:30	9-Jul-10 7:15	9-Jul-10 6:36	9-Jul-10 6:48	9-Jul-10 7:10
Arrival	BELLA	107	24-Jul-10 14:00	24-Jul-10 18:50	24-Jul-10 19:30	24-Jul-10 19:48	24-Jul-10 18:35
Arrival	BOUNDARY	204	21-Jul-10 17:50	25-Jul-10 20:38	25-Jul-10 21:24	25-Jul-10 21:36	25-Jul-10 20:18
Arrival	BRILLIANT	202	3-Jul-10 12:30	10-Jul-10 2:20	10-Jul-10 3:00	10-Jul-10 3:18	10-Jul-10 2:05
Departure	BRILLIANT	202	3-Jul-10 12:30	11-Jul-10 12:32	11-Jul-10 12:00	11-Jul-10 12:06	11-Jul-10 12:30
Arrival	BRILLIANT	202	22-Jul-10 12:40	23-Jul-10 8:10	23-Jul-10 8:42	23-Jul-10 8:54	23-Jul-10 7:50
Departure	BRILLIANT	202	22-Jul-10 12:40	24-Jul-10 19:25	24-Jul-10 18:48	24-Jul-10 19:00	24-Jul-10 19:20
Arrival	CAP SCOTT	105	11-Jul-10 23:40	12-Jul-10 7:40	12-Jul-10 8:18	12-Jul-10 8:30	12-Jul-10 7:15
Departure	CAP SCOTT	105	11-Jul-10 23:40	14-Jul-10 10:38	14-Jul-10 9:48	14-Jul-10 10:06	14-Jul-10 10:38
Arrival	CITY OF SHANGHAI	102	21-Jul-10 20:10	21-Jul-10 20:55	21-Jul-10 21:24	21-Jul-10 21:36	21-Jul-10 20:30
Departure	CITY OF SHANGHAI	102	21-Jul-10 20:10	22-Jul-10 13:35	22-Jul-10 13:00	22-Jul-10 13:12	22-Jul-10 13:30
Arrival	CMA CGM VERNET	105	7-Jul-10 10:15	14-Jul-10 11:10	14-Jul-10 11:36	14-Jul-10 12:06	14-Jul-10 10:55
Departure	CMA CGM VERNET	105	7-Jul-10 10:15	16-Jul-10 22:50	16-Jul-10 22:06	16-Jul-10 22:18	16-Jul-10 22:45
Arrival	CSAV LLANQUIHUE	203	2-Jul-10 23:30	4-Jul-10 3:15	4-Jul-10 4:00	4-Jul-10 4:18	4-Jul-10 2:20
Departure	CSAV LLANQUIHUE	203	2-Jul-10 23:30	5-Jul-10 16:56	5-Jul-10 16:18	5-Jul-10 16:30	5-Jul-10 16:51
Arrival	CSAV RANQUIL	203	3-Jul-10 19:30	5-Jul-10 18:50	5-Jul-10 19:36	5-Jul-10 19:54	5-Jul-10 18:30
Departure	CSAV RANQUIL	203	3-Jul-10 19:30	7-Jul-10 19:30	7-Jul-10 18:42	7-Jul-10 18:54	7-Jul-10 19:27
Arrival	CSAV SANTOS	203	17-Jul-10 19:25	20-Jul-10 20:11	20-Jul-10 20:54	20-Jul-10 21:06	20-Jul-10 19:32
Departure	CSAV SANTOS	203	17-Jul-10 19:25	21-Jul-10 8:50	21-Jul-10 8:12	21-Jul-10 8:24	21-Jul-10 8:45
Arrival	CSCL CALLAO	105	8-Jul-10 5:30	17-Jul-10 12:18	17-Jul-10 12:48	17-Jul-10 13:00	17-Jul-10 12:00
Departure	CSCL CALLAO	105	8-Jul-10 5:30	18-Jul-10 3:25	18-Jul-10 2:48	18-Jul-10 2:54	18-Jul-10 3:25
Arrival	CSCL MONTEVIDEO	107	4-Jul-10 3:00	10-Jul-10 6:50	10-Jul-10 7:24	10-Jul-10 7:42	10-Jul-10 6:40
Departure	CSCL MONTEVIDEO	107	4-Jul-10 3:00	11-Jul-10 4:50	11-Jul-10 4:00	11-Jul-10 4:18	11-Jul-10 4:45
Arrival	CSCL SAN JOSE	107	23-Jun-10 18:55	28-Jun-10 15:26	28-Jun-10 16:06	28-Jun-10 16:42	28-Jun-10 15:00
Departure	CSCL SAN JOSE	107	23-Jun-10 18:55	30-Jun-10 16:58	30-Jun-10 16:00	30-Jun-10 16:24	30-Jun-10 16:54
Arrival	DAL KALAHARI	205	18-Jun-10 15:40	27-Jun-10 7:50	27-Jun-10 8:30	27-Jun-10 8:48	27-Jun-10 7:30
Departure	DAL KALAHARI	205	18-Jun-10 15:40	30-Jun-10 0:27	29-Jun-10 23:36	29-Jun-10 23:48	30-Jun-10 0:22
Arrival	DIMITRIS Y 2	107	13-Jul-10 19:00	14-Jul-10 15:35	14-Jul-10 16:00	14-Jul-10 16:18	14-Jul-10 15:12
Departure	DIMITRIS Y 2	107	13-Jul-10 19:00	19-Jul-10 1:45	19-Jul-10 0:54	19-Jul-10 1:06	19-Jul-10 1:35
Arrival	GEMINI	204	22-Jun-10 6:20	29-Jun-10 7:05	29-Jun-10 7:54	29-Jun-10 8:18	29-Jun-10 6:47
Departure	GEMINI	204	22-Jun-10 6:20	2-Jul-10 0:52	1-Jul-10 23:18	1-Jul-10 23:30	1-Jul-10 23:54
Arrival	HAMMONIA GALICIA	203	16-Jul-10 1:30	19-Jul-10 19:06	19-Jul-10 20:00	19-Jul-10 20:18	19-Jul-10 18:46
Departure	HAMMONIA GALICIA	203	16-Jul-10 1:30	20-Jul-10 19:57	20-Jul-10 19:24	20-Jul-10 19:30	20-Jul-10 19:52
Arrival	HANJIN PORT ADELA	105	10-Jul-10 22:40	16-Jul-10 23:14	16-Jul-10 23:42	16-Jul-10 23:54	16-Jul-10 22:55
Departure	HANJIN PORT ADELA	105	10-Jul-10 22:40	17-Jul-10 12:42	17-Jul-10 12:06	17-Jul-10 12:12	17-Jul-10 12:39
Arrival	HANJIN RIO DE JANE	105	20-Jul-10 9:15	21-Jul-10 18:48	21-Jul-10 19:12	21-Jul-10 19:24	21-Jul-10 18:33
Departure	HANJIN RIO DE JANE	105	20-Jul-10 9:15	22-Jul-10 13:48	22-Jul-10 11:12	22-Jul-10 11:18	22-Jul-10 11:45
Arrival	HANSA AUGSBURG	202	12-Jul-10 15:00	14-Jul-10 21:25	14-Jul-10 22:00	14-Jul-10 22:18	14-Jul-10 21:15
Departure	HANSA AUGSBURG	202	12-Jul-10 15:00	16-Jul-10 21:15	16-Jul-10 20:36	16-Jul-10 20:42	16-Jul-10 21:10
Arrival	HORIZON	204	22-Jul-10 21:45	24-Jul-10 10:50	24-Jul-10 11:24	24-Jul-10 11:54	24-Jul-10 10:28
Departure	HORIZON	204	22-Jul-10 21:45	25-Jul-10 21:33	25-Jul-10 20:48	25-Jul-10 21:06	25-Jul-10 21:30

It would be noted that the reporting for each month commences on the 25th of the previous month. This is in line with the financial closing period

ANNEXURE 2

ABSTRACT FROM THE PORT RULES

CONTENTS • INHOUD

No.		Page No.	Gazette No.
	GOVERNMENT NOTICE		
	Transport, Department of		
	Government Notice		
255	National Ports Act (12/2005): Ports Rules	3	31986

31. Notice of port movements

(1) The terminal operator, *master or agent of* a vessel must give at least four hours notice to the *Harbour Master* of the time the *vessel will* be ready to *shift* within a *port.*

(2) The terminal operator, *master* or *agent* of the *vessel* must confirm this notice no less than two hours before the movement takes place.

ANNEXURE 3

ABSTRACT FROM THE GLOBAL ENABLING TRADE REPORT 2012

3rd pillar: Efficiency of import-export procedures	**100**	**3.7**	**Singapore**	**6.4**
Efficiency of the clearance process, 1–5 (best)	26	3.3	Singapore	4.1
No. of days to import	104	32	Singapore	4.0
No. of documents to import	74	8	France	2.0
Cost to import, US$ per container	102	1,795	Malaysia	435.0
No. of days to export	108	30	Multiple economies (4)	5.0
No. of documents to export	95	8	France	2.0
Cost to export, US$ per container	97	1,531	Malaysia	450.0

5th pillar: Availability and quality of transport infrastructure	**63**	**4.3**	**France**	**6.3**
Airport density, number per million pop.	87	0.4	Iceland	21.9
Transshipment connectivity, index 0–100 (best)	21	82.2	United States	100.0
Paved roads, % of total	105	17.3	Multiple economies (17)	100.0
Quality of air transport infrastructure, 1–7 (best)	16	6.1	Singapore	6.9
Quality of railroad infrastructure, 1–7 (best)	47	3.4	Switzerland	6.8
Quality of roads, 1–7 (best)	39	4.8	France	6.6
Quality of port infrastructure, 1–7 (best)	47	4.7	Singapore	6.8

3rd and 5th Pillar of Highlighting South Africa's Position and score in relation to 132 countries surveyed.

Source: Lawrence et al (2012)–Reducing Supply Chain Barriers, World Economic Forum. The Global Enabling Trade Report

The Global Enabling Trade Report looks at nine pillars namely:

A. The market access subindex measures the extent to which the policy framework of the country welcomes foreign goods into the country and enables access to foreign markets for its exporters. It includes the following pillar: Pillar 1: Domestic and foreign market access
B. The border administration subindex assesses the extent to which the administration at the border facilitates the entry and exit of goods through the following pillars: Pillar 2: Efficiency of customs administration Pillar 3: Efficiency of import-export procedures Pillar 4: Transparency of border administration
C. The transport and communications infrastructure subindex takes into account whether the country has in place the transport and communications infrastructure necessary to facilitate the movement of goods within the country and across the border through the following pillars: Pillar 5: Availability and quality of transport infrastructure Pillar 6: Availability and quality of transport services Pillar 7: Availability and use if information communication technologies (ICTs)
D. The business environment subindex looks at the quality of governance as well as at the overarching regulatory and security environment impacting the business of importers and exporters active in the country through the following pillars: Pillar 8: Regulatory environment Pillar 9: Physical security

ANNEXURE 4

MARINE RESOURCE ALLOCATION POLICY

Annexure C Part 1					
NPA	HARBOUR MASTER				
POLICY	MARINE RESOURCES				
Effective Date		Policy Status	Draft		
Approved By	PORT MANAGER	Amendment		Policy Number	

National Ports Authority of South Africa

DRAFT

MARINE RESOURCE ALLOCATION POLICY

Port of Durban

Page 1 of 4

NPA	HARBOUR MASTER				
POLICY	MARINE RESOURCES				
Effective Date		Policy Status	Draft		
Approved By	PORT MANAGER	Amendment		Policy Number	

CONTENT

NPA	HARBOUR MASTER				
POLICY	MARINE RESOURCES				
Effective Date		Policy Status	Draft		
Approved By	PORT MANAGER	Amendment		Policy Number	

Background:

The National Port Act Section 11 (1),(g), (ii) which states that the Authority must "regulate and control:
(ii) the entry of vessels in ports, and their stay, movements and operations in and departures from ports"

This places an obligation on the Authority (National Ports Authority) to own, manage, control and administer ports to ensure their efficient and economic functioning.

In ensuring compliance there is a need to prioritize Marine Resource Allocation to ensure efficient and effective use of Marine Resources.

Definitions

Port Manager: Any person appointed by the National Ports Authority of South Africa (NPA) as Port Manager or in his absence, any person duly appointed to act in that capacity

Harbour Master: Any person appointed by the NPA as Harbour Master or in his absence, his appointed deputy

Marine Resources: Includes any pilot, pilot boat, tug, launches, berthing staff and helicopter under the jurisdiction of the NPA

Authority: National Ports Authority

Scope

This policy is applicable to all vessels utilizing Marine Resources at the Port of Durban

Objectives

The objective of this policy is to prioritize the use of Marine Resource Allocation. It determines the order in which Marine Resources will be allocated to vessels in the Port of Durban

NPA	HARBOUR MASTER				
POLICY	MARINE RESOURCES				
Effective Date		Policy Status	Draft		
Approved By	PORT MANAGER	Amendment		Policy Number	

5. Policy

5.1 Allocation of Marine Resources

All Marine Resources shall be allocated as follows:

- Foreign Navy Vessels on official business
- Passenger Vessels
- Container Vessels
- Car Carriers
- All other vessels not listed above

5.2 Tidal and daylight restricted operations shall be given special considerations to move in their windows of opportunity.

5.3 The Harbour Master shall have the final authority in all matters relating to movement of vessels within Port Limits

6. Date review and supported by the Port Committee

Signed: Chairperson, Policy Committee Date:

7. Review Authority

Harbour Master

8. Review Period Frequency

Annual Review

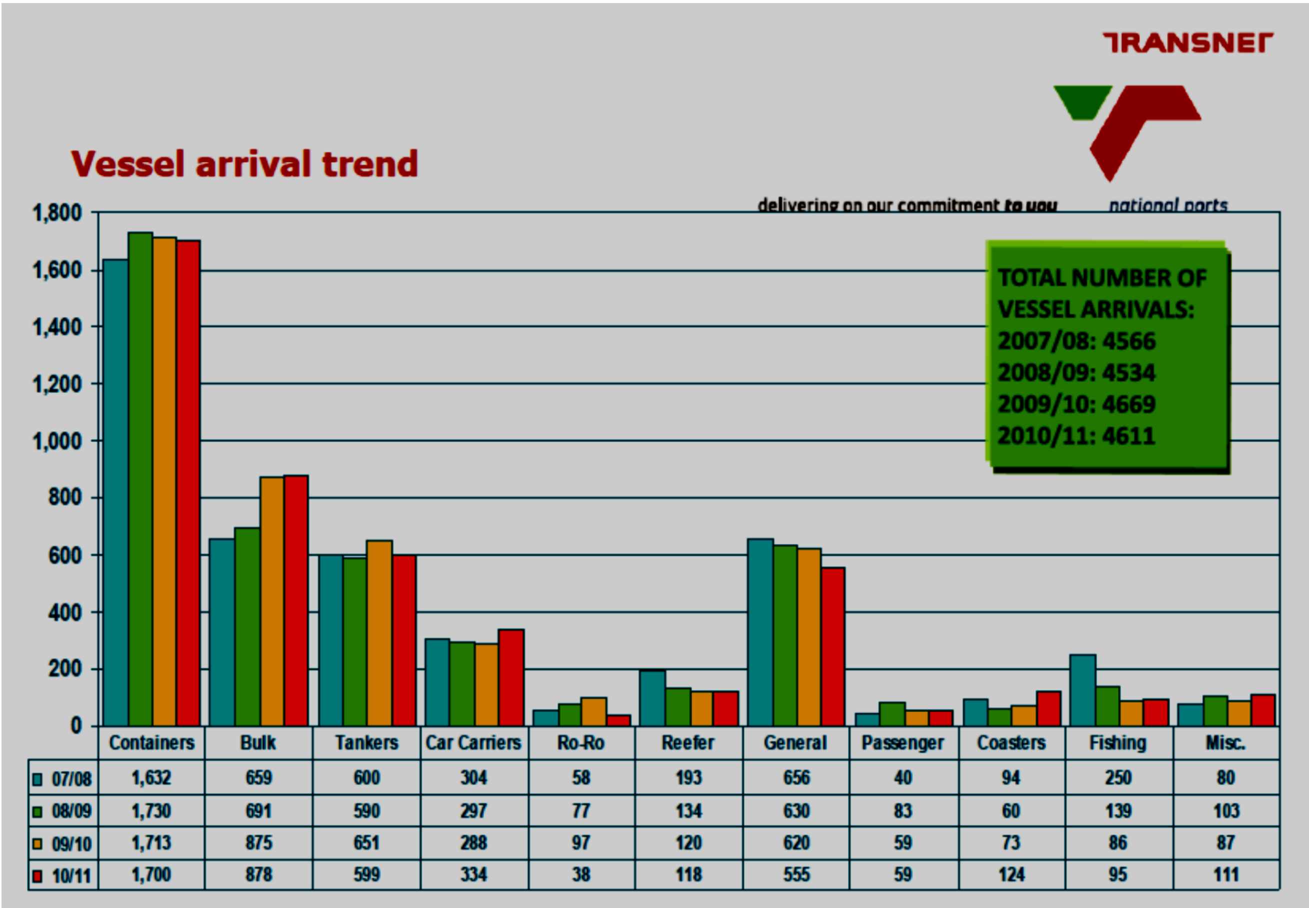
9. Approved By the CEO

Signature Date

Name

ANNEXURE 5

VESSEL ARRIVALS - TRENDS FROM 2007-2011



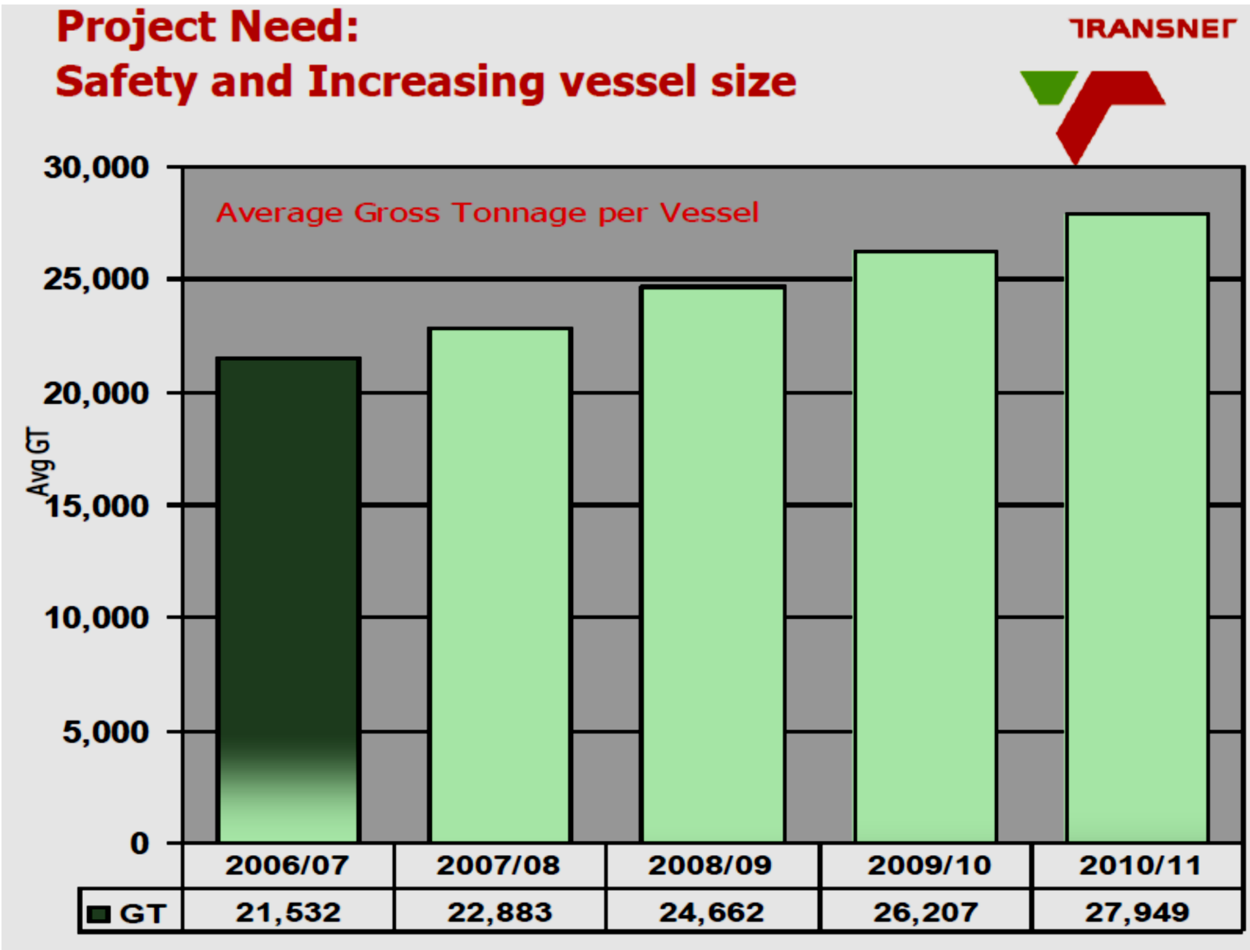
	Containers	Bulk	Tankers	Car Carriers	Ro-Ro	Reefer	General	Passenger	Coasters	Fishing	Misc.
07/08	1,632	659	600	304	58	193	656	40	94	250	80
08/09	1,730	691	590	297	77	134	630	83	60	139	103
09/10	1,713	875	651	288	97	120	620	59	73	86	87
10/11	1,700	878	599	334	38	118	555	59	124	95	111

SOURCE: Paper by the Transnet National Ports Authority entitled - The Durban Harbour Entrance Widening Project: Dredging Africa Conference 2012

This shows the mix of vessels arriving at the Port of Durban over the last five years. The increase in container ships from 2007 to 2008 shows the port's growth in container traffic. Despite a drop in the number of ships in 2010 and 2011, the data clearly shows an increase in average gross tonnage [see annexure six] of vessels arriving at the port and containers handled.

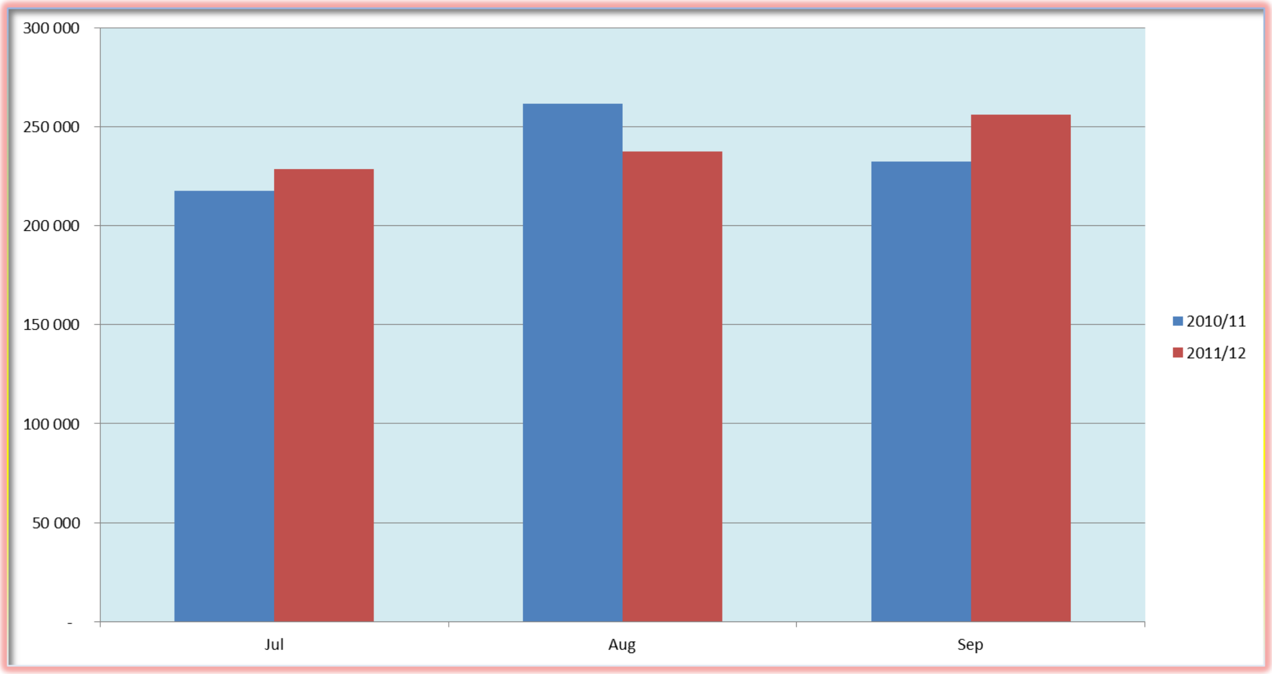
ANNEXURE 6

VESSEL ARRIVALS - GROSS TONNAGE INCREASE FROM 2007-2011 AND CONTAINERS HANDLED IN 2009-2011

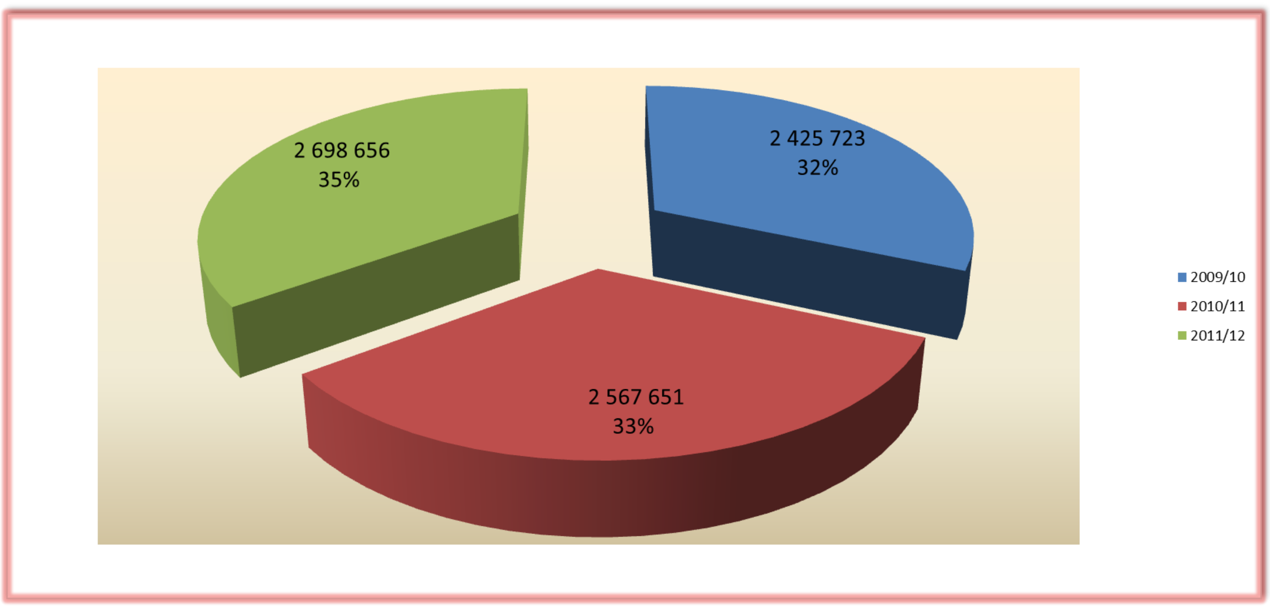


SOURCE: Paper by Transnet National Ports Authority entitled - The Durban Harbour Entrance Widening Project: Dredging Africa Conference 2012

The average gross tonnage of vessels arriving at the Port of Durban has increased steadily over the last five years. In January 2010 the Durban Harbour Channel Widening Project was completed with the entrance channel [222m] now able to accommodate container vessel sizes in excess of 9200 teus. On the 05th July 2012 the MSC SOLA docked in the Port of Durban with a capacity of 11 660teus when fully laden. This shows the growing trend of vessel sizes to the port.



Containers handled over the two three months periods July-September 2010/2011



Containers handled between 2009-2012

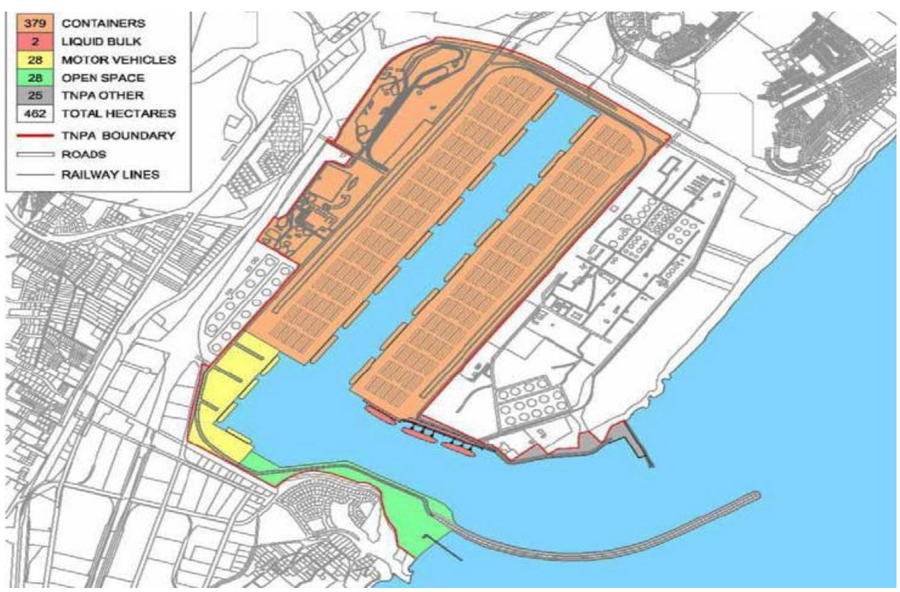
Note: The financial year is from April to March

Source: TNPA figures 2009-2012

ANNEXURE 7

PROPOSED DURBAN DUGOUT PORT

This above manipulated image shows what the old Durban International Airport site would look like after its transformation to a dugout port. [Source: Mercury Business Report - 16 August 2012]



Source: TNPA Port 2020 Master Plan Document

South African state company Transnet has signed a R1.8-billion deal to buy the old Durban International Airport, which will be turned into a multibillion-rand dug-out port that will boost the country's competitive edge while creating thousands of new jobs.

Source: http://www.southafrica.info/business/economy/infrastructure/durban-dugout-port-130412.htm#ixzz2BhfHEb74

Oil

Microwave Sample Preparation Note: XprOP-1 Rev. Date: 6/04
Category: Oils

Sample Type: Oil
Application Type: Acid Digestion
Vessel Type: 55 mL
Number of Vessels: 12
Reagents: Nitric Acid (70%)
Method Sample Type: Organic
Sample Weight: 0.5 gram

Step 1:

Acid Type	Volume
Nitric	10 mL

Heating Program: Ramp to Temperature Control

Stage	Max. Power	% Power	Ramp (min.)	Pressure (psi)	Temperature (°C)	Hold (min.)
(1)	1200 W	75	15:00	-	200	15:00

NOTE A: This procedure is a reference point for sample digestion using the CEM Microwave Sample Preparation System and may need to be modified or changed to obtain the required results on your sample.
NOTE B: Manual venting of CEM closed vessels should only be performed when wearing hand, eye and body protection and only when the vessel contents are at or below room temperature to avoid the potential for chemical burns. Always point the vent hole away from the operator and toward the back of a fume hood.
NOTE C: Power should be adjusted up or down with respect to the number of vessels. General guidelines are as follows: 8-12 vessels (50% power), 13-20 vessels (75% power), >20 vessels (100% power).
NOTE D: "Organic Method Sample Type" should be used for most sample types. Choose "Inorganic" for samples with more than 1 gram of solid material remaining at the bottom of the vessel at the end of the digest (ex leach methods). Choose "Water" for samples that are largely aqueous prior to digestion.