

UNIVERSITY OF KWAZULU-NATAL

**Tidal vessels constrained in movement in the port of Durban – associated
cargo costs and potential remedies**

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DECLARATION

I, Ian Santana Martin Rosario hereby declare:

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I dedicate this work to my late papa, Martin Rosario. I thank my mama, Christine Rosario for solely focussing on the education of her three children, Xly, Ovy, and myself. I thank my brother, Ovy, for letting me pursue my dreams, whilst he took over the reins from my dad.

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ABSTRACT

Large container callers into the port of Durban are not able to explore their inherent captive capacities, resulting in restricted cargo flow through the country aligned to the permissible draft, thus having an adverse impact on seaborne commerce and the wider economy of the country. It is therefore crucial for the berth deepening project to take its intended shape as deeper berths will facilitate the modern generation of large container vessels to be exploited to its full loadable capacity at the summer marks. This will enhance a secure and improved complementarity within the South African ports system, in respect of their roles as both gateway and trans-shipment hub ports for containers. The direct and indirect losses to Transnet and the shipping lines due to the methodical and phased erosion of trans-shipment volumes have been elucidated. The main contributory factors to the loss in trans-shipment volumes have been attributed to capacity constraints stemming out of draft limitations at Durban, as well as the vital component of port operations, namely, efficiency.

In the interim, in order to mitigate the constraints, as a short-term remedy for partial recovery with regards to optimisation in cargo liftings, it has been proposed that Durban adopts the concept of operating as a NAABSA port, whereby working container vessels that are “Not Always Afloat But Safely Aground” may sustain continuous working operations while alongside at the port’s container berths, in place of the current stop-start operations. Both the vessels and the port are shown to possess all the essential credentials to safely execute this widely practised manoeuvre. To this effect, the structural integrity of the container ships has been established beyond any reservation, for the fitness of the NAABSA operation while working cargo, as has the plane and homogeneous nature of the seabed in the port of Durban.

Regional competitor ports in the southern African region, in their drive to attract additional container volumes through their terminals, are creating capacity ahead of demand, to a point where they may be perceived as a threat to the dominance of the port of Durban. The status quo of these regional foreign ports gives an insight to the infrastructural developments and equipment status. This could perhaps instil a sense of circumspection for Transnet to forge ahead in the right direction.

LIST OF ACRONYMS

a: Acceleration
CASP: Computer Automated Stowage Planning
CBD: Central Business District
CD: Chart Datum
CFD: Computational Fluid Dynamics
COLREGS: Collision Regulations
CS: Coarse-grained sand
CSIR: Council for Scientific and Industrial Research
CTCT: Cape Town Container Terminal
DCT: Durban Container Terminal
DRC: Democratic Republic of Congo
DRT: Durban RO-RO Terminal
EA/MOZ: East Africa/Mozambique
F: Force
FEA: Far East Asia
FEU: Forty Feet Equivalent Unit
FS: Fine-grained sand
g: Acceleration due to gravity
GCH: Gross Crane moves per Hour
H.O.T.: Height of Tide
HW: High Water
ICD: Internal Container Depot
IOI: Indian Ocean Islands
KNA: Kenya News Agency
KPA: Kenya Ports Authority
LOA: Length Over All
LW: Low Water
MAIB: Marine Accident Investigation Branch
MHC: Mobile Harbour Crane
MHW: Mean High Water
MLW: Mean Low Water
MPA: Mauritius Ports Authority
MPa: Mega Pascals
MPET: MSC PSA European Terminal
MPT: Multi-Purpose Terminal
MS: Medium-grained sand
MSC: Mediterranean Shipping Company
MSCEAMAZ: East Africa/Mozambique Service Code
MSEAM: Europe Service Code
N: Newtons
NAABSA: Not Always Afloat but Safely Aground
NAMPORT: Namibian Ports Authority
NATCOR: National Corridor
NCT: Ngqura Container Terminal

NP: New Pier
NWC: North-West Continent (of Europe)
PECT: Port Elizabeth Container Terminal
PIDA: Programme for Infrastructure Development in Africa
RTG: Rubber Tyred Gantry
SADC: Southern African Development Community
SAF-WAF: South Africa-West Africa
SAMSA: South African Maritime Safety Authority
SI: International System of Units
SMS: Ship Management System manuals
SOLAS: Safety of Life at Sea
STS: Ship to Shore (gantry)
SWH: Ship Working Hour
TEU: Twenty Feet Equivalent Unit
TFR: Transnet Freight Rail
TICTS: Tanzania International Container Terminal Services
TNPA: Transnet National Ports Authority
TOC: Total organic content
TPC: Tons per centimetre
TPT: Transnet Port Terminals
UKC: Under Keel Clearance
ULCS: Ultra Large Container Ship
USA: United States of America
USD: United States Dollars
v: Velocity
VCS: Very coarse-grained sand
VFS: Very fine-grained sand
VCI: Vessel Call Information
VIP: Very Important Person
VLCS: Very Large Container Ship
WAF: West Africa
ZA: South Africa
ZAR: South African Rand
ZPMC: Zhenhua Port Machinery Company

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CHAPTER ONE

INTRODUCTION AND SCOPE OF THE RESEARCH

This dissertation aims to primarily cover large container vessels calling the Port of Durban, drawing in excess of the chart datum at the container berths (12.8 metres at chart datum), and hence deemed tidal for all practical purposes. Essentially, these large and deep-drafted vessels are constrained in movement due to the available depth alongside the container berths, despite the relatively ample depth of 19.0 metres at the entrance channel of the port and 16.0 metres in the inner harbour. Therefore, the berthing and sailing of larger container vessels constrained by draught is restricted to tidal "windows" associated with high or rising tides, and this means that the vessels may potentially lose cargo-working time while waiting for these tidal windows. As per the stipulations by Transnet National Ports Authority (TNPA), the vessels must maintain a minimum under keel clearance (hereinafter UKC) of 0.60 metres for berthing and sailing, and a minimum UKC of 0.30 metres whilst alongside at the berth. This requirement pertaining to the minimum UKC at the berth may further interrupt the progression of cargo operations, prompting the vessels to possibly stop cargo operations to meet these requisites promulgated by the Harbour Master's Office. Operations may only be resumed on the rising tide; here again, potential cargo-working time is compromised as the vessels await the turn of tide. The study intends to explore the economic consequences of these water-depth constraints, and will interrogate the costs of tide-constrained movements, in the form of cargo that is short shipped (not carried) as a result of tidal compulsions, and the additional vessel costs due to the delays in the port of entry or exit. Data for a few selected incidents will be compiled into a suitable narrative format to highlight the diverse dynamics from an operational and economic perspective, incorporating the far-reaching impact of developments at foreign regional competitor ports and the further responses and plans of action that may be necessitated in the port of Durban to mitigate the consequential adversities.

The work will encompass the calculations involved, whilst the vessels deemed tidal for all practical purpose are being discharged and/or loaded, to align with the progression of the rising or ebbing tide, as the case may be. Further, the intention is to establish, should a vessel be compelled to take the bottom for various reasons, that the damage to the ship's hull, in particular the ship's bottom, is almost non-existent. A reference is made to the NAABSA (Not Always Afloat but Safely Aground) Clause, whereby the Charterparty makes provision for vessels to sit on the seabed during the course of cargo operations. Various ports in the world wherein this procedure is undertaken as a common practice will be interrogated to validate the practicality of this operation. A comparative study between the vessels taking the dry-dock blocks and the vessels subjected to the NAABSA operation will be undertaken. In addition to establishing this co-relation, the factors taken into consideration in determining the strength of the hull of the large container vessels will be analysed. All the strategic data are fed into a software for computational analysis at the design stage to calculate the scantling profiles and dimensions of all the primary and secondary strength members in order to ensure that the structural integrity of the ships will not be compromised when subjected

to extreme possible stresses, under the varying load profiles and most adverse conditions at sea. To this effect, an account of a few grounding incidents involving vessels that accidentally ran aground will be presented and the resultant damages will be evaluated in an attempt to demonstrate how robust the construction of modern vessels is, even in unexpected and adverse circumstances.

Another dimension of this research comprises a systematic presentation of tidal vessel movements in the port of Durban, including case studies of vessels that have experienced incidents or near misses (refer appendix 4.4)

The lack of deep-water berths in the Port of Durban has consequences well beyond the immediate port itself, and has a significantly negative impact on the wider economy of South Africa. There is a huge scope for more cargo volumes, more specifically in trans-shipments, that could be mobilised through South African ports, but where the unavailability of deeper berths has had an adverse impact and where, as a consequence, shipping lines are compelled to redirect these potential trans-shipments through other ports. It is critical to note that the draft restrictions imposed in the port of Durban may have an impact on the volumes in the other South African ports, more specifically the port of Ngqura, which offers deep-water berths with no restrictions on vessels size or draft. The losses South Africa has incurred as a combined ports system will be dealt with in greater detail. The scope of this study will include quantifying the potential losses by way of cargo that has been re-directed to the other foreign ports in the past. Strategic responses on the part of the carrying lines that were incorporated to combat this limitation will be presented to further elucidate the concerns of being unable to handle volumes across South African ports due to draft restriction at the port of Durban. This study will also seek to understand the influence on gateway cargo from the hinterland and neighbouring countries in the southern African region that arises from the more complex overarching problem of inefficiencies resulting in depleted capacity on rail, which exacerbate the capacity issues on the ships due to the draft restrictions at the port of Durban.

1.1 Research Objectives

The main objectives of this study are as follows:

- To establish the suitability of the port of Durban as a NAABSA port, given that the port has all the credentials to qualify for an effective NAABSA operation. Should a vessel be obliged to take the bottom due to unforeseen circumstances and factors beyond control, this study aims to demonstrate that there will be no damage to the ship owing to the characteristics of the seabed at the port of Durban and the design strength of the ship's hull.
- To establish the strength of the vessels' hull, in particular the ship's bottom structure to endure the force equivalent to the force of buoyancy transferred to the ship's hull, whilst the ship takes the seabed. A study detailing the structural reinforcement and construction features will be presented, more specific to the flat bottom area. A comparison of stability conditions in the Harbour Condition and Sea-going Condition will be carried out to reference the stresses the vessels are subjected to under these diverse conditions, in order to determine that a vessel taking the seabed is an acceptable operation under stipulated conditions.

- To detail the adverse impact on the South African economy due to the unavailability of deeper berths and the bearing this has across the South African ports system. In assessing the complementarity between the various container terminals in South Africa, deeper berths in the Port of Durban can have a direct influence in the facilitation of the port of Ngqura into a better trans-shipment hub for containers
- To carry out, as a primary objective of the study, a detailed assessment of losses in trans-shipment volumes and the gateway cargo from the hinterland and southern African region. Case studies based on factual in-house information detailing the steady erosion of trans-shipment volumes will be presented to this effect.
- To study the implications of constrained movements of large and deep-drafted vessels and carry out a detailed assessment of the direct and indirect losses incurred by shipping lines owing to the delays in berthing and sailing awaiting a tidal window, and interruptions in cargo operations to maintain the port's stipulated under keel clearance. To detail the losses owing to the planned cargo that may have to be short shipped (not loaded/left behind) due to the terminal inefficiencies. To further analyse the costs/losses incurred through steps taken to mitigate the schedule integrity by way of omission or curtailment of scheduled port calls, and additional trans-shipment that may be necessitated in another port owing to scheduled port omission/s. Consumption of fuel forms the largest component of expenses; the delays have a direct bearing on the consumption of fuel which is exponential with increased speeds.

1.2 Research Questions

The principal research questions that this study will seek to highlight and address, include the following:

- To what extent are large container vessels constrained by draft limitations in the Port of Durban and what adverse impacts might this have on seaborne commerce and on the wider economy of the country?
- What role do productivity and terminal efficiencies play in optimising (or exacerbating) cargo flows, within the constraints of the berth infrastructure of the port of Durban?
- To what extent might berth-deepening in the port of Durban secure improved complementarity within the South African range of ports, in respect of their roles as both gateway and trans-shipment hub ports for containers?
- To what extent do port developments in competitor ports in Southern Africa threaten the gateway and trans-shipment hub dominance of the port of Durban, and how might these developments be mitigated?
- In the short term, how readily might the port of Durban operate as a NAABSA port, and what benefits might be achieved in these circumstances?

1.3 Research Methodology

Most of the data used for the purpose of this dissertation will be compiled in-house within the Mediterranean Shipping Company (MSC), which is both the biggest single carrying line using the port of Durban, and it is the institution within which the researcher is employed in a senior operational capacity. Many of the ships operated by MSC that arrive at the port of Durban are deemed tidal and hence first-hand information with reference to the particular

circumstances of these port calls is available in-house. These particular circumstances include: (1) vessels' berthing and sailing schedules, restricted to tidal windows; (2) the records of daily terminal productivity and therefore the impact of inefficiencies that further compounds and exacerbates the situation of vessels that are deemed "tidal"; and (3) the adverse impact on trans-shipment cargo across the South African ports system due to the limited depths alongside at the DCT berths, and the adverse impact on the economy of the country. Additional data of neighbouring foreign ports with specific reference to present and future developments, and the threat these ports pose to the port of Durban, will be researched through publicly-available desk-top studies and available in-house data. Information of various relevant tidal ports will also be researched through publicly-available desk-top studies and available in-house data. Data for the NAABSA ports will be researched and sourced primarily through desk-top studies. Likewise, data on ship construction and ships' structural integrity will be researched and sourced through desk-top studies of the relevant technical literature. The details on the depth at the container berths (DCT) and composition of the seabed at the port of Durban will be obtained from Transnet National Ports Authority (TNPA).

1.4 The research context: port characteristics and port access

In the maritime world, the term, "vessel constrained by her draft", can be understood in various contexts, but each time this term is mentioned, it is in relation to the available depth of water. For a power-driven vessel, it implies that a vessel is severely restricted in her ability to deviate from the course she is following owing to the available depth and width of navigable water (Rule 3 [h], COLREGS, SOLAS). For a vessel awaiting a berthing opportunity at a port, at the rising tide, this indicates that there is insufficient navigable water at other times, implying that the vessel will have to wait for a specific "tidal window" depending on her draft. The insufficient navigable water referred to, could either be in the channel to the port entrances, the inner basins or alongside the berths.

Large and deep-drafted container vessels calling the port of Durban are constrained in their movements due to the limited depth alongside the container berths, despite greater water depths at the entrance channel and the inner harbour, therefore movement is constrained to the tidal windows associated with the high or rising tides. This implies that the vessels may potentially lose cargo-working time while waiting for these tidal windows and/or that these vessels may sit on the bottom alongside the berths for periods, waiting for tidal movement windows. At the port of Durban, the depth at the entrance channel to the port is maintained at 19 metres, whereas inside the harbour, the depth is maintained at 16 metres with differing depths along the various berths. These differential depths are illustrated in Figure 1, overleaf, which shows water depths in the port's entrance channel and immediate internal channel, and in Figure 2, below, which indicates water depths alongside the principal container berths and other working berths within the port.

The depths at the container berths, namely DCT Pier 1 and Pier 2, are maintained at 12.80 metres at chart datum. Port calls by the neo-Panamax generation of container ships with lengths of 366 metres and width of 48 metres (and indeed at times by somewhat larger vessels, dimensionally) have become a regular feature at the port of Durban. These classes of vessels draw up to 15.5 metres to 16.0 metres at the maximum loadable draft (summer marks), and therefore these vessels remain largely under-utilised owing to the draft restrictions at the container berths in Durban.

This is a huge disadvantage for a port that claims to be one of the largest and busiest in the African continent, and which handles 65% of South Africa's container traffic. Indeed, the port of Durban has shallower berths compared to the other container terminals located in Cape Town and Ngqura. There was an initiative to deepen the container berths, however, this was interrupted by concerns over contract irregularities. Transnet is currently revisiting the plan of deepening the container berths; the non-availability of such a facility is a major concern and significant deterrent to vessels drawing in excess of 12.20m, which are, for all practical purposes termed as "tidal". In this respect, Durban clearly lags behind other deeper-water comparator ports in the Southern African range of ports. Vessels with a draft of approximately 13.30m are handled at high tide and under exceptional circumstances vessels drawing up to 13.50m are considered. The berth-deepening project along with other strategic developmental plans for the container traffic are also aimed at capacity enhancement, which seems to be the main focus at the moment (Master Plan 2021 – Port of Durban).

This lack of deep-water berths in the port of Durban has a direct impact on the economy of this country, as this constraint jeopardises the possible trans-shipment cargo (and indeed at times even national or gateway cargoes) that the shipping lines may contemplate to divert through the South African ports. It is not only the deep-water berths that are a determining factor, but also the congestion and inefficiencies within the ports system that has an extensive influence. To lure the shipping lines into diverting trans-shipment volumes through a ports system, the terminals should be able to demonstrate significant capacity. Having evaluated the volumes that are moved through the port of Durban, Transnet Port Terminals (TPT) should have been able to handle such traffic with ease, given the deployment of a state-of-the-art equipment that is aligned to the best terminals in the world. However, this is not the case, as poor performance continues to have a bearing on the turnaround times of the ships, clearly exposing the restraints within the supply chain and consequently having a far-reaching impact on the economic situation. Whilst referring to trans-shipment volumes, it is important to understand that the port of Durban need not necessarily handle these volumes, but the increased carrying capacity of the vessels by virtue of providing deeper berths will encourage carriage of such volumes, which may perhaps be handled at another South African port. The mention of the "ports system" is intentional and South African ports should be viewed in a holistic perspective complementing each other in a bid to provide a release valve should there be issues at any of the ports.

An account of a gradual but definitive erosion of such trans-shipment volumes is elucidated in greater detail in Chapter 3, below; the account details the numerous opportunities afforded by way of diverting trans-shipment traffic through South African ports, but which could not

be sustained on account of the inefficiencies within these ports. This, in turn, has resulted in a diversion of these cargo flows to alternative ports and corridors, with a serious sacrifice of economic benefits that are seldom understood or enumerated.

There seems to be complacency in seeking comfort from the gateway cargo, both import and export, hence being blindfolded in exploring the potential for growth. The gateway cargo, too, from the landlocked regions of various SADC countries, which was earlier routed via South African ports, is finding alternative routes (as explored in Chapter 5, below) through other foreign ports; in essence, these seemingly secured shipments are gradually being lost to ports which earlier were not perceived to be a threat. Even the cargo from South Africa could well be routed through foreign ports as these ports are offering better incentives to attract cargo. In fact, the exasperation of the shippers and consignees has established their mandate in securing a more reliable and predictable service through foreign ports. South Africa has a tremendous potential and is comparatively better placed to explore its competitive advantage, and therefore, cannot afford to remain dormant and non-responsive to the developments in the surrounding ports.

At the port of Durban, the depths at the entrance channel and in the harbour are greater than the available depth at the berths. This is a rather peculiar situation as the reverse is true for most ports whereby water depths alongside berths are greater than the depths in the channels. It is much easier to handle vessels in ports where the depths at the berth are greater as these vessels can be better managed in terms of loading and discharging operations that may continue unhindered. The port of Durban necessitates a different approach in dealing with tidal vessels. The fact that the berths are shallower dictates that the vessels need to be closely monitored at the crucial periods, during the course of cargo operations, to a point where the vessels' drafts jeopardise the permissible UKC as specified in the port. The vessels' draft needs to be managed in conjunction with the height of tide to ensure that the mandatory UKC recommended by the port authority (TNPA) is maintained at all times throughout the vessels' occupation of the berth. The seabed at the port of Durban, and at the container berths is flat and homogeneous with the major composition being sand and mud, as shown in Chapter 4, below. This being the case, the port of Durban is exactly similar to the NAABSA (**N**ot **A**lways **A**float **b**ut **S**afely **A**ground) ports of the world, implying that it is completely safe for the ships to sit on the seabed at the port of Durban as in other NAABSA ports. The vessels can hence be optimised to a much greater extent, in terms of arriving and departing at greater drafts, and in sustaining cargo-handling operation throughout their time alongside. In the absence of deeper berths, this flexibility to the shipping lines as a discretionary option will benefit in optimising cargo. The new generation container ships are very robust, constructed with high tensile steel and impeccable design features to endure such events without any damages whatsoever to the ship's hull, in particular the flat bottom structures. The structural reinforcement, specifically at the flat bottom of the ship, is so constructed to withstand at least the light ship displacement (the bare weight of the ship, without cargo, fuel, ballast water, provisions, stores, crew, etc.) of the vessel when the ship takes the dry-dock blocks as she emerges out of the water completely dry, as would be the case during periods of major repairs or surveys. A comparative analysis conducted principally in Chapter 2, below, to this effect establishes the ship's structural integrity to safely take the

bottom, specifically, at the port of Durban. A comprehensive scrutiny, undertaken to determine the endurance of the strength members in way of the flat bottom, further endorses the fitness for the purpose.

In fact, a lot of ships probably do “take the bottom” during the course of cargo operation (refer appendix 4.4; case studies 3, 4, 5 and 6). Such occurrences are a consequence of the non-alignment in the actual rates of discharge or load performed by the terminal as compared to the estimated productivity used to calculate the decrease or increase in draft, respectively, in order to avoid this incident. For example, if the ship berths at high tide with a deeper draft that qualifies her to be termed as “tidal”, the vessel will be required to discharge and lighten (decrease her draft) before the low tide sets in, in order to avoid sitting on the seabed. In this instance, if the actual rate of discharge performed by the terminal, for various possible reasons, is less than the nominal rate used to calculate the time this operation to lighten the vessel should take, the ship could possibly sit on the seabed. In the case of a tidal sailing, if the loading operations were not completed as planned at the high tide, there are two options available at this stage, either to “cut and run” or stay on the berth and continue loading and possibly take the bottom, sailing at the next rising tide or high tide after completion of cargo operations. The reason for the failure in the required performance actually achieved, even though a nominal productivity rate is used to determine the estimated times to lighten or load the vessels within the allocated timeframe, could be various, such as sheer inefficiencies, or incidents like gantry breakdowns, or it could be that the cargo operations are interrupted due to adverse weather, that might compel vessels to take the bottom. This is one of the reasons that the ships cannot be optimised as the cargo has to be planned in a conservative manner, making allowance for any unexpected decline in productivity or interruptions in cargo operations. If these likely inefficiencies are not factored in, the damage caused due to the short-shipment of cargo is irrefutable, resulting in stained Letters of Credit affecting payment and cash flow, split-bills preventing release of cargo at the ports of discharge until the entire consignment is reconciled, etc., and therefore caution needs to be exercised to ensure all the cargo that is planned is shipped or discharged. At this point, it is evidently clear that the NAABSA clause should be invoked at the port of Durban in order to ensure that the cargo is optimised, given the depth limitations at the berths.

One of the ports similar to the port of Durban in terms of the depth differential at the berth and the channel, is Maputo. The depth at chart datum alongside the container berth at Maputo reads 11.8m and that in the channel is 14.2m, rendering the same concept as Durban, wherein the depth at the berth is lesser compared to the channel, which implies that the vessels’ draft will have to be managed alongside the quay when the drafts are at limits during berthing and sailing.

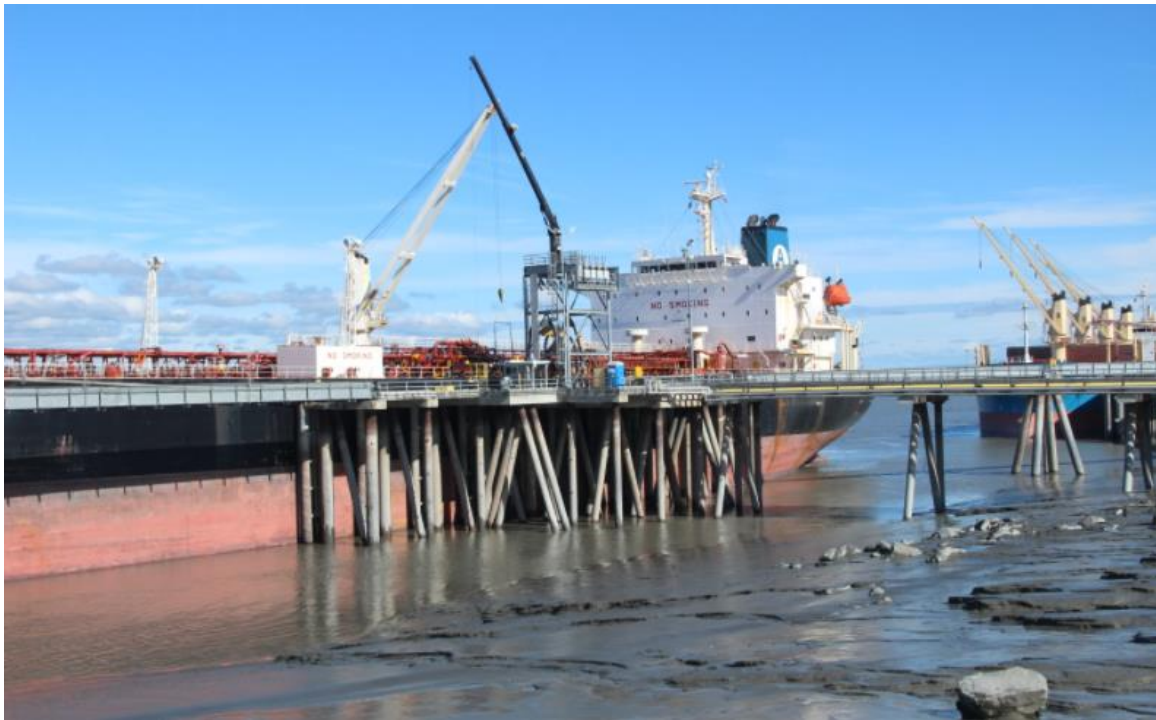
Conceptually, in contrast, is the port of Beira. The depth at the container berth is maintained at 12.0m and in the channel is 8.0m at chart datum. In essence, the vessels have to berth or sail on the tide, which a considerable tidal range of approximately 6 metres at springs permits. Once on the berth, the vessels can continue with the loading or discharging operations unhindered, with the limiting draft being the permissible draft in the channel depending on the height of tide of the day. Similarly, at the port of Walvis Bay, the depth in the channel is

maintained at 14.0m and that at the container berths at 16.0m at chart datum (NAMPORT). At the port of Dar es Salaam, the depth in the channel is 10.20m and at the container berths is 12.0m, at chart datum (TICTS). This concept of deeper depths at the berth as compared to the depths in the channel is predominant in most of the tidal ports of the world, whereby the vessels are restrained by the draft. The marine infrastructure and navigational port access characteristics of these and other African ports will be dealt with more fully in Chapter 5, below.

Further afield, the port of Santos in Brazil, for all practical purposes, is deemed to be a tidal port. The depths at the berth and the channel/basin, are each maintained at 15.0m at chart datum. The maximum permissible draft is 14.5m with the tide of 1m for berthing and unberthing operations. Although the draft of 14.5m may seem to be substantial, Santos is usually the first and the last port of call for vessels calling South America (east coast), mostly for vessels from and to the Far East (MSC runs the IPANEMA service), and therefore the vessels usually arrive or depart with the maximum permissible draft. Special dispensation may be allowed upon request to the Harbour Master, for drafts exceeding 14.5m (This study). The draft differential being zero, managing the vessels is a straightforward affair, with deep-drafted vessels using the tidal windows for berthing and sailing. Most Brazilian ports are tidal, namely Navegantes, Itajai, Itapoa, Paranagua, Rio de Janeiro, Sepetiba, Salvador, Suape and Pecem.

There could be situations where it is impossible to manage the draft by maintaining an under-keel clearance, and furthermore if the circumstances are feasible, the ships may be forced to take the bottom. This is allowed in a few ports of the world, known as the NAABSA ports. Essentially, in these ports, the vessels take the bottom by resting on the seabed during the course of cargo operations. Usually, these ports have a high tidal range and therefore, it becomes practically impossible to continue with cargo operations without safely sitting on the seabed at the ebb tide. There are other parameters that deem this operation safe, namely the nature of the seabed and the contour. In such ports, the vessels berth or sail on high water and the drafts to this effect are pre-planned in conjunction with the height of the highest tide of the day, if the vessel arrives at a maximum capacity or sails with a maximum draft in reference to the tide. Essentially a NAABSA port is characterised with a soft and a reasonably flat seabed that is conducive to the vessel resting on the bottom without causing damage to the ship's hull. Quite a few ports in Brazil, namely, port of Cabedelo, located on the banks of the river Paraíba do Norte River estuary, Recife at the confluence of the rivers Capibaribe and Beberibe, Maceio, Sao Sebastiao, Santos and Paranagua allow for NAABSA operations. The Argentinian ports of Buenos Aires, La Plata, Necochea and Bahia Blanca, also allow for such operations. Estuaries and rivers such as the Thames and the Humber in England are further examples of NAABSA ports. Ports having a high tidal range, such as Bromborough, Greenwich and Glasgow in the UK, or Rochefort and Les Sables-d'Olonne in France, can fall dry at low tide and hence the vessels that call these ports are subjected to greater challenges in terms of weight bearing, as the forces of buoyancy are transferred to the ship's hull. This will be dealt with in greater detail in Chapter 2. Image 1.1 refers to a ship safely sitting on the seabed in Anchorage, Alaska, one of the ports with the highest tidal ranges in the world.

Image 1.1 Port of Anchorage, Alaska



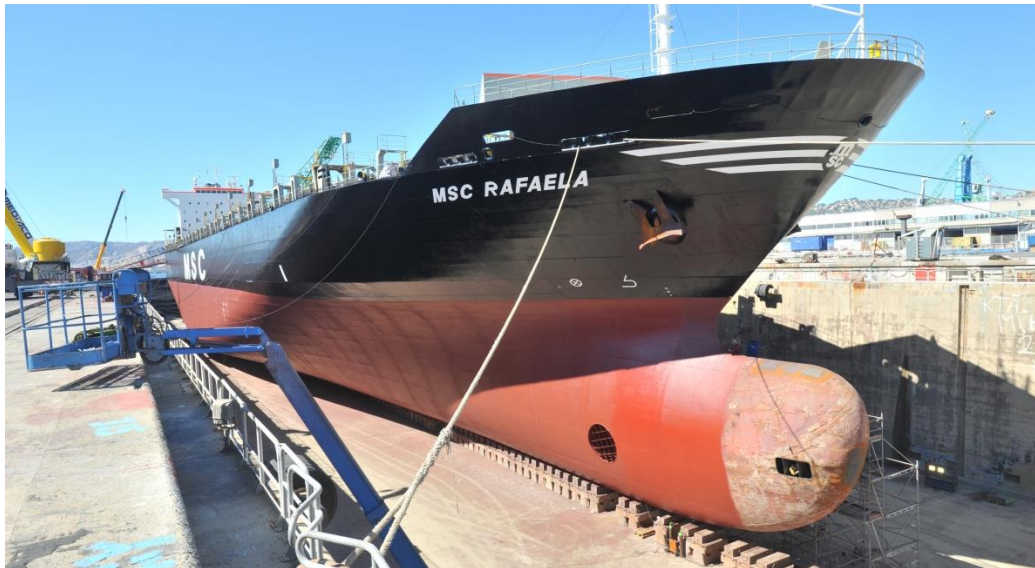
Source: The World

Whilst the port of Bridgwater in the western part of the Bristol Channel in the United Kingdom is a NAABSA port, other ports in the area are managed within lock gates, for example, the Royal Portbury Docks, in the port of Bristol. Due to the huge variance of the tidal range in the Bristol channel, as the water begins to recede at the ebb tide, the water within the dock is trapped with the assistance of lock gates. The area outside the dock could then run completely dry at the low tide, whilst the ships within the dock remain afloat as the water is locked within the gates, similar to a dam. The tidal range in the Bristol Channel is approximately 13m, the second largest in the world (Refer to Bristol Channel Tide Tables for tidal variance). In comparison, the highest tidal range is experienced in the Bay of Fundy, situated between New Brunswick and Nova Scotia in Canada; the tidal range averages to approximately 16m (Wikipedia; Bay of Fundy – Highest Tides in the World). Other ports, like the Belgian port of Antwerp, the second-largest port in Europe, are managed within lock gates to ensure that depths at the berths are maintained. Indeed, the two principal lock systems providing access to the Port of Antwerp and to its container-handling terminals, the Kieldrecht Lock and the Berendrecht Lock, are the largest and second-largest port-based lock gates in the world, respectively. Both have similar dimensions in terms of length and breadth (500m x 68m), and a depth of 17.5m and 17.8m respectively. In fact, the container terminal at the port of Antwerp operated by MSC PSA European Terminal (MPET) is the single largest container-handling facility in Europe with a capacity of 9 million TEUs. The maximum depth at this terminal at chart datum is 17.0m (PSA Antwerp). This terminal is geared to handle the largest container vessels drawing up to 16.0m, whereby a tidal window will have to be established to navigate deep drafted vessels. It is of interest to note that a port located within a lock gate can handle vessels of the largest possible dimensions, within the dimensional

constraints of the locks. The core purpose of the lock gates is to contain the water and maintain the depth of the dock within the lock gates aligned to the high tide of the day. The required level of water may be maintained depending on the draft of vessels and stipulated under keel clearance within the lock.

It is indeed interesting, how ports evolve in the different regions of the world despite the varying pressing limitations. As illustrated in the preceding examples, the ports have adapted to a suitable model depending on the topography and characteristics of the region, thus emphasising the significance of seaports and trade by sea, which by far is the single most important means of conveyance to sustain international trade and global economic viability. Approximately 80% of the global trade by volume, and 70% by value are transported by sea. In an attempt to optimise cargo liftings, this research will seek to demonstrate that this principle of adaptation could be made applicable to the port of Durban, by permitting NAABSA operations, whereby the port may become less constrained in handling deep-drafted vessels. The port of Durban can be rendered as a NAABSA port by virtue of its inherent characteristic of having a homogeneous, soft, and flat seabed. Essentially, for a successful NAABSA operation to materialise, the seabed must be conducive, and the ships taking the bottom must be suitably constructed to bear the weight that is transferred from the upward thrust of the buoyant force to the ships' flat bottom. In the following chapters, the fitness of ships to take the bottom will be discussed in greater detail. The constructional aspect of the ships, with specific reference to the strength and reinforcement of the ships' hull, particularly at the flat bottom structure of the ships will be dealt with to determine this capability. To further establish the suitability of ships for the purpose of the NAABSA operation, a close comparison to the vessels taking the dry-dock blocks will be referenced. At a dry dock, the ship entering the facility is sealed within the lock gates and the water within is pumped out rendering the ships completely dry with the weight of the ship totally borne by the blocks. This is illustrated clearly in image 1.2, below, which shows a medium-sized container vessel in a dry-dock facility, and with the full weight of the vessel carried quite safely by its own structural integrity

Image 1.2 Chantier Naval de Marseille Dry Dock, France



Source: MSC

Additionally, a few incidents involving vessels that accidentally ran aground, and survived these incidents without significant damage to the ship's hull or bottom, will be illustrated in Chapter 2, below, to establish the strength and impact bearing ability of the ship's bottom.

This study essentially aims at demonstrating the suitability of rendering the port of Durban as a NAABSA port. In doing so, the cargo throughput through the port of Durban will be increased as the ships will be able to maintain deeper drafts. As illustrated in the following chapters, this should sustain a better appetite for trans-shipment cargoes through South African ports. Besides, the cargo from the hinterland destinations like Zimbabwe, Zambia, Lesotho, Botswana, DRC can be accommodated with greater ease. At present, as the ships are constrained by water depth alongside berths at the port of Durban, these restrictions impose an impediment to the cargo carrying capability, with vessels unable to exploit their spare capacity, and consequently their full economic capability. Many other ports around the world have evolved in aligning themselves more optimally with the local requirements, hence there is a demonstrable opportunity for the port of Durban to widen its cargo catchment areas in a bid to increase cargo throughput, not only for the port of Durban itself, but all other South African ports. The impact on other South African ports will be discussed in detail in the following chapters by presenting data related to specific vessel calls in an endeavour to quantify losses of traffic volumes and resultant economic costs. As per the latest plan drawn out for the port of Durban (Master Plan 2021 – Port of Durban), there is a plan to address the issue of draft restrictions by the berth deepening project that has been envisaged as a part of this program. The capacity constraints within the terminal precinct are planned to be addressed by building an off-dock facility (or inland dry-port) served by rail. These developments, of course, relate to a long-term planning horizon, but this research will also argue that there is a dire shorter-term need to address the constraints encountered in the current form and configuration of the port (Scholtz, 2017).

CHAPTER TWO

THE CONCEPT OF NAABSA – VESSEL DESIGN CHARACTERISTICS AND APPLICABILITY TO THE PORT OF DURBAN

NAABSA is a term associated with shipping, an acronym for “not always afloat but safely aground”. The port of Durban has its inherent limitations in terms of water depths, due to which ships cannot be optimised to their captive capacity. This situation is further compromised by the regulations enforced by the Transnet National Ports Authority defining the mandatory UKC requirements, which present further complexities. The last couple of decades have witnessed a significant evolution of container vessels with a radical increase in size or TEU capacity, which has put the port’s infrastructure under immense pressure to upgrade the existing amenities and equipment. Large container vessels of neo-Panamax size frequently call the port of Durban, despite the significant limitations that constrained water depth alongside container berths impose on the full-load carrying capacity of these vessels. Under the circumstances, the overall situation can be alleviated to a certain degree by taking advantage of the flat and soft seabed within the Durban harbour and introducing the concept of NAABSA. Effectively, the restrictions imposed in relation to the water depths may be partly mitigated and cargo intake may be optimised to the extent possible if this concept is incorporated. The bathymetric features of the seabed are conducive to make allowance for such operations whereby the vessels may lie safely aground during loading and/or discharging. Ships’ structural integrity is vital in determining a critical manoeuvre of this nature; this study undertakes to dissect the constructional characteristics of the vessels to determine their structural strength and the ability to withstand the stresses when subjected to take the bottom, without damage to the ships’ hull. To further establish the viability of this operation, a comparative study of two neo-Panamax vessels under NAABSA operation and with those same vessels in dry dock, whereby their displacement weight is borne by the dry-dock blocks, will be undertaken. In addition, an account of a few grounding incidents involving vessels that accidentally ran aground will be presented and the resultant damages will be evaluated in an attempt to establish the inherent design of the modern container vessels and the ability to withstand dynamic impact to a certain degree, even in unexpected and adverse situations. In essence, an extraction of data from the relevant sources will be compiled to determine the feasibility of NAABSA operation.

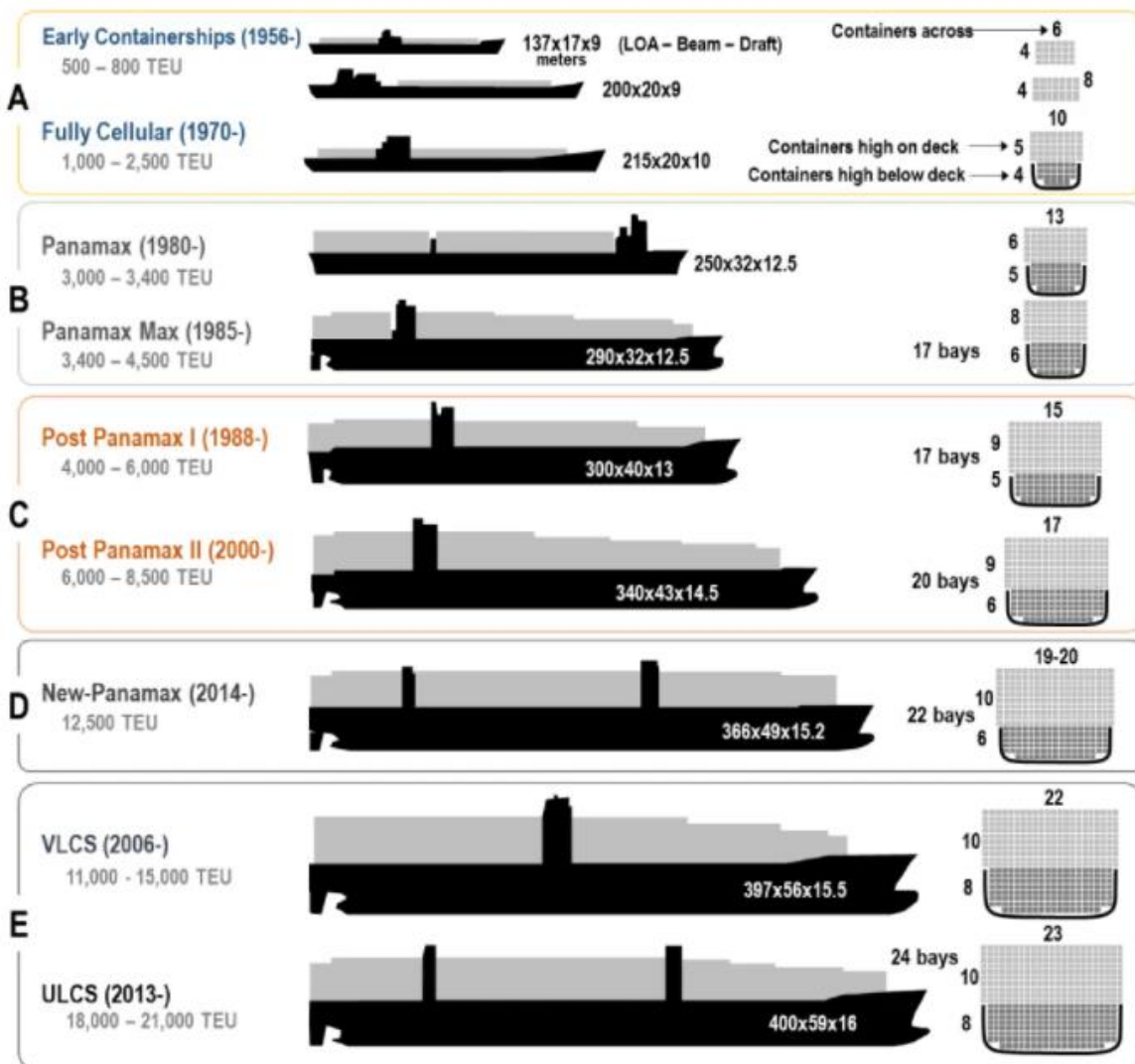
2.1 Advent of containerisation – Evolution of container ships

There has been a significant evolution of container vessels over a period of time, with the last decade being revolutionary in this regard. The newest generation of Ultra Large Container Ships are 400m in length, nearly 60m wide, drawing approximately 16m with a carrying capacity in excess of 20000 TEUs (Twenty-foot Equivalent Units).

The early generation container ships were multipurpose general cargo ships that could also carry containers either only on deck or under-deck too. Subsequently, modified bulk carriers and tankers were added to the fleet. In the 1980s, the concept of containerisation gained traction and economies of scale dictated the building of fully-cellular container vessels of Panamax standards, such that the maximum beam of these vessels was limited to 32.2 metres in order to be able to pass through the Panama Canal. In a bid to maintain the vessels of Panamax class and maximise the TEU capacity as economies of scale would dictate, the ships became lengthier with a capacity reaching to 4500 TEUs. In the late 1990s, as global trade grew further, this boom in trade prompted the introduction of post-Panamax vessels on specific trade routes. These vessels were not much lengthier than the Panamax vessels but were wider; the carrying capacity was hence increased to 8500 TEUs. Once the Panamax parameters were surpassed, the limitations shifted to designing Neo-Panamax, Very Large Container Ships (VLCS) and Ultra Large Container Ships (ULCS), to reap the cost benefits associated with further economies of scale. As much as economies of scale prompt the deployment of larger vessels (neo-Panamax, VLCS and ULCS), these vessels are restricted to calling only a few ports on dominant trade routes, whereas the infrastructure in many ports does not support the calls of larger vessels for various reasons that include available depths in the channels, inner harbour or alongside the berths, diameter of the turning basin, height-reach of the gantries or mobile harbour cranes, outreach of the gantries or the mobile harbour cranes, insufficient expertise in handling larger vessels, etc. Many ports around the world are under pressure to review their infrastructure and equipment in the wake of this continuous evolution of container ship sizes. However, these upgrades are capital-intensive, and not only the ports, but the inland infrastructure, have to be accordingly aligned to the demands. Commercial attributes must also eventually justify these investments.

In line with the Masterplan 2021 for the port of Durban, the port will apparently cater to vessels of 15000 TEUs, although the port has already been handling neo-Panamax vessels of 14000 TEUs, overall length of 366 metres and beam up to 51.2 metres, albeit not in fully laden condition. These vessels can draw up to 16m, however, the depths alongside the berth in the port of Durban are maintained at 12.80m at chart datum, such that alongside water depth serves as a constraint on the full operation of these larger container vessels. If an upgrade needs to be envisaged, it must be in the area of the latest generation of containers vessels of 24000 TEUs with lengths of 400 metres.

Figure 2.1 Evolution of Container Ships



The Geography of Transport System, Jean-Paul Rodrigue (5th Edition)

2.2 The Port of Durban as a NAABSA port

At the Port of Durban, the seabed is homogeneous and plane with a charted depth of 12.80m at the Durban Container Terminal (DCT), Pier 1 and 2. However, owing to the depth limitations at the berths, the loading ability of the container ships is severely restricted. The vessels loading in excess of a draft of 12.40m are deemed tidal and a tidal calculation needs to be sent to the port authority, Transnet National Ports Authority (TNPA), to decide on the time the services may be dispatched having due regards to the stipulated UKC. TNPA mandates UKC of at least 0.30m whilst the vessel is under operations at berth and a minimum UKC of 0.60m at berthing or sailing. The exercise of maintaining UKC of 0.30m whilst the vessel is at berth may be jeopardised for various reasons. There could be instances when the container vessels might be compelled to take the bottom owing to various evolving situations, on a receding tide, which may be deemed perilous. This affords an opportunity to deal with tidal vessels calling the Port of Durban with a more pragmatic approach, in a bid to optimise cargo intake, circumvent the necessity to interrupt cargo operations (eliminate stop-start operations) and hence induce efficiencies, and to evaluate any perceived damage to the ship's hull.

The following must be considered, whilst assessing the situation:

- the displacement that has been transferred to the seabed, in order to establish the weight borne by the ship's bottom, in particular the bottom shell plating and the structural elements supporting the bottom shell plating.
- a soft landing, without an impact, is a vital element in contemplating damages, being directly proportional to the Impact Energy which is a measure of mass and acceleration. At the instant when the ship is just about touching the seabed, the mass that is transferred to the seabed is negligible, whereas the initial relative velocity at the time of impact is the sum of the rate at which ship is being loaded and the rate at which the tide recedes.

Example: Consider a ship that is being loaded with three gantries at a rate of 20 moves per hour per gantry. The total moves per hour across the ship amounts to 60 moves/hour. Consider a weight of 30 tons per container. The rate of loading per hour = 60 containers x 30 tons/container = 1800 tons

Therefore, the rate of loading = 1800 tons per hour

Consider an average TPC (tons per centimetre) immersion of 120 tons/cm

Immersion = 1800 tons per hour/120 tons per cm = 15cm per hour

Converting the immersion of 15cm/hour to metric (SI) units = 0.000042m/s

This implies that as the vessel loads at the rate of 1800 tons/hour, the vessel's velocity/speed through the water in the downward direction is 0.000042m/s

Now, consider the receding tide at springs (as the rate is maximum at springs). As the tide approaches low water, the level of water drops by an average of 0.45m/hour. This implies that the entire medium of the water mass along with the ship is moving downwards relative to the seabed at the rate/velocity of 0.45m/hour.

Converting 0.45m/hour into metric (SI) units = 0.000125m/s

Combining the effects of loading and the receding tide, the resultant velocity at the instance the vessel just touches the bottom, equals to the sum of the velocities.

$$= 0.000042\text{m/s} + 0.000125\text{m/s} = 0.000167\text{m/s}$$

$$= 0.60 \text{ metres/hour}$$

When the vessel touches the bottom, the vessel's movement relative to the seabed stops as she sits on the seabed itself and the velocity at this point is zero (0m/s). Arguably, although there would be an instantaneous acceleration, the mass that is transferred to the seabed at this instance is negligible and hence there is negligible impact, as the impact force is a measure of mass and acceleration.

As the water recedes, the weight is gradually transferred to the seabed exerting a force equivalent to the product of the mass and the acceleration due to gravity (Force = mass x gravitational acceleration; $F = mg$) on the seabed. As a consequence, the reaction force acting on the ship as per Newton's third law of motion is contained or absorbed as the ship's hull is suitably designed to withstand the reaction force. The infinitesimally small deformation due to the reaction force will correct itself upon being relieved from such stresses when completely afloat due the elastic properties of the high tensile steel used for construction.

The above example is possibly a worst-case scenario; as the water recedes during the course of the low tide at springs, the ship will emerge by 0.60m in a span of an hour or 1cm every minute. Therefore, it is evident that the mass which is progressively transferred to the seabed due to the loss in buoyancy as a consequence of the receding tide is very gradual, taking into consideration the weight distribution across the surface area of the flat bottom.

This then raises the central question as to whether it is safe for ships to lay on the bottom in the port of Durban. As detailed below, this is deemed to be a safe operation, for the following reasons:

1. The single most important element in rendering the operation safe is establishing the suitability of the seabed. The seabed must be plane and homogeneous, with no hard points (see Chapter 4 for a fuller account of the seabed condition in the port of Durban);
2. The ship, especially the bottom structure, must be suitably constructed with sufficient reinforcement to withstand the transference of the buoyant upthrust to the ship's keel;
3. The ship should be drawing even keel in order to prevent possible damage to the propeller and rudder as the vessel begins to take the bottom, should the vessel be trimmed by the stern;
4. The ship must switch over to high sea water suction; and
5. Steering gear motors must be switched off (Technical manual for NAABSA operations, Ship specific for vessels calling NAABSA ports/Part of SMS)

However, falling dry impacts a vessel's ability to fight fires and cool engines, whereas equipment such as thrusters, propellers and rudder can be affected as well.

2.2.1 Structural strength of modern vessels

As noted in Chapter One, there are many ports in the world wherein vessels are subjected to this phenomenon of taking the bottom. These ports are termed as NAABSA ports, whereby the vessels safely lie aground at ebb tide; with many ships, this is a common feature, as much as it might come across as an abnormal practice. Of course, an elaborate risk assessment must be carried out together with risk mitigating measures.

These vessels that call at the NAABSA ports are not specifically designed or constructed for the purpose. However, a recent development in the classification regulations effective from 1 July 2019, has made allowance for the NAABSA notation for ships of LOA 90m or less, by introducing technical specifications for the reinforcement of the primary bottom structural elements, namely the bottom shell plating, longitudinal girders, transverse floors, and bottom longitudinal stiffeners. Existing ships were not originally built for this NAABSA notation, but can be checked for the suitability of construction, for the NAABSA notation (DNVGL-RU-SHIP Design requirements: Pt.6 Ch.1 Sec.13 [3]; Pt.1 Ch.2 – 2019). For ships to be classified with the NAABSA notation, the following is taken into consideration:

1. The ships' length must be less than 90 metres
2. The ship falls completely dry with the flat bottom area resting on the seabed. Essentially, at ebb tide, the water would have completely run out, having the ship to fully emerge, and be exposed.
3. The load bearing is equivalent to the displacement at the moulded draft. The vessel could be fully loaded, equivalent to the load displacement at the summer marks and allowed to fall dry, with the weight completely supported by the seabed.
4. The pressure exerted on the flat bottom area is calculated by dividing the displacement at the moulded draft across the total flat bottom area.
5. The spacing of the longitudinal side girders at the ship's bottom must not exceed 4.5 metres.

6. The spacing and design specifications of the transverse floors for the vessels classified with the NAABSA notation is deciphered after carrying out an assessment of maximum load condition and maximum permissible load density.
7. The bottom shell plate thickness shall be increased by 10% having due consideration that the vessel will be completely dry whilst she lays on the seabed and the load bearing is equivalent to the displacement at the moulded draft.

An instance of a ship safely lying aground and emerged completely dry in one of the NAABSA ports in UK, where the tidal range is significantly high, is illustrated in Image 2.1, below.

Image 2.1 A commercial vessel fully aground in a tidal UK port



Source: DNV

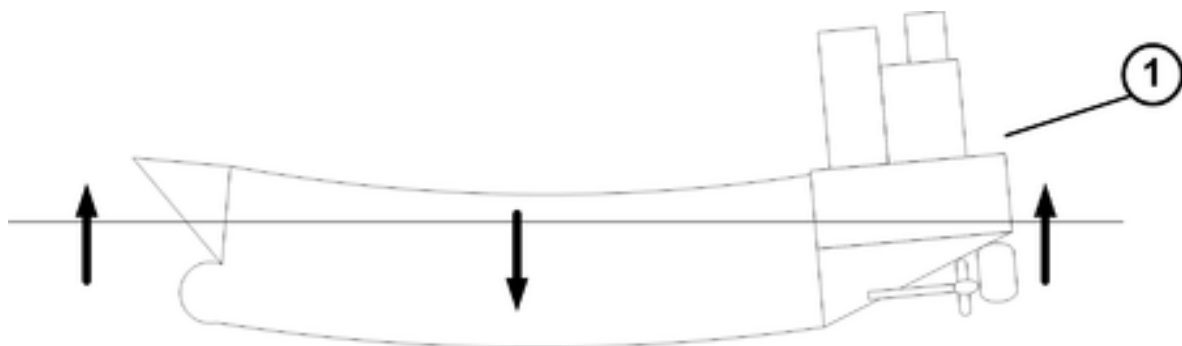
Many ports in the United Kingdom, France and the Northern coast of Western Australia, having a high tidal range, can fall completely dry at low water. There are other ports in India, Argentina and Russia with high tidal range, wherein ships lie on the bottom at low tide. The NAABSA concept was proposed and developed for very specialized ships, usually plying between fixed ports. Ships with length of < 90m do not necessarily have to be classified for NAABSA notation, although the vessels may call such ports. The ships that usually call the NAABSA ports do not have the Class notation as these ships are predominantly greater than 90 metres in length, nor were these specifically built for the purpose. These ships that call NAABSA ports, like any other ships, are originally constructed with sufficient integrity to withstand the pressure exerted, particularly on the ship's bottom structural elements when the displacement supported by the buoyant forces are shifted to the flat bottom of the ship. For this reason, ships can be dry docked and stay in the dry-dock for days without being subjected to deformation. There have been incidents whereby the ships had to call the dry dock on an emergency basis with cargo on board, and the ships did so without suffering any damage. There is, however, a careful prior assessment done, to establish the endurance and limitations. Under normal circumstances, the load bearing at the dry-dock facility is limited to

the plans stipulated in the Docking Condition, which is primarily the Light Ship Displacement and some ballast to trim the vessel (Docking Condition for two container callers of neo-Panamax dimensions to the port of Durban – MSC Judith and MSC Beatrice – are attached as Exhibits 1 and 3).

Essentially, ships are constructed to withstand the varying dynamics to which they may be subjected during their life span at sea, usually considered to be a period of approximately 25 years. The construction takes into consideration the following under the severest sea conditions. For the purpose of severity of sea conditions, the sea-going conditions are referenced with the North Atlantic region during the winter months as the conditions during this period are deemed very severe (DNVGL Ship rules Pt.3 Ch.1 Hull Structural Design // Edition July 2016; amended Jan 2018). These considerations are:

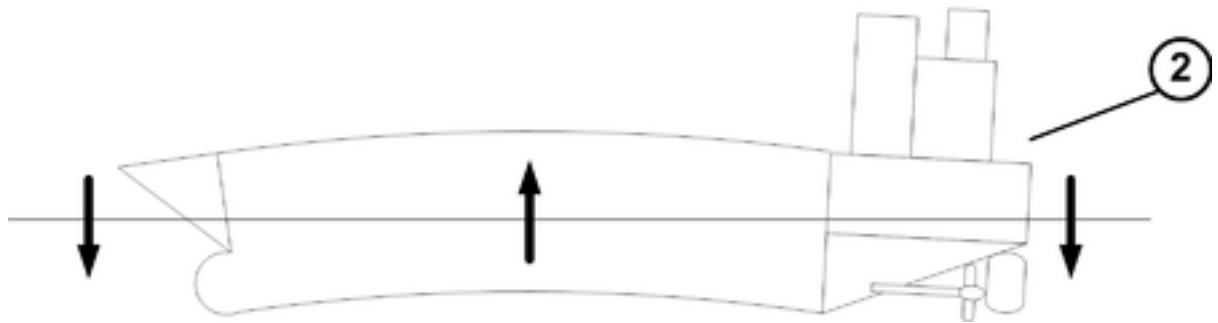
1. The stresses a ship experiences, i.e., bending moments, shearing forces and torsional moments, are calculated under the possible severe conditions referenced above.
2. The stresses are calculated, based on a hypothetical approach caused by a single wave, of length equivalent to the ship's length, with the crest, at the extreme ends, perpendicular to the fore and aft centre line; at midship, perpendicular to the fore and aft centre line. Technically, this will cause the ship to sag (1) and hog (2) respectively, to its maximum under the prevailing load conditions, as presented in Figures 2.2 and 2.3, below.

Figure 2.2 Sagging (1): The crest of the single wave is at the fore and aft ends and the trough of the wave in the mid-section causing the vessel to sag



Source: Wikipedia

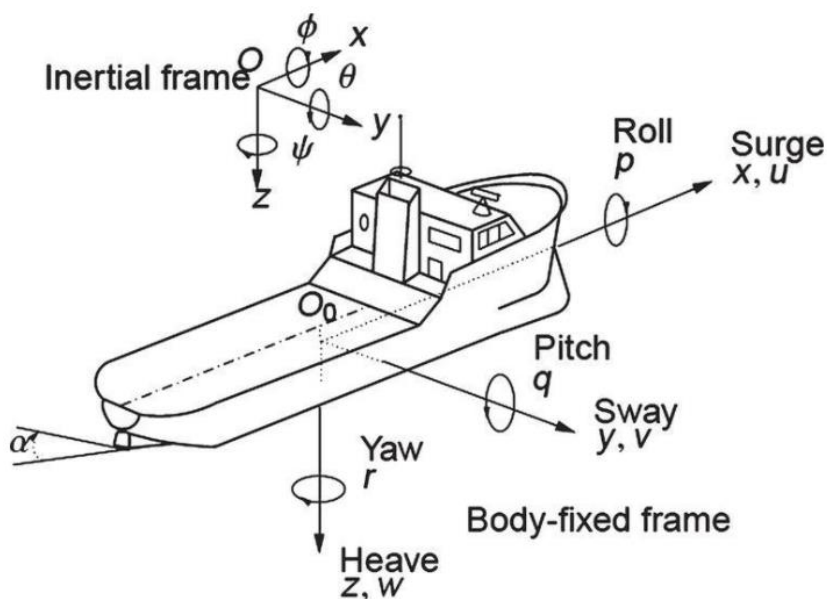
Figure 2.3 Hogging (2): The crest of the single wave is at the mid-section and the trough of the wave is at the fore and aft ends causing the vessel to hog



Source: Wikipedia

3. The construction dynamics further evaluate the moment of inertia (refer to the inertial frame as shown in Figure 2.4, below) experienced due to the vessels' movements along the different axes, i.e., the fore and aft axis (x - axis), the transverse axis (y - axis) and the vertical axis (z - axis), with specific references to the roll (p), pitch (q) and yaw (r), and surge (u), sway (v) and heave (w) respectively.
4. Relevant effects of the vessels' dynamics (enlisted) are duly referenced under abnormal sea conditions in order to factor in the additional strengthening requirements.
 - Surge along the x -axis (u) in the fore and aft direction
 - Sway along the y -axis (v), in the athwartship direction (sideways movement)
 - Heave along the z -axis (w), in a vertical direction (up and down movement)
 - Roll around the x -axis (p)
 - Pitch around the y -axis (q)
 - Yaw around the z -axis (r)

Figure 2.4 Body Frame of Reference for Ships



Source: ResearchGate

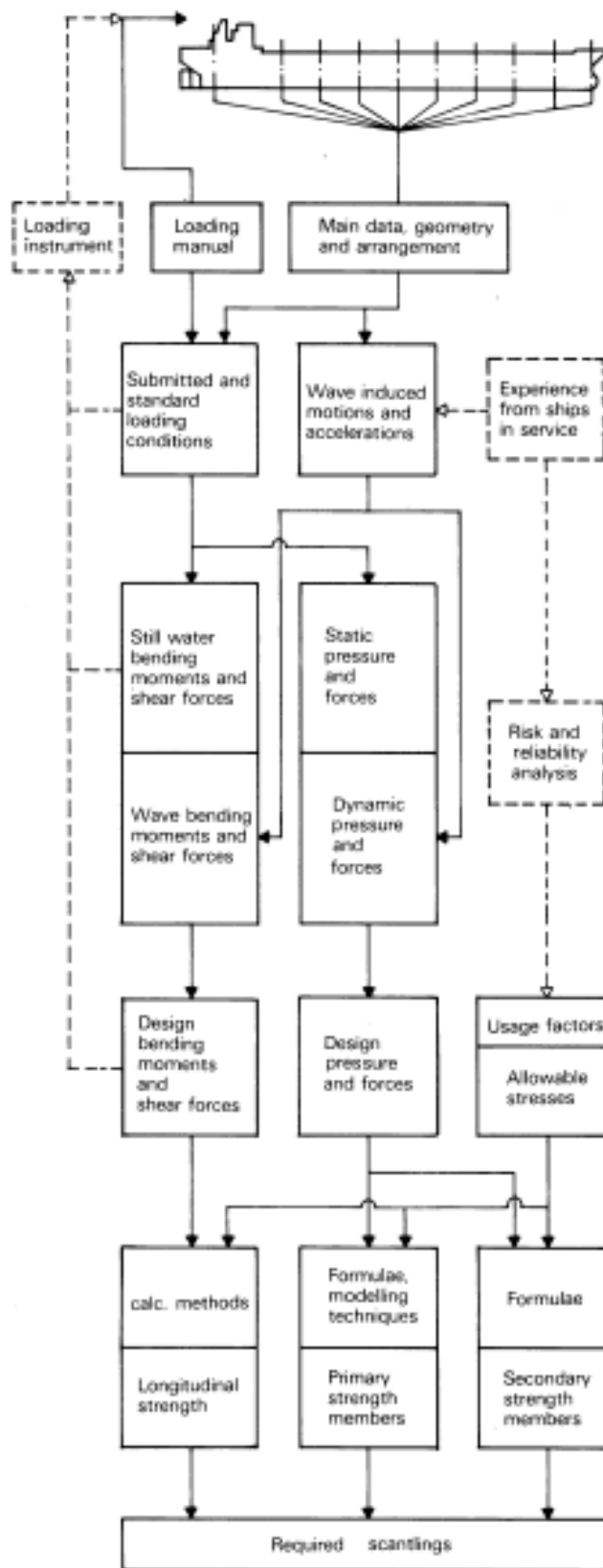
5. Different ship-to-wave heading angles are customarily considered with a uniform probability of occurrence.
6. Wave-induced loads are calculated according to accepted theories, and model tests or full-scale measurements may be accepted as an equivalent method in determining the strength of the scantlings (DNVGL-CG-0130, 2018; Measurement of Wave-Induced Loads on Ships at Sea - J. C. Brown, J. D. Clarke, R. S. Dow, G. L. Jones, C. S. Smith, R. Cazzulo, D. W. Robinson and P. T. Pedersen, 1991).

Ship design is complex, as a delicate balance is struck between the space that has to be made available for commercial purposes, the construction aspect that takes into consideration the most severe sea going conditions the ships are subjected to, the safety features and the cost involved with such projects which further encompasses the lifespan envisaged in executing the project. The design of the present-day lengthier ships must take into consideration the wave-induced loads that chiefly influence the bending moments, shearing forces and torsional stresses on the hull. The subjection to induced loads leads to fatigue, and this feature is considered in relation to the lifespan envisaged, ensuring the vessels' structures remain in the elastic band. In contemplating a fail-safe design of the hull girder, the assessment takes into consideration maximum wave loads with a view to endurance for the planned life span and a very low probability of collapse of the hull structures.

7. Vessels are designed and constructed to sustain impact loads and whipping. Impact loads, for example, pounding, are abrupt and intense, producing a pattern of vibrations onto the ship's hull. These high-frequency vibrations cause severe loads on the entire structure and may sometimes exceed the wave-induced stress, thus aggravating the situation when both are superimposed. The outcome is whipping, hence inducing complex bending moments on the hull girders leading to fatigue damage and failure of the structural components. Whipping causes rapid flexing of the hull girder as a consequence of a wave impact on the hull. This usually results in high frequency cyclic oscillations of the hull girder which may result in increased vertical wave induced bending moments and shear forces. Pounding causes the ships to pitch in heavy seas; it may so happen that the bow rises over the crest of a wave and emerges completely out of the water and when the bow comes back down on the water, it can be subjected to a major impact. The structural design and integrity is maintained to prevent buckling of structural elements when subjected to such compressive stresses and shear stresses. Utmost priority is given to the midship section having due regards to the maximum hull girder bending and buckling loads, especially around the double bottom areas. The susceptibility of hull structures to fatigue cracking is taken care of by special requirements to detail design. (Journal of Fluids and Structure 2015; Whipping – Simulation – Safety4Sea 2016; DNV GL Container Ship Update No. 01 2016).

8. The structural requirements for container ships >150m in length are more stringent if the notation CONTAINER SHIP is appended. The areas under the container corner posts, where the corner posts of the containers rest, are strengthened by localised reinforcements. The transverse floors and longitudinal girders are additionally fitted in way of the container corner posts. This construction feature, specific to container vessels, provides for a rigid support to the bottom shell and supports the dissemination of loads along the length and breadth of the vessel (DNVGL-RU-SHIP Pt. 3 Ch. 1, 2015; Pt. 3 Ch. 3, 201Pt. 3 Ch. 10, 2017).
9. Classification Societies for ships have devised standard calculations to regulate the strength of the primary and secondary structural elements to ensure that the reinforcements are aligned to the hull loads under the most stringent sea-going conditions; the thickness of the bottom shell plating, longitudinal girders, longitudinal stiffeners, transverse frames, transverse webs and other strength members are hence determined, and additionally incorporate a margin of safety within the design.
10. The following flow diagram (Figure 2.5) demonstrates the feed that is populated into the CFD Software (Computational Fluid Dynamics) to determine the scantling strength and dimensions of the primary structural strength members (shell plating, hull girders, longitudinals, transverse floors, etc.) and secondary elements (beams, brackets, etc.). The General Arrangement plan is referenced to superimpose the dimensions of the overall structural composition, i.e., cargo holds, tanks, machinery spaces, superstructures, etc.; all the data from the Hydrostatic Tables in the Trim and Stability booklet are fed into the loading manual or loading computer [Computer Automated Stowage Planning (CASP) program is used by MSC]. The Trim and Stability booklet is an integral part of the ship's mandatory manuals and is ship specific. This manual incorporates different loading conditions including full load with maximum stack weight per slot, conditions without any cargo on board, and other intermediate settings. The bending moments and shearing forces are then computed by introducing wave-induced motions and accelerations in static and dynamic conditions. The effects are studied in relation to the design, and modifications are accordingly executed, in either limiting the tolerances by adjusting the load capacity or exceeding the design to accommodate the stresses the vessel may be subjected to. The design principles for ships in general are executed per the flow diagram, which takes into account the various stringent parameters, essentially for dynamic loads. Having designed the vessels for dynamic conditions, the loads in discussion under static conditions should be able to be handled without causing any damage to the ship's bottom shell or other bottom structural element. The bottom scantlings are designed to provide ample strength. This design feature applied to the bottom scantlings further provides for the ships taking the blocks at the dry-dock facility and may be safely extended to the vessels taking the seabed at the port of Durban.

Figure 2.5 Data fed into the CFD software to design structural elements



2.2.2 Comparison of vessels with NAABSA notation and container vessels

The NAABSA notation is applicable to vessels with rule length of 90m or less. However, vessels calling NAABSA ports do not necessarily have the NAABSA notation. For the NAABSA notation, maximum permissible spacing between the longitudinal side girders should not exceed 4.5m. On container ships, the spacing between the longitudinal side girders is usually 2.4m as these are placed/fitted in way of the container corner pedestals. For the NAABSA notation, the space between the frames is 0.6m-1.5m. On many container ships, this is the case (appended plans of MSC Beatrice with LOA 366m as reference: Exhibit 1 Shell Expansion Plan; Exhibit 2 Docking Plan) Bottom plating thickness must be increased by 10% for NAABSA notation. The bottom shell plating on container ships is constructed with high tensile steel and reinforced for extreme dynamic loads under severe sea-going conditions and hence the strength for the purpose of this study and recommendation is substantial, having due regards to the proposed (negative) UKC of -0.30m to -0.50m as compared to a vessel with NAABSA notation where the construction allows for the vessel to fall completely dry at load displacement. The structural requirements for container vessels are much more stringent when compared to vessels with NAABSA notation. It could well be argued that the vessels with NAABSA notation are < 90m in length and the reinforcement criteria detailed is suitable for the length. However, the ship's length will essentially have a bearing on the dynamic conditions. Under static conditions, with the ship resting on a plane seabed, the load dissemination is comparable, regardless of the ship's length. Under static conditions, container vessels are very suitably designed and reinforced to withstand the pressure, considering the amount of load transference for the purpose of this study, to the seabed, in relation to the displacement of the vessel. The total hypothetical load for the purpose of this study does not exceed 5% of the load displacement at moulded draft, whereas the vessels with NAABSA notation are supposed to withstand the full displacement at the moulded draft. With the structural features similar on the vessels with NAABSA notation and container vessels, there is a significant spare capacity for weight bearing by the seabed, subject to the seabed being plane and homogeneous as is the case with the port of Durban. The stance can be further supported by the fact that the weight of the vessels at a dry dock facility is completely supported by the blocks, the weight being equivalent to approximately 40% of the load displacement at moulded draft.

In summary, the structural integrity of container vessels is of a very high standard, with very stringent requirements from Classification Societies, suitably built to withstand the most complex loads under the most severe conditions as detailed above. The structural integrity is aligned with the dynamic conditions whilst the vessel is at sea and subjected to the various loads discussed earlier. This study is aimed at determining the constructional strength and integrity of the ship's structures, in particular at the ship's flat bottom area. The preceding passages established the structural integrity by highlighting the various building aspects of the ship's bottom shell plating and the design specifications of the primary elements used for reinforcement as per guidelines from the Classification Societies. It can therefore be inferred, if the ship is obliged to take the bottom due to compelling reasons, the structural integrity of the ship will not be jeopardised under the stipulated conditions, specific reference being made to the port of Durban.

2.3 Studies of vessel integrity – MSC Beatrice and MSC Judith

The structural integrity of large, modern container vessels will be explored further in this section by considering the design and characteristics of two container vessels of neo-Panamax dimensions that are typical of the larger generation of recent container callers to the port of Durban. Indeed, both vessels – the larger MSC Beatrice and the somewhat smaller MSC Judith – are vessels that have made container-working calls to the Durban Container Terminal. In each case, a comparative analysis will be presented between the vessel's taking the dry dock blocks during a standard dry-docking exercise and the vessel's safely laying aground on a flat and homogenous surface with specific reference to the port of Durban. The analysis will primarily compare the vessel's displacement that is transferred to the dry dock blocks and to the seabed, with specific reference to the weight-bearing capability of the ship's hull through the ship's flat bottom structure that is the direct interface during the course of these exercises. The flat bottom area of the two ships in question has been measured directly from the ships' Shell Expansion Plan and the Docking Plan extracted from the ships' library. These plans are appended in Exhibits 1, 2 and 3 for reference.

2.3.1 Case 1 MSC Beatrice – Dry Docking Condition versus NAABSA operations

The MSC Beatrice is one of the newer generation neo-Panamax container vessels with a length of 366m and beam of 51m. The vessel's capacity is 13798 TEUs with a Summer Deadweight of 162867MT and a draft of 15.6m at the Summer Displacement.

The following exercise draws out a comparative analysis between the vessel's taking the dry dock blocks during a standard dry-docking exercise and the vessel's safely laying aground on a flat and homogenous surface with specific reference to the port of Durban.

When a ship is in a dry-dock, the entire displacement (weight) of the ship is supported by the wooden or concrete blocks that are strategically placed at the ship's flat bottom. The minimum weight supported by the blocks in the docking condition is the Light Ship Displacement, which in the case of the MSC Beatrice is 46000MT. In order to maintain a minimum required trim during docking, as this is the preferred condition to reduce the critical period, the vessel of the magnitude of the MSC Beatrice, may have to pump in approximately 10000MT of ballast water in the tanks at the fore part of the ship. Critical Period is the interval from the time the ship's stern takes the blocks until the entire keel rests on the block, as the water in the dock is being pumped out. It is termed as a critical period as the stability of the ship progressively reduces until the entire keel takes the dry-dock blocks and therefore it is essential to maintain a minimum required trim to reduce the critical period. At the time the ship takes the blocks, the total displacement supported by the blocks is approximately 56000MT.

The port of Durban has depth limitations at the berths, as a consequence, vessels constrained by draft could possibly be compelled to take the bottom for various reasons as set out above. The seabed at the port of Durban is flat and homogeneous; for a ship taking the bottom, no damages may be anticipated to the ship's hull, in particular the ship's flat bottom structure that is resting on the seabed, if the stipulated precautions are taken in anticipation of the event. This incident could possibly occur during the course of cargo operations at a receding

tide and the landing impact is quite comparable to the vessel that takes the dry dock blocks, slow and soft. As the tide recedes, the weight that is supported by the buoyant upthrust is slowly transferred to the seabed; the maximum weight that could possibly be transferred is equivalent to a displacement of 0.30m to 0.60m (in rare cases). The transition from the ship being completely afloat to taking the seabed is impact free, which the ship's bottom is designed to withstand; it is imperative that the vessel draws even keel at the period this is likely to occur, in order to eliminate any likelihood of damage to the rudder and propeller even though these are constructed clear of the baseline. As illustrated with calculations that will follow, the TPC (tons per centimetre) of the MSC Beatrice, that is the weight required to either increase or decrease the average draft of the vessel by one centimetre, is approximately 150MT at the draft of 13.30m. Considering that weight transferred to the seabed is equivalent to a displacement of 30cm, the weight that is taken off the upward buoyant thrust is equivalent to 4500MT (150MT/cm x 30cm). Considering the weight transferred to the seabed is equivalent to a displacement of 50cm, the weight supported by the seabed is equal to 7500MT (150MT/cm x 50cm). In comparing this to the dry-docking condition, the weight transferred and borne by the seabed is 8% and 13% of the dry-docking conditions, respectively. With these illustrations, it is clearly evident that ships are designed to endure the weight that is transferred as a consequence of resting on the seabed with specific reference to the port of Durban.

MSC Beatrice Docking Calculation

The blocks in a dry-dock facility bear the entire weight of the ship as she emerges completely dry when the water inside the dock is pumped out. These blocks are tactically placed under the flat bottom area of the ship with the position of the blocks being alternated at the subsequent dry docking of the ship, more so for maintenance purposes. Since the weight of the entire ship is now transferred to the blocks through the interface of the flat bottom area, it infers that the flat bottom plate has substantial thickness, and strength, as it is suitably reinforced in way of the precautionary double bottom hull protection design. The following calculations are undertaken to calculate the area of the flat bottom from the Shell Expansion Plan (see Appendix 2.1) using the Trapezoidal Rule [Trapezoid Rule and Simpson's Rule by Donald Kreider and Dwight Lahr, 2010; Trapezoidal Rule by Douglas Wilhelm Harder, 2005]. The Shell Expansion Plan (Exhibit 1) is one of the mandatory plans/drawings carried on board, drawn to a scale. In the case of the MSC Beatrice, the scale used is 1:200, from which actual measurements are extracted in order to determine the flat bottom area. The flat bottom area is deciphered to calculate the pressure acting per unit area of the interfaced bottom structure in a dry dock condition. A comparison of the pressure exerted per unit area of the flat bottom in the dry dock condition with the conditions when the vessels safely take the bottom on a flat and homogenous surface, is undertaken to establish that such an event can be safely executed with reserve endurance capacity, having due regards to the scope of the study.

The area of the flat bottom structure is calculated using Simpson's Rule and the calculations are appended in the Appendix 2.1 along with the respective Shell Expansion Plan (Exhibit 1). The calculated flat bottom area is 5585m² and the displacement (weight) in the docking condition (as shown in Exhibit 2) is 55850MT, which translates into a weight borne per area of square metre in the docking condition of 10 tons.

In the case of the vessel at berth, in a loaded condition, resting on the seabed, let's consider the weight borne by the seabed is equivalent to a displacement of 0.10m or 10cms. This essentially means, if the vessel was loaded to a draft of, for example, 13.40m, on a berth having sufficient water depth to keep the vessel completely afloat, the ship's draft would read 13.40m. But, if the tide recedes and the total depth of water now reduces to 13.30m, the vessel's draft would now read 13.30m as there is insufficient depth to keep the vessel afloat. Part of the vessel's weight that was earlier supported by the buoyant upthrust has now been transferred to the seabed, in this case, a weight equivalent to a displacement of 10cms of immersion. The vessel is now resting on the seabed, i.e., there is no under keel clearance. On a free-floating vessel, at the draft of 13.40m, it would take approximately 150 tons to effect one centimetre of sinkage or rise, i.e., Tons Per Centimetre (TPC) = 150 tons/cm. This essentially implies that if 150 tons is added on the ship (by way of loading cargo, taking ballast water or fuel, stocking up stores or provisions, etc.) the draft will increase by one centimetre or 0.01m. Therefore, with a TPC of 150 tons/cm at the draft of 13.40m, the total weight transferred to the seabed, considering that the present draft is reading 13.30m owing to the receding depth of water, is equivalent to the product of the TPC (150 tons/cm) and the difference between the drafts when completely afloat and when sitting on the seabed (10cms).

$$= \text{Difference in drafts when completely afloat and when sitting on the seabed} \times \text{TPC}$$

$$= 10\text{cm} \times 150\text{tons/cm} = 1500 \text{ tons}$$

Therefore, in the above example, a weight of 1500 tons from the total displacement of 120 000 tons (displacement equivalent to a draft of 13.40m) has been shifted to the seabed. Essentially, the displacement supported by the buoyant force acting upwards is:

$$= \text{Total weight corresponding to a draft of 13.40m} - \text{Weight transferred to the seabed}$$

$$= 120000 - 1500 = 118500\text{tons}$$

Comparing the weight of 1500 tons to the light ship displacement of 46080 tons (the least weight that is borne by the blocks in the dry-docking condition), the percentage is equivalent to $1500/46080 \times 100 = 3.25\%$ of the least weight borne by the blocks in the dry-docking condition.

With a transference of displacement equivalent to 20cm, this percentage increases to 6.5%. With a transference of displacement equivalent to 30cm, the percentage is less than 10%. Even if the weight borne by the seabed is equivalent to a displacement of 60cm of sinkage or immersion, which is the maximum that may be dispensed through the flat bottom structure for the purpose of this study as explained in Chapter 4, the apportioned force exerted does not exceed 20%. So, in all these cases a small proportion of force associated with an instance of safe dry-docking would be encountered.

Consider a displacement equivalent to an immersion of 10cms, i.e., 1500 tons is transferred to the seabed as the vessel takes the bottom. This essentially means that the flat bottom area of the ship that has interfaced with the seabed is subjected to a weight bearing of 1500 tons. This weight is distributed across the entire flat bottom surface area of 5585m² (as calculated

above). Therefore, the weight distributed per unit area, one square metre is = $1500/5585 = 0.269 \text{ tons/m}^2 = 269\text{kgs/m}^2$

Now, let's consider a transference of weight equivalent to an immersion of 30cm, i.e., 4500tons.

The weight of 4500tons is distributed across the entire flat bottom surface area of 5585m^2 .

The weight distributed per unit area, i.e., one square metre is = $4500/5585 = 0.806 \text{ tons/m}^2 = 806 \text{ kgs/m}^2$

Essentially, the weight borne by a unit square metre area (1m^2) of the ship's flat bottom ranges between approximately 250kgs to 800kgs, for 10cm and 30cm immersion respectively, whereas the design weight bearing strength per unit square metre area (1m^2) of the flat bottom at the time of dry-docking is 10000kgs/m^2 , leaving a huge scope for further endurance.

Comparison with a flat rack shipping container for better understanding as this is a much familiar weight bearing equipment

Distribution of load

To draw out relevance, compare this with a 6 metre or 20 feet equivalent unit of a flat rack shipping container which has been tested and certified to safely carry a payload of 30140kgs.

The surface area of this flat rack = length x breadth = $6\text{m} \times 2.4\text{m} = 14.4\text{m}^2$

Weight bearing capacity per square metre unit area (1m^2) of a flat rack container.....

= $30140/14.4 = 2093\text{kgs/m}^2$

In comparison, as per above inference, the weight borne per unit area (1m^2) of the ship's flat bottom ranges between 250kgs/m^2 to 800kgs/m^2

Subjection to impacts and shocks

Further, a loaded flat rack is further subjected to severe impacts and shocks during loading and discharging operations. Despite this, there is no damage or deformation to the flat rack container. The corner posts of the flat rack are the weight and impact bearing points. The bottom rails of the flat racks assist with weight distribution across the entire flat rack container. The flat rack corner posts can be compared to intersection of longitudinal girders and transverse frames that are constructed under each rest pad for the corner posts of the containers on the tank top in the cargo holds, to reinforce the load bearing region and evenly distribute the weight along the tank top and bottom structures.

In comparison, the flat bottom of the ship when compelled to take the seabed is free of impact and shocks.

Comparison of the weight density of an empty flat rack with the ship's bottom plate

The weight of the unit square metre area (1m^2) of an empty flat rack is as shown below.

Tare weight of the 6m/20ft flat rack shipping container = 2360kgs

Area of flat rack shipping container = $6\text{m} \times 2.4\text{m} = 14.40 \text{ m}^2$

Cross sectional weight of a flat rack shipping container per unit area = $2360\text{kgs}/14.40 \text{ m}^2 = 164\text{kgs}$

Weight of the cross-sectional unit area (1m^2) of the ship's bare bottom plate only (without any reinforcements/stiffeners), which for the MSC Beatrice is 25mm thick (Shell Expansion Plan)

$$\begin{aligned} &= \text{length} \times \text{breadth} \times \text{thickness} \times \text{density of steel} \\ &= 1\text{m} \times 1\text{m} \times 0.025\text{m} \times 8050\text{kgs/m}^3 \\ &= 201\text{kgs} \end{aligned}$$

Consequently, the unit area of a flat bottom plate of the ship, without any reinforcement, is denser than the flat rack container (including reinforcement), whereas the flat rack container is subjected to greater loads per unit area,

In conclusion, as elucidated, it is clear that if the ship is compelled to take the seabed to the extent sought above, there will be no damages to the hull, whatsoever. This can be inferred from the comparison made with a flat rack shipping container, whereby the bottom structure of the ships is constructed of solid steel and denser in composition. In comparison, the ship's flat bottom structure is subjected to substantially lesser loads per unit area. Besides, the flat rack container unit is subjected to severe impacts and shocks as compared to the ship's structure whereby the impact is subtle and soft for the purpose of the study undertaken. This comparative analysis demonstrates beyond doubt the strength and endurance capability of the ship's bottom structure, and consequently also the suitability of the vessel to take the bottom if compelled to.

The flat bottom area of the MSC Beatrice, as calculated from the Shell Expansion Plan, is 5585m^2 . An even distribution of weight ranging between 1500 tons to 4500 tons (as per the above exercises of considering a transference of displacement equivalent to 0.10m and 0.30m as the vessel takes the bottom) across the entire cross-sectional area of 5585m^2 , essentially means that a unit square metre area is subjected to a load ranging between 0.25 tons to 0.8 tons per unit area, on a flat high tensile steel plate of grade AH36 (refer to Table 2.1), 25mm plate thickness, weighing 0.20 tons, suitably reinforced with carefully designed strength members. If the load distribution is compared to the Docking Condition, wherein the entire flat bottom structure of the MSC Beatrice is designed to withstand a load of approximately 50000 tons, the weight that is borne by the dry dock blocks is significantly higher when compared to the load that the ship's bottom structure is subjected to for the purpose of this study, when the ship may be compelled to take the seabed that is characterised by a soft, flat, and homogenous surface. There will be no damaging impact on the ship's hull structurally, as there is a substantial reserve endurance capacity as inferred from the comparisons made.

The steel used for construction of the newer generation ships is of the AH36 grade (Shell Expansion Plan of the MSC Beatrice appended for reference as Exhibit 1). The AH36 grade of steel is of a high tensile quality that has a better strength when compared to general steel strength and are used in the region where high stresses are experienced. With the ships increasing in length, the requirement of this grade of steel has become imperative as the vessels of greater length are subjected to flexing in the longitudinal direction in a seaway, especially when resultant waves of varying magnitudes are experienced. This grade of steel (Table 2.1) is comparatively more "tough" possessing a better range of ductility, has a comparatively higher yield point, $\geq 355\text{MPa}$ and a tensile strength between 490-620 MPa.

Table 2.1 - Mechanical Properties of the different grades of Steel

Mechanical Properties							
Steel Grade	Thickness/ mm	Yield point/ MPa	Tensile strength/ MPa	Elongation/ %	V-type impact test		
					Temperature/ °C	Average impact absorption work A_{KV} /J	
						Vertical	Horizontal
A	≤50	≥235	400~490	≥22	-	-	-
B	≤50	≥235	400~490	≥22	0	≥27	≥20
D	≤50	≥235	400~490	≥22	-10	≥27	≥20
E	≤50	≥235	400~490	≥22	-40	≥27	≥20
AH32	≤50	≥315	440~590	≥22	0	≥31	≥22
DH32	≤50	≥315	440~590	≥22	-20	≥31	≥22
EH32	≤50	≥315	440~590	≥22	-40	≥31	≥22
AH36	≤50	≥355	490~620	≥22	0	≥34	≥24
DH36	≤50	≥355	490~620	≥22	-20	≥34	≥24
EH36	≤50	≥355	490~620	≥22	-40	≥34	≥24

(Source: OCTAL - AH36, DH36, EH36 High Strength Ship Building Steel Plate)

The Charpy Impact test (Basic principle and practical procedure of the Charpy Impact test, 2013) indicates the energy absorption is 34J, thus endorsing the values of a higher yield point and tensile strength, which in essence means there is a better balance obtained between the hardness and toughness, consequently addressing the brittleness of such grades of steel. This is achieved by controlling the Carbon composition (Table 2.2), which is controlled and limited to $\leq 0.18\%$ in such grades of steel. Carbon is a very important element, critical to the hardness of steel; high quantities of carbon render the metal brittle, hence the presence of carbon is controlled to strike the correct balance between the “hardness” and “toughness”. The other elements such as Manganese, Phosphorus and Sulphur contents are also appropriately controlled. The AH36 grade of steel is further subjected to micro-alloying by adding Niobium, Vanadium and Titanium to increase the strength and toughness that contributes towards the high tensile characteristics of the steel.

Table 2.2 – Chemical composition of different grades of Steel

Elements	C	Mn	Al	Si	P	S
AH32	≤0.18	0.7~1.60	≥0.015	0.10~0.50	≤0.04	≤0.04
DH32	≤0.18	0.90~1.60	≥0.015	0.10~0.50	≤0.04	≤0.04
EH32	≤0.18	0.90~1.60	≥0.015	0.10~0.50	≤0.04	≤0.04
AH36	≤0.18	0.7~1.60	≥0.015	0.10~0.50	≤0.04	≤0.04
DH36	≤0.18	0.90~1.60	≥0.015	0.10~0.50	≤0.04	≤0.04
EH36	≤0.18	0.90~1.60	≥0.015	0.10~0.50	≤0.04	≤0.04

(Source: OCTAL - AH36, DH36, EH36 High Strength Ship Building Steel Plate)

Owing to a comparatively higher yield point ($\geq 355\text{MPa}$), the material has a better range for correction, should there be any deformation (when subjected to stress) up to the yield point. Given the higher tensile strength, the metal will have greater endurance prior to a fracture. It is crucial to note, this grade of steel can withstand an elongation of $\geq 22\%$, which is substantial, before a fracture could occur. These characteristics of the AH36 grade of steel clearly demonstrate its suitability in withstanding the external pressure without any deformation or damage to the ship's hull, specifically the ship's bottom that has been assumed to interface with the seabed at the Port of Durban, should the ship be compelled to take the bottom (OCTAL - AH36, DH36, EH36 High Strength Ship Building Steel Plate).

Consider a steel rod of grade AH36 (Image 2.2), being subjected to a forced elongation in the test machine (Image 2.3).

Yield stress is expressed in Force/Unit area = Newtons/ mm^2

Yield Point of Steel Grade AH 36 is $\geq 355\text{MPa}$

1 MPa = 1 Newton/ mm^2

Therefore, 355 MPa = 355 N/ mm^2

Consider the cross-sectional area to be 1mm^2

Therefore, the Force applied = 355N for a cross sectional area of 1mm^2 , which is a significant force applied considering the cross-sectional area of 1mm^2

Image 2.2 Steel Rod of Grade AH36 (Test sample)



(Source: Tension Test on Steel Rod – Procedures and Results; Tensile Test – MaterialsScience2000)

Image 2.3 Rod subjected to elongation in a Testing Machine



(Source: Tension Test on Steel Rod – Procedures and Results; Tensile Test – MaterialsScience2000)

When subjected to an elongation with the application of force, the metal rod of this particular grade of steel will elongate until a force of approximately 355N is applied. When the tension is released the metal rod will regain its original size, thus retaining its elastic properties and returning to its normal shape. If the rod is further subjected to an applied force beyond approximately 355N, the rod will continue to elongate, but will lose its elasticity and remain permanently deformed. This loss in elastic property, being the causation of permanent deformity, continues until the application of an external force ranging between 490N and 620N, beyond which, upon further application of force, a fracture will occur. The range from the yield point (approximately 355N) to the point whereby the fracture in the steel rod is initiated (between 490N and 620N) is defined as the tensile range, beyond which a fracture will occur. The properties of AH36 grade of steel allows for an elongation of approximately 22%. This clearly defines the endurance strength of the AH36 grade of steel, and endorses the properties of hardness and toughness, whilst specific reference is made to sitting on the seabed at the port of Durban (OCTAL - AH36, DH36, EH36 High Strength Ship Building Steel Plate).

2.3.2 Case 2 MSC Judith – Dry Docking Condition versus laying safely on the seabed during continuous cargo operations

MSC Judith is a post-Panamax/early generation neo-Panamax container vessel with a length of 325m, a maximum beam of 43m and a carrying capacity of 8034 TEU. She has a Summer Deadweight of 105083MT drawing a maximum draft of 14.5m at the summer marks.

In the coverage that follows, the docking condition of MSC Judith is detailed with the intention to compare this with the NAABSA exercise, whereby the ship safely sits on the seabed, when compelled to do so. Broadly, there are two motives, the first being to conclude with reason that it is completely safe to do so, and secondly to continue loading or discharging operations uninterrupted, regardless of the fact that the vessel will seek the bottom or safely lie aground during the course of cargo operations.

Load cycle

On the loading cycle, cargo operations could continue, irrespective of the vessel sitting on the seabed, as it is deemed completely safe to do so, until the vessel is loaded to the intended departure draft which is pre-calculated. The intended departure draft will have to be calculated by taking into consideration, 1) the height of tide (H.O.T.) at the high tide of the date this operation is expected to be effected; and 2) the required/TNPA-stipulated UKC, for the vessel to sail. On the basis of the pre-calculated departure draft, the quantity of cargo that needs to be planned for loading is determined. Cargo operations may continue uninterrupted, without the need to stop-start, if the stipulated requirement by TNPA with reference to UKC, whilst at berth, is dispensed with, to the extent that the vessel is permitted to safely sit on the seabed during the course of the load cycle. In doing so, the sailing delays will be minimised by eliminating stop-start operations, and as a consequence the vessel can be optimised/loaded to the maximum permissible sailing draft aligned to the highest tide of the day.

Discharge cycle

Similarly, on the discharge cycle, the vessel can arrive and berth with a draft aligned to the highest available tide of the day, maintaining the mandatory UKC, with sufficient safety margin, preferably on a rising tide. Thereafter, upon commencement of the discharge operation, if the rate of discharge is not quick enough to lighten the vessel and hence does not correspond to the required reduction in draft, consequent to which the vessel might be briefly compelled to take the bottom, it is deemed safe to do so.

In due consideration of the vessel's carrying out the above operation, taking the bottom, the weight transferred to the seabed is not likely to exceed the displacement equivalent to approximately 50cms or 0.50m of sinkage, equivalent to approximately 18% of the light ship displacement which is the minimum weight borne by the dry-dock blocks in a dry-docking operation.

The flat bottom area of the MSC Judith is calculated from the Docking Plan (Exhibit 3) by using the trapezoidal rule; the details of the calculations are shown in Appendix 2.2 along with the Docking Plan itself which is appended for reference. The vessel's displacement or weight borne by the dry-dock blocks is extracted from the Docking Plan and hence the weight disseminated per unit metre area of the flat bottom is calculated.

The strength of the ship's hull in sustaining a critical NAABSA operation at the port of Durban is assessed by cross-referencing the weight disseminated through the ship's flat bottom structure in both cases, i.e., dry-dock and NAABSA operation.

MSC Judith – Dry-docking condition

Displacement at dry-docking condition (as per the Docking plan, Exhibit 3) = 39284 tons

The flat bottom area has been calculated from the superimposed docking plan sections between the frames (as per Appendix 2). The profiles of the various sections are so chosen such that they are either triangular, rectangular, or trapezoidal.

The total flat bottom area = 4287m^2

Therefore, a weight of 39284 tons is supported by a flat bottom area of 4287m^2

Weight distribution per square meter in the docking condition = $39284/4287 = 9.2 \text{ tons/m}^2$

Cross referencing with the docking condition

A comparative analysis of a hypothetical situation with the vessel sitting on the seabed with UKC of -10cm, -20cm, -30cm, -50cm, respectively, is presented here.

The “negative” under-keel clearance referred above represents the weight equivalent to the displacement of 10cm, 20cm, etc., that is transferred to the seabed by virtue of the vessel sitting on the bottom. To further clarify, if the vessel had to be completely afloat, the drafts would read as 10cm, 20cm, etc., higher, under similar conditions of displacement respectively. Therefore, technically the UKC is zero in all the above conditions; the negative UKC is relevant to the transference of displacement equivalent to an immersion of the ship by 10cm, 20cm, etc.

Consider a sinkage of 120 tons per centimetre (TPC), at a draft of 13.30m

At UKC of -10cm, the displacement transferred to the seabed will be 1200tons; at this UKC the weight bearing per square meter unit $1200/4287 = 0.28\text{tons/m}^2$

At UKC of -20cm, the displacement transferred to the seabed will be 2400tons; at this UKC the weight bearing per square meter unit $2400/4287 = 0.56\text{tons/m}^2$

At UKC of -30cm, the displacement transferred to the seabed will be 3600tons; at this UKC the weight bearing per square meter unit $3600/4287 = 0.84\text{tons/m}^2$

At UKC of -50cm, the displacement transferred to the seabed will be 6000tons; at this UKC the weight bearing per square meter unit $6000/4287 = 1.40\text{tons/m}^2$

The plate thickness at the ship’s bottom (MSC Judith) is 23mm

As it is clear from the above, the displacement supported by the seabed is between 3% and 15% of the displacement supported by the concrete blocks in the docking condition, for a transference of buoyant upthrust up to 50cm; this demonstrates a substantial available scope for transference of weight when compared to the docking condition.

It is significant to note that the vessels are placed on the dry-dock blocks for extended periods running into several days as compared to vessels under NAABSA operation, which sit on the seabed only for a few hours when alongside a cargo berth. There is a significantly greater possibility of a structural deformity whilst the vessel is placed on the dry dock blocks for such lengthy periods, yet this isn’t the case. There is indeed a temporary infinitesimally small structural deformity, depending on the number of days the vessels lie on the blocks, due to being subjected to unbalanced forces, which corrects itself when the vessel is rendered afloat. In comparison, the vessels taking the bottom during the progression of a cargo operation may do so for a maximum period of approximately eight hours during the course of low water, considering the phenomenon of semi-diurnal tides at the port of Durban. The semi-diurnal tides generally assist with the immediate relief of stresses that the vessel may be subjected to, during the course of this (NAABSA) operation.

2.4 Grounding Incidents

Some further perspective on the circumstances encountered by vessels sitting temporarily on the seabed during the course of cargo operations in the port of Durban may be gleaned from a consideration of the consequences of vessels experiencing unplanned grounding incidents while underway. These also indicate the demonstrable safety of permitting modern container vessels to take the bottom while conducting cargo operations. In the events listed below, it is of significance to note that the vessels were making way through the water using engines and were laden at the time of the incident. This implies that the vessels would have been subjected to a severe impact and high stress. Despite this, the vessels were able to survive these incidents with little or no notable damage to the ships' hulls, once again demonstrating the structural strength and constructional integrity of modern vessels to withstand the perils encountered at sea. Six such incidents are set out briefly below.

Leda Maersk

The Leda Maersk is a fully-cellular container vessel registered in Denmark with length of 266m, maximum beam of 37m, Gross Registered Tonnage of 50688, and Summer Deadweight 63200 tons. On 10 June 2018, the ship was bound for the port of Otago in New Zealand, drawing 10.80m even keel. With the pilot on board, negotiating the final bend before approaching the berth, the vessel drifted to the port side of the channel. The vessel was proceeding at 6 knots at the time and eventually ran aground. Engines were ordered to stop; the ship heeled over to starboard. Upon establishing the ship was aground, the pilot instructed the tugs to pull the vessel, and with the assistance of the bow thruster she was refloated and subsequently berthed. Divers were organised to inspect the ship's hull for any damages; the inspection revealed superficial paint abrasion without any damage to the ship's hull whatsoever.

Inference: The vessel was steaming at 6 knots at the time of the incident and therefore there was quite a significant impact. Additionally, the vessel was ordered to be pulled out with the assistance of tugs and bow thruster; this operation would certainly subject the bottom structure of the vessel to considerable stresses. Despite the impact and stresses, the vessel sustained only superficial paint abrasion. The propeller and rudder were undamaged.

(<https://taic.org.nz/sites/default/files/inquiry/documents/MO-2018-203%20Final.pdf>;
Transport Accident Investigation Commission, Report MO-2018-203)

Gustav Maersk

The Gustav Maersk is a VLCS registered in Denmark with length of 367m, maximum beam of 43m, Gross Registered Tonnage 99002, and Summer Deadweight 127015 tons.

On 10 January 2017, the Gustav Maersk was on a voyage from Rijeka, Croatia to Gioia Tauro, Italy, scheduled to take pilot at Torre Cavallo, North of Messina Strait. Whilst manoeuvring to pick up the pilot, and following a mechanical failure, the vessel ran aground on rocks. The ship was re-floated using two tugs. Full details are not available, but it is credible to note that there was no breach to the ship's hull, and after being re-floated proceeded to Gioia Tauro, where an interim inspection at the anchorage concluded that there was no breach to the ship's hull, nor any damage to the rudder or propeller even though this was an incident that involved an impact with the rocks [[https://www.vesselfinder.com/news/8232-Container-ship-Gustav-Maersk-refloated-after-grounding-at-Torre-Cavallo-Messina-Strait-;](https://www.vesselfinder.com/news/8232-Container-ship-Gustav-Maersk-refloated-after-grounding-at-Torre-Cavallo-Messina-Strait-;https://gcaptain.com/maersk-containership-grounds-in-southern-italy/)
<https://gcaptain.com/maersk-containership-grounds-in-southern-italy/> (gCaptain)]

Maersk Garonne

Maersk Garonne is container vessel registered in Singapore with length of 292m, maximum beam of 32.3m, Gross Registered Tonnage 50757, and Summer Deadweight 61636 tons.

On 28 February 2015, at the port of Fremantle, the harbour pilot boarded the vessel to assist the vessel into the inner harbour. As the vessel approached the entrance channel to the inner harbour, the pilot anticipated that the tugs would not arrive in time and hence decided to take a detour and consequently grounded the vessel. The vessel was re-floated later, on a rising tide. However, no damage to the vessel's hull was noted due to this incident. Here again, the vessel was under propulsion at the time the incident occurred with the impact being significant; despite this, there was no damage to the ship's hull [[https://www.atsb.gov.au/media/5302244/MO-2015-002-PRELIMINARY.pdf;](https://www.atsb.gov.au/media/5302244/MO-2015-002-PRELIMINARY.pdf;https://gcaptain.com/preliminary-report-maersk-garonne-grounding-in-fremantle-wa/)
<https://gcaptain.com/preliminary-report-maersk-garonne-grounding-in-fremantle-wa/> (gCaptain)]

K-Wave

K-Wave is container ship registered in United Kingdom with length of 133m, width of 19m, Gross Registered Tonnage 7170, and Deadweight 8508 tons.

On 15 February 2011, whilst the vessel was on a passage from Algeciras to Valencia, she ran aground 13nm East of Malaga, South of Spain. At the time of the incident, the vessel was steaming at full navigational speed. The Spanish authorities boarded the vessel for inspection and found no signs of damage. This was later confirmed by the Classification Society that there was no damage to the ship's hull, except for paintwork and the vessel was allowed to resume her voyage (<https://www.safety4sea.com/wp-content/uploads/2014/09/pdf/MAIB-%20Grounding%20of%20K-Wave.pdf>; MAIB Accident Report Number18/2011).

APL Vanda

APL Vanda is a ULCS with a length of 398m and beam of 51m. Vessel is registered in Singapore with a Gross Tonnage of 169423 and Summer Deadweight of 177408 tons.

On 14 February 2016, APL Vanda, had to be “intentionally grounded” in a controlled grounding incident after it lost power at the West Bramble Bank in the Solent. She was stuck on a sand bar between Cowes, the Isle of Wight and Southampton and was later re-floated using eight tugs. No damage or pollution was reported following the incident.

[<https://www.maritime-executive.com/article/container-ship-executes-controlled-grounding>; <https://gcaptain.com/another-megaship-apl-vanda-aground-in-europe/> (gCaptain)]

CMA CGM Vasco da Gama

CMA CGM Vasco da Gama is a ULCS with a length of 399m and beam of 54m. She is registered in Malta. She has a capacity of 17859 TEUs. Her Gross Tonnage is 179922 and her Summer Deadweight is 184700 tons.

In the early hours of 22 August 2016, the CMA CGM Vasco da Gama grounded on the western side of the Thorn Channel at the approaches to the port of Southampton. The vessel was close to a fully-laden condition drawing a draft of 13.75m. The ship ran aground on a flat shingle seabed and was re-floated relatively quickly with the assistance of tugs and the ship’s engines on the rising tide. As per the report from the Marine Accident Incident Branch (MAIB), the vessel was unable to maintain the rate of turn within the dredged Thorn Channel, failing to negotiate the bend, resulting in the incident. However, the report further stated that the vessel did not endure any damage to the hull despite the heavily laden condition and severe impact. (MAIB Accident Investigation Report Number 23/2017)

2.5 Conclusion

Despite limitations, progressive ports in the world adapt and plan around the confines these ports may be exposed to. This practice of adaptation may be extended to the port of Durban, whereby the port is constrained currently in handling deep-drafted vessels. Developments of the port’s marine infrastructure have failed to keep pace with the evolution of the newer generation of container ships. Although there are plans to develop the port to cater to the latest generation of container vessels in the near future, as an immediate remedy, a mitigating strategy is vital to optimise cargo liftings and dampen the direct or indirect impact on the economy of South Africa. These economic consequences will be addressed in the next Chapter. In accepting the concept of NAABSA and approving the operation at the discretion of the shipping lines, this impact may be considerably compensated. In overall terms, what this Chapter has sought to demonstrate is that modern container vessels seeking to undertake NAABSA exercises at the port of Durban may do so quite safely, given both the demonstrable structural integrity of the vessels, and the physical attributes of the seabed alongside the port’s container berths. Permitting modern container vessels to take the bottom while conducting cargo operations in the DCT has consequently been shown not only to make navigational and ship-handling sense, but also to facilitate a continuous cargo-working opportunity, and consequently to increase the efficiency of the port.

CHAPTER THREE

EROSION OF TRANS-SHIPMENTS THROUGH SOUTH AFRICA

South Africa could incontestably be promoted as a major transshipment hub for container traffic in the Southern African region, and beyond. The potential is phenomenal and should certainly be explored to give an impetus to the South African economy. Given the supremacy of its geographical location in the de compelled to call South African ports owing to the substantial volumes of local imports and exports, this implies that ships that carry gateway cargoes can indeed also be deployed to mobilise the trans-shipment cargo. The major trans-shipment ports like Singapore, Hong Kong, Colombo, Port Louis, Antwerp, Rotterdam, etc., have been predominantly developed to handle trans-shipment cargo with quite limited and at times almost negligible gateway volumes. In contrast, South Africa handles a significant amount of local cargo, which essentially places our ports in a better position to boost trans-shipments without additional investments, utilising the existing infrastructure. Of course, in order to impress upon the shipping lines to explore this option, it is essential to instil confidence and demonstrate capacity ahead of demand, and the only way to achieve this is to draw efficiencies into the ports system. The South African ports should be viewed as a comprehensive system complementing each other. With state-of-the-art equipment comparable to any other developed ports in the world, the terminals should be able to project South African ports as a favoured trans-shipment hub. The principal objective of this chapter will be to explore these trans-shipment opportunities, the impediments that may challenge their full exploitation, and the benefits that may be foregone should trans-shipment opportunities not be seized.

The draft restrictions in Durban combined with the inefficiencies within the South African Ports system have imposed major impediments in exploring the South African ports as a trans-shipment hub, which also has a far-reaching impact on the economy of the region. Consequently, various plans have had to be advanced on the part of carrying lines and shippers alike, to re-direct the historic trans-shipment connections that were originally executed via South African ports to other regional trans-shipment hubs.

What follows is an account of the gradual methodical strategy adopted by Mediterranean Shipping Company (MSC), the biggest single carrying line serving the South African ports, to do just this. It demonstrates the strategies adopted by MSC, in mitigating the continual issues encountered at the port of Durban, namely the depth constraints further compounded by inefficiencies within the terminal, as a result of which, vessels are not able to utilise the available capacity (unable to load to the loadable summer draft) due to draft limitations in Durban. Further, due to congestion and uncertainties around berthing prospects, vessels cannot be optimised; cargo intake has to be adjusted to the least possible draft in order to accommodate for a wide range of berthing dates, in a bid to ensure the opportunity for berthing is availed under all circumstances, regardless of the tide, bearing in mind that cargo has to be planned much in advance from the previous ports.

MSC offers services to world-wide destinations and operates a diverse range of services from the South African ports, prominent of which are the services to ports in Europe, Far East, Middle East, and Indian subcontinent. Other services offered from South Africa are to the east and west African ports, as well as the Indian Ocean islands via Port Louis. This wide network of operations opens varied avenues for trans-shipments and places South Africa in a strategic geographic location to execute these connections. In Sections 3.1 to 3.4 below, several of these services will be dealt with, with specific focus on the services that presented trans-shipment opportunities to South African ports. To this effect, vessels deployed on the following services will be discussed in some detail to analyse the potential earnings and the impact to the South African economy. These are:

1. **INGWE service** - This rotates between ports in the Middle East, the Indian sub-continent, the Far East, Port Louis and South African ports. Relative to this service, an account, more specifically on the cargo that was earlier trans-shipped through South African ports will be detailed. A major setback was perceived when alternative strategies were undertaken to re-route, predominantly the Mozambique and East Africa cargo, via Mundra, Colombo and Port Louis. This strategy was achieved by introducing additional services or extending the existing services as detailed in 3.1, below.
2. **East Africa Express service** – This service is essentially an extension of the East Africa/ Mozambique service, with the East Africa Express calling Mundra and Colombo in addition. The original port rotation was Coega – Durban – Maputo – Beira – Mombasa – Dar es Salaam and back. Having introduced an extended service to Mundra and Colombo, the trans-shipments on the north bound voyage were routed through the ports of Mundra and Colombo. Likewise, the cargo for the East African and the Mozambican ports was directly loaded on this service from Mundra and Colombo. The trans-shipments on both legs, north and south bound were originally executed via South African ports. This service is discussed more fully in 3.2, below.
3. **Angola Service** – This service has been continually evolving and linked to the evolution of other major services. Essentially, this service shuttles between the South African ports and West African ports, as discussed in 3.3, below.
4. **Cheetah service** – This service, discussed in 3.4, below, plying between the Far East and South Africa, was in existence up to 2015. The service was subsequently replaced by the Africa Express service and later the INGWE service. In 2013 an event of note illustrates how trans-shipment volumes that were motivated to be executed through the port of Ngqura (South Africa) were eventually reinstated back to its original routing. Huge trans-shipment volumes averaging roughly 7000 TEUs per week were generated, as the cargo for the west African ports was diverted on the Cheetah service to be trans-shipped through the port of Ngqura. This cargo was feedered using the South Africa-West Africa (SAF-WAF) service that was introduced for the purpose. These additional volumes could not be handled by the port, inducing serious inefficiencies due to high stack occupancy and a multiplier effect. The vessels incurred massive delays thus prompting the principals to re-divert the volumes to their earlier routing.

5. **Africa Express** – This service replaced the Cheetah service for the export leg out of South Africa. The vessels deployed on this service arrived Durban from Lome (Togo) and proceeded to the Far East. Neo-Panamax vessels were deployed on this service. As shown in 3.5.2, below, the vessels incurred huge recurring delays due to port congestion and inefficiencies, as a result of which it became progressively unsustainable to retain this service on the South African loop. The elimination of this service triggered a series of measures to be undertaken for the trans-shipment cargo as set out below. The trigger for the conception of the East Africa Express was partly the discontinuation of the Africa Express service, which created a void for the Far East cargo arriving from the East African and the Mozambican ports. This cargo could now be trans-shipped through Mundra and Colombo.

Revenue/earnings implications associated with phased changes in these principal services, and most notably estimations of revenue streams that may be foregone by TPT and the TNPA as a consequence of any of these service or port-sequencing changes, are all based on the ruling Transnet tariff for trans-shipment containers, which is set out below:

Table 3A Transnet tariff structure: South African tariff for containers in transit

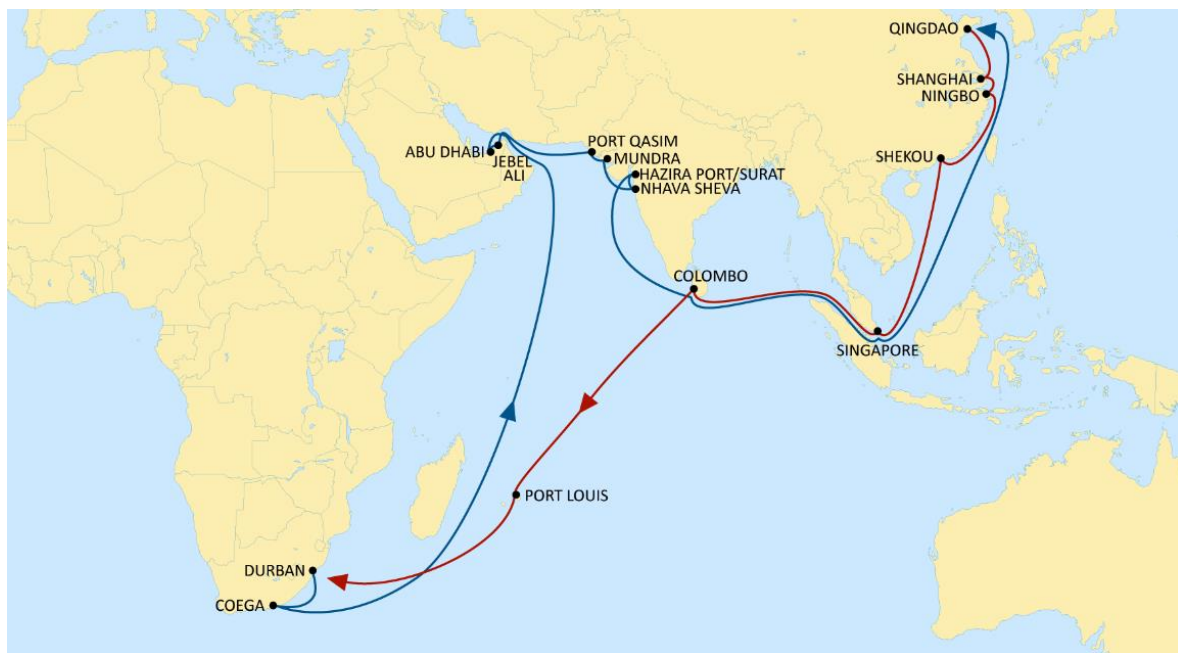
Transshipment cost at South African ports for a 20' unit (full or empty)
 = ZAR 1980 (inwards) + ZAR 1980 (outwards)
 Cargo dues for 20' unit = ZAR 76.95 (in) + ZAR 76.95 (out)
Total cost to tranship a single 20' unit = ZAR 1980 + ZAR 1980 + ZAR 76.95 + ZAR 76.95
= ZAR 4113.90

Transshipment cost at South African ports for a 40' unit (full or empty)
 = ZAR 2924 (inwards) + ZAR 2924 (outwards)
 Cargo dues for 40' unit = ZAR 153.88 (in) + ZAR 153.88 (out)
Total cost to tranship a single 40' unit = ZAR 2924 + ZAR 2924 + ZAR 153.88 + ZAR 153.88
= ZAR 6155.76

(TRANSNET PORT TERMINALS TARIFFS APRIL 2020; TRANSNET NATIONAL PORTS AUTHORITY TARIFFS APRIL 2020)

Going forth, this exercise seeks to quantify the loss in potential earnings incurred by Transnet (revenue that is no longer earned), on the basis of the business rescue strategies adopted by a single shipping line as deemed necessary. In order to quantify these losses, the Transnet tariff structure displayed in Table 3A will be applied.

3.1 INGWE service



Source: MSC

MSC's INGWE service loads out of the Middle East, Indian sub-continent, Far East and Indian Ocean Islands for South Africa. The routine port rotation is Durban – Coega – Abu Dhabi – Jebel Ali – Bin Qasim – Nhava Sheva – Mundra – Colombo – Singapore – Far East (Qingdao – Shanghai – Ningbo – Shekou) – Singapore – Colombo – Port Louis – Durban – Coega. Of note is that the vessels are scheduled to call Colombo twice on the INGWE service. On the first Colombo call, all the cargo loaded from the Middle East and the Indian sub-continent for South Africa and via South Africa is discharged. This cargo for and via South Africa, that is discharged on the first call Colombo, is loaded/trans-shipped back on another vessel deployed on the INGWE service, returning from the Far East on the second call Colombo. This additional trans-shipment is executed in Colombo in order to provide better transit times as well as better management of capacity and stowage on this route. In essence, the cargo on the INGWE service for and via South Africa, is loaded:

1. directly out of the Far Eastern ports;
2. from Colombo, the cargo from Middle East and Indian sub-continent is shipped (cargo discharged on the first call of the INGWE service is shipped on the earlier INGWE vessel arriving from the Far East on the second call); and
3. from Port Louis, for the cargo trans-shipped from Indian Ocean Islands.

A significant amount of cargo is available from these ports for Mozambique, Angola, Namibia, Europe (from Indian Ocean Islands [IOI] via Port Louis), and the United States, that can be routed via South African ports.

3.1.1 Shift of trans-shipment via Colombo and Port Louis

On the MSC's **present** INGWE service, the cargo is shipped to South Africa, predominantly from the Indian sub-continent ports and the Far East ports. Earlier, prior to 2018, there were independent services, one from the Middle East and the Indian sub-continent ports and the other from the Far East into South Africa. These services have since been combined into the INGWE service. Regardless of the services, besides shipping local cargo for South Africa, cargo for East Africa, Mozambique, Namibia, Angola, USA and Europe (primarily from Port Louis) was being trans-shipped via South African ports as MSC had direct services from South Africa.

3.1.2 Trans-shipment to Mozambique and East Africa

Significant volumes of cargo to Mozambique and fairly substantial volumes to East Africa were being trans-shipped via South African ports. The final leg of the INGWE service is Singapore – Colombo – Port Louis – Durban – Coega. Since Durban is the first port of call in South Africa, the vessels could not be utilised to their full design capacity due to draft constraints. Secondly, the congestion at the South African ports at the time was quite extensive, with vessels having to wait for a berth between five and ten days on an average. This was the result of a combination of factors, including extremely low productivity partly due to inefficiencies arising from lack of resources, both personnel and equipment. Consequently, the following strategies were initiated, in order to find collective solutions that would address the issues encountered, i.e., the draft constraints and to mitigate delays to trans-shipment cargo.

3.1.2.1 Cargo connections - Nacala

All the cargo from the Indian sub-continent, Far East ports and the cargo trans-shipped in Colombo for the port of Nacala, Mozambique, loaded on the INGWE service is now being discharged in Port Louis. All this cargo was earlier routed via South African ports, but alternate arrangements were made to handle the cargo to and from Nacala differently. A feeder service was introduced between Port Louis – Nacala – Port Louis in October 2019. This had dual repercussions, as all the cargo originating from the port of Nacala for various destinations had originally been trans-shipped via South African ports. This cargo was subsequently routed via Port Louis. This service continues to remain in operation. Nacala was specifically chosen as this is the only port in the East Africa-Mozambique service loop that necessitated the deployment of a geared vessel. Essentially, it seemed to be less complicated to deploy a handy-sized geared vessel between Port Louis – Nacala – Port Louis, the service being called the Indian Ocean Island Relay Service 2. The introduction of a new service meant additional geared vessels had to be deployed. Of course, this also meant additional costs, but this strategy unquestionably outweighed the cost, and most importantly the service reliability was reinstated. The consequential loss in TEUs for South Africa for the entire calendar year 2020, is set out in in Table 3.1 and 3.2.

Cargo loaded from Nacala for trans-shipment in Port Louis

The cargo loaded from the port of Nacala for the various destinations has been separately categorised by trade routes in table 3.1 (NWC: North-West continent of Europe; INGWE: Indian sub-continent; FEA: Far East Asia; WAF: West Africa). As mentioned, this cargo was originally routed via South African ports, but for the reasons stated earlier, this cargo is now being trans-shipped through Port Louis. As shown in table 3.1, the total trans-shipment cargo lost to Port Louis for cargo loaded from Nacala amounts to 6557 TEUs, 77781 tons. The (full) cargo under the category of INGWE service, has been the worst impacted. The final destinations for the cargo under this service were for ports in the Indian sub-continent. Besides, the handling of empty containers for trans-shipments from foreign ports is an additional and gratuitous incentive for terminals, as the revenue generated from this is supplementary. In this case the empty units amounted for approximately 50% of the total volumes, more than 3000 TEUs.

Table 3.1 Cargo loaded in the port of Nacala by category, calendar year 2020

NWC: North-West continent of Europe; INGWE: Middle East and Indian sub-continent;
FEA: Far East Asia; WAF: West Africa;

Vessel / Voyage No.	Date	NWC 20'/40'	INGWE 20'/40'	FEA 20'/40'	WAF 20'/40'	EMPTY 20'/40'	OTHER 20'/40'	TOTAL 20'/40'	TEUs	Weight Tons
MSC Elsa KB950A	01/01/2020	65/1	66/1		0/6	9/5	0/2	140/15	170	3544
MSC Agata KB001A	24/01/2020	104/9	4/38	13/0	0/20	40/42		161/109	379	4771
MSC Elsa KB007A	04/03/2020	74/0	24/0	15/0	0/6	38/43		151/49	249	2840
MSC Agata KB010A	21/03/2020	64/7	4/23	4/0	0/2	132/53	0/34	204/119	442	3746
MSC Agata KB014A	28/04/2020	18/0	24/1			0/22	0/24	42/47	136	1529
Paris Jr KB015R	25/04/2020	59/5	3/20	2/0	0/1	322/136	2/5	388/167	722	3526
Paris Jr KB018R	09/05/2020	19/0				154/31		173/31	235	903
Paris Jr KB020R	25/05/2020	34/0	112/5	25/0		47/65		218/70	358	4628
Paris Jr KB022R	11/06/2020	16/0	142/9			224/98	0/6	382/113	608	5136
Paris Jr KB024R	30/06/2020	45/6	181/20	40/0	0/5	7/109		273/140	553	7845
MSC Agata KB030A	30/07/2020	5/1	183/5	52/12	0/3	2/23	0/1	242/45	332	6518
Paris Jr KB033R	20/08/2020	19/1	138/5	26/12		0/8	0/12	183/38	259	5198
Paris Jr KB035R	07/09/2020	3/1	309/0	0/12	0/26	0/23	0/14	312/76	464	9893
MSC Denisse KB041A	04/11/2020	25/5	337/0	38/0			9/0	409/5	419	10680
Paris Jr KB042A	15/11/2020	13/0	30/0	1/36	0/29	17/112	2/8	63/185	433	3347
Paris Jr KB049A	24/12/2020	17/1	39/18		0/6	440/120	0/6	496/151	798	3677
Total		580/37	1596/145	216/72	0/104	1432/890	13/112	3837/1360	6557	77781

Source: This study

The loss in monetary value in respect of terminal-handling charges (a loss of potential revenue earnings for Transnet) is quantified below.

The total loss in South African Rands (ZAR) is calculated hereunder as per the Transnet tariff structure set out above in Table 3A.

Total 20' units = 3837 (2405 x Full units + 1432 Empty units)

Total 40' units = 1360 (470 x Full units + 890 Empty units)

Totals of 20' units and 40' units as per table 3.1

1. For 20' x 3837 units = 3837 x ZAR 4113.90 = ZAR 15 785 034.30
2. For 40' x 1360 units = 1360 x ZAR 6155.76 = ZAR 8 371 833.60
3. Total loss incurred over a period of one year = ZAR 24 156 867.90

The overall revenue loss for the South African ports, calculated solely on the basis of terminal handling charges no longer earned, therefore amounted to a little more than ZAR 24 million in calendar year 2020, in respect of cargo loaded in the port of Nacala.

Cargo for Nacala trans-shipped in Port Louis

Table 3.2 below sets out volumes of trans-shipment cargo loaded from Port Louis to Nacala, which was earlier trans-shipped through South African ports, for the calendar year 2020.

Table 3.2 Cargo loaded from Port Louis for Nacala, calendar year 2020

Vessel / Voyage No.	Date	Nacala 20'/40'	TEUs	Weight Tons
MSC Elsa KB951R	02/01/2020	484/105	694	14695
MSC Agata KB001R	09/01/2020	441/178	797	15274
MSC Elsa KB008R	04/03/2020	174/74	322	5946
MSC Agata KB011R	09/03/2020	243/96	435	8690
MSC Agata KB014R	20/04/2020	27/20	67	1113
Paris Jr KB015A	14/04/2020	279/71	421	9603
Paris Jr KB017A	02/05/2020	449/119	687	14399
Paris Jr KB019A	17/05/2020	151/74	299	5476
Paris Jr KB023A	22/06/2020	171/109	389	7147
Paris Jr KB027A	06/07/2020	195/41	277	5630
MSC Agata KB031R	22/07/2020	120/27	174	3848
Paris Jr KB032A	08/08/2020	141/52	245	4792
Paris Jr KB034A	29/08/2020	211/84	379	7766
Paris Jr KB036A	17/09/2020	164/98	360	5955
MSC Denisse KB042R	17/10/2020	911/242	1395	29185
Paris Jr KB043R	01/11/2020	159/60	279	5645
Paris Jr KB048A	15/12/2020	398/166	730	14351
Paris Jr KB050A	29/12/2020	407/161	729	14160
Total cargo		5125/1777	8679	173715

Source: This study

This cargo that originated predominantly from the Far East and Indian sub-continent, had earlier been shipped on the INGWE service and discharged in South African ports for trans-shipment to Nacala. With the introduction of the feeder service between Port Louis and Nacala, this cargo is now routed via Port Louis. As shown, yet again, a significant volume has been lost by South Africa to Port Louis, amounting to 8679 TEUs, 173715 tons, logged for the calendar year 2020.

The potential loss in South African Rands calculated as per the Transnet tariff, Table 3A.

Totals of 20' units and 40' units as per table 3.2

Total 20' units = 5125

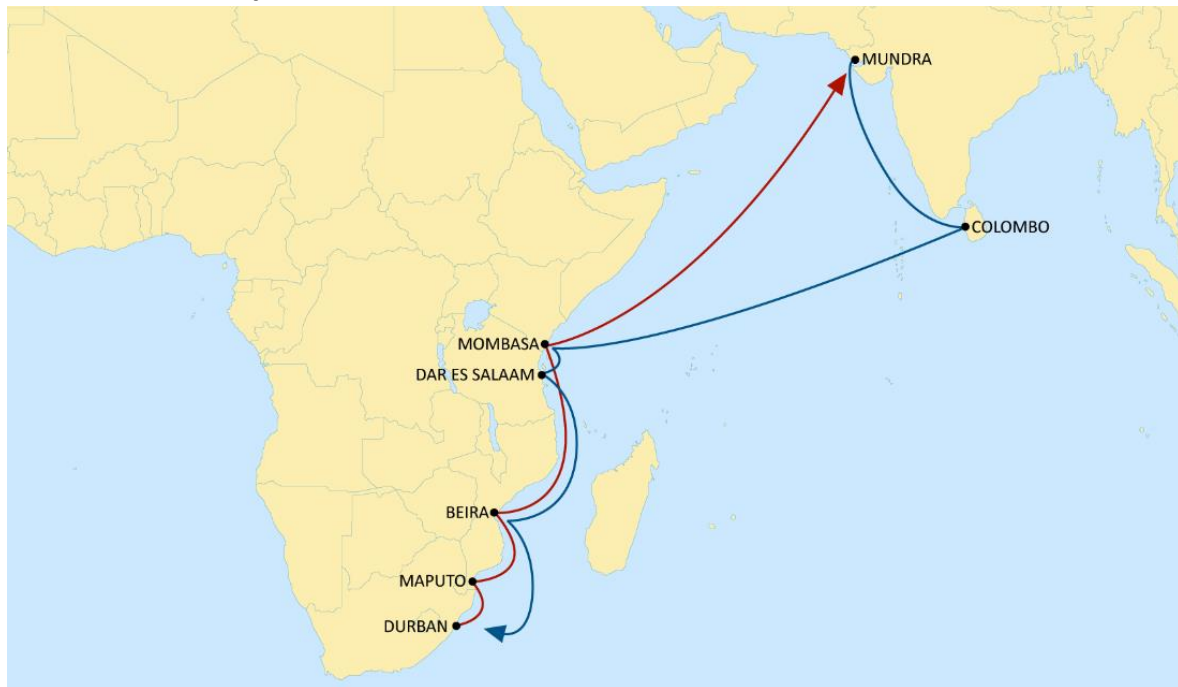
Total 40' units = 1777

1. For 20' x 5125 units = 5125 x ZAR 4113.90 = ZAR 21 083 737.50
2. For 40' x 1777 units = 1777 x ZAR 6155.76 = ZAR 10 938 785.52
3. Total loss incurred over a period of one year = ZAR 32 022 523

The annual loss of terminal handling charges incurred (in calendar year 2020) for cargo loaded from Port Louis to Nacala therefore amounted to fractionally over ZAR 32 million.

The total loss incurred owing to the re-routing of the trans-shipment cargo only to and from the port of Nacala (Mozambique) that was earlier executed through South African ports therefore amounted to a significant cost of ZAR 56M on the basis of cargo movements for the year 2020.

3.2 East Africa Express service



Source: MSC

MSC operated the East Africa/Mozambique service with rotation, Mombasa – Dar Es Salaam – Nacala – Beira – Maputo – Coega – Durban – Maputo – Beira – Nacala – Mombasa until 2019. All the cargo, more specifically to the Mozambican ports from all the services that called South Africa (i.e. from Europe, Far East Asia, Middle East, Indian sub-continent, USA) was trans-shipped via South African ports as per the service operated between South Africa and East Africa/Mozambique (MSCEAMOZ). In October 2019, another strategy was introduced; the East Africa/Mozambique service was extended to call Mundra (India) and Colombo (Sri Lanka), i.e., Coega – Durban – Maputo – Beira – Mombasa – Mundra – Colombo – Mombasa – Dar Es Salaam – Beira – Coega – Durban. The new service was called the **East Africa Express** service. As a result of this initiative, whereby the service was further extended to Mundra and Colombo, there were further repercussions to the trans-shipments via South Africa. The cargo **to** the Far East Asia, Middle East, Indian sub-continent, and Europe loaded **from** Maputo, Beira, Mombasa and Dar es Salaam is now being routed via Mundra and Colombo on the north bound leg of the East Africa Express service. The cargo from Nacala is now being routed via Port Louis on the new feeder service deployed between Nacala and Port Louis (Indian Ocean Relay service, loop 2) as per section 3.1.2.1. This cargo was earlier being trans-shipped via South African ports on the original EA-MOZ service. Not only the cargo **from**, but the cargo **to** East Africa/Mozambique, from Middle East and Indian sub-continent, as well as the Far

East to an extent (depending on the capacity constraints to enter Durban and the available capacity on the East Africa Express service) is now routed via Mundra and Colombo to these destinations direct. Cargo for Nacala is trans-shipped through Port Louis as discussed. The cargo volumes loaded to these destinations, once again based on calendar year 2020 magnitudes, are detailed in Table 3.3, below.

As earlier stated, the INGWE service discharges the cargo loaded from ports in the Middle East and Indian sub-continent, destined for South Africa and via South Africa in Colombo on its first call. This cargo is on-carried by another vessel on the INGWE service from Colombo (second call) arriving from Singapore/Far East in order to provide a better transit time. On the first call of the INGWE service, the cargo for East Africa and Mozambican ports was also being discharged in Colombo along with the cargo for South Africa which would then be loaded on another vessel deployed on the INGWE service (arriving from Singapore) to be trans-shipped via South Africa. This cargo for East Africa and Mozambique, that is discharged in Colombo, previously planned to be trans-shipped via South Africa is now loaded direct on the East Africa Express service from Colombo. Essentially, this cargo is also lost adding to the deficit of the trans-shipment volumes handled via South Africa. The cargo originating from Mundra and Colombo for East Africa and Mozambique is now directly loaded on the East Africa Express, which under original routing would have been via South Africa.

3.2.1 Vessels deployed on the East Africa Express service

The vessels deployed on the Africa Express service are in the range of 3000 TEUS to 4000 TEUS with a capacity ranging between 40000 tons and 50000 tons. The size and type of the vessels are carefully chosen owing to restrictions in Maputo and Beira. These vessels are usually loaded to full capacity from South Africa, considering the draft limitations in Maputo and Beira. Cargo is loaded for Maputo and Beira (Mozambique), Dar Es Salaam (Tanzania) and Mombasa (Kenya). Since the vessels are loaded to capacity from South Africa, the restraining factor is the draft at these respective ports and hence the available space out of these ports would be more or less limited to the quantity (weight) of the cargo discharged at these ports. There is a substantial amount of cargo available out of Maputo and Beira for various destinations, more specifically to Europe, Far East and Indian sub-continent. All this cargo was earlier trans-shipped via South Africa. Since the introduction of the East Africa Express service, this cargo is preferably routed via Mundra and Colombo. Owing to capacity constraints, all the available cargo cannot be loaded on the North bound leg of the East Africa Express service with the intention of trans-shipment via Mundra and Colombo; the cargo that cannot be accommodated on the North bound vessels of the Africa Express service is routed Southbound to be trans-shipped via South African ports. This is more of a compulsion rather than a choice. However, the cargo for the European destinations, especially to the northwest continent, is preferably routed via South African ports owing to a more reliable Europe service (MSCEM) out of South Africa, unless there are delays on the South bound leg of the East Africa Express service.

3.2.1.1 East Africa Express - Southbound

As per Table 3.3 below, the cargo loaded directly on the East Africa Express service from Mundra (India) and Colombo (Sri Lanka) for discharge in Mombasa, Dar Es Salaam, Beira and Maputo for the entire year 2020 has been consolidated. All the vessel calls on this service during the year 2020 have been enumerated. A substantial portion of this cargo, prior late-2019, was routed via South African ports on the INGWE service. The depletion of the cargo via South African ports has significantly impacted the volumes and this can be clearly identified on the yearly decline in MSC's trans-shipment volumes (Refer table 3.11). Approximately 50% of the cargo for Mombasa (Kenya) and Dar es Salaam (Tanzania) as tabulated in table 3.3 was originally being routed via South African ports. The remaining cargo was being carried by the Mogadishu Express service, plying between Mombasa – Dar es Salaam – Mogadishu – Kismayu – Jebel Ali – Karachi – Mundra – Salalah – Mombasa. There were capacity constraints on this route, being the main reason for diversion of cargo emanating from Mundra via South African ports. All the cargo emanating from Colombo was trans-shipped via South Africa, previously.

The direct fiscal losses related to this cargo loaded primarily from the Far East and Indian subcontinent are estimated below. The potential loss in South African Rands (ZAR), is calculated as per the Transnet tariff structure displayed in Table 3A:

Total number of units as per table 3.3 = $46033 \times 20' + 18010 \times 40'$

Considering 50% of the volumes for Mombasa and Dar es Salaam, were diverted through South Africa on the previous East Africa/Mozambique service,

Adjusted units = $26488 \times 20' + 10457 \times 40'$

1. For 20' x 26488 units = $26488 \times \text{ZAR } 4113.90 = \text{ZAR } 108\,968\,983$
2. For 40' x 10457 units = $10457 \times \text{ZAR } 6155.76 = \text{ZAR } 64\,370\,782$
3. Total loss incurred over a period of one year = $\text{ZAR } 173\,339\,765$

The potential annual loss of terminal handling charges and cargo dues incurred (in calendar year 2020) for cargo loaded from the Far East and Indian subcontinent for East Africa and Mozambique ports therefore amounted to over ZAR 173 million.

Table 3.3 East Africa Express – Cargo loaded from the Indian subcontinent for East Africa and Mozambique

EAST AFRICA EXPRESS - PORT OF LOAD -MUNDRA + COLOMBO - PORT OF DISCHARGE MOMBASA (KEMBA) / DAR ES SALAAM (TZDAR) / BEIRA(MZBEW) / MAPUTO (MZMPPM)															
VESSEL / VOYAGE	DEPARTURE	KEMBA		TZDAR		MZBEW		MZMPPM		MTY		TOTAL		WEIGHT	TEUs
		20'	40'	20'	40'	20'	40'	20'	40'	20'	40'	20'	40'		
OSAKA OM001R	2020/01/08	924	478	308	184	17	42					1249	704	48021,1	2657
MSC ALABAMA OM002R	2020/01/14	1250	404									1250	404	41775,1	2058
MSC LEVINA OM003R	2020/01/22	1266	377									1266	377	39763,6	2020
MSC REBECCA OM004R	2020/02/03	576	241	664	150							1240	391	40846,3	2022
MSC CHIARA OM005R	2020/02/04	315	143	494	128	120	89					929	360	32100,1	1649
MSC KERRY OM006R	2020/02/14	540	315	508	167	67	12					1115	494	39686,8	2103
MSC LEVINA OM007R	2020/02/23	554	268	493	146	144	26			2		1193	440	40807,4	2073
MSC MARIA LAURA OM008R	2020/02/28	390	351	197	152	229	57					816	560	35515,1	1936
MSC PAOLA OM009R	2020/03/06	366	325	665	239							1031	564	40255,7	2159
MSC SABRINA OM010R	2020/03/17	502	259	697	156							1199	415	38843,5	2029
OSAKA OM013R	2020/03/28	668	172	697	228	155	51					1520	451	47954,6	2426
MSC GINA OM017R	2020/04/23	644	377	639	106	132	21		1	6	12	1421	517	49502,5	2455
MSC MARIA LAURA OM019R	2020/05/05	648	245	519	110	10						1177	355	36471,7	1887
MSC SABRINA OM021R	2020/05/25	782	95	57	37	281	58	24				1144	190	37513,9	1524
OSAKA OM022R	2020/06/02	624	320	576	172	84	47					1284	539	45383,3	2361
CALI OM023R	2020/06/11	664	247	594	126	235	94					1493	467	47475,8	2427
LORI OM024R	2020/06/17	430	136	497	129	288	121	4	8			1219	394	40171,7	2007
MSC GINA OM025R	2020/06/27	568	278	451	147	207	124	2				1228	549	41957,1	2325
MP THE LAW OM026R	2020/06/30	595	171	405	75	213	89	7				1220	335	42235,8	1890
MSC DIEGO OM027R	2020/07/08	930	309	410	199	115	33					1455	541	48782,6	2537
MSC JASMINE OM030R	2020/08/03	361	113	370	128	234	80					965	321	31234,8	1607
MP THE LAW OM031R	2020/08/06	638	249	279	184	267	129					1184	562	45324,8	2308
LORI OM032R	2020/08/14	466	246	260	231	421	142					1147	619	44612,6	2385
CALI OM033R	2020/08/19	671	310	544	125	144	62					1359	497	46363,2	2353
MSC GINA OM034R	2020/08/30	476	234	391	225	416	215					1283	674	50089,1	2631
MSC JESSENIA R OM035R	2020/09/04	519	318	467	275	163	124					1149	717	44288,2	2583
MP THE LAW OM041R	2020/10/13	607	252	624	239	68	88					1299	579	47295,1	2456
LORI OM038R	2020/09/26	590	245	398	274	272	78	2				1262	597	45407,5	2456
MP THE BROWN OM039R	2020/10/02	234	136	249	134	281	68	21	21	2	4	787	363	28775,2	1513
OSAKA OM042R	2020/10/24	580	227	427	105	456	150			2		1465	482	46760,2	2431
MSC DIEGO OM043R	2020/11/03	708	295	623	168	128	67				5	1459	535	50185,1	2529
MSC GINA OM045R	2020/11/13	693	213	715	306							1408	519	47152,3	2445
MSC MARIA LAURA OM046R	2020/11/23	573	184	554	238							1127	422	36248,2	1970
MSC REGINA OM047R	2020/12/01	530	189	429	122	559	179					1518	490	50917,6	2498
LORI OM048R	2020/12/05	565	260			708	318					1273	578	44896,8	2429
MP THE BROWN OM050R	2020/12/17	633	240	539	196	140	120					1312	556	46214,4	2424
WIDE JULIET OM053R	2021/01/02	612	150	657	133	318	169					1587	452	50268	2490
TOTAL		22692	9372	16397	5734	6872	2853	60	30	12	21	46033	18010	1591096,8	82053

Source: This study

3.2.1.2 East Africa Express - Northbound

Table 3.4 below, lists the vessels deployed on the East Africa Express (northbound) during the year 2020. The cargo loaded on each vessel on its northbound voyage from Beira and Mombasa is detailed to reference the cargo for Europe, Indian sub-continent, Far East Asia, USA, and smaller volumes for other destinations that are now routed via Mundra and Colombo. Before the East Africa Express service was started, this cargo was loaded on the East Africa/Mozambique service to be trans-shipped through South African ports.

As in the case of the southbound leg of the East Africa Express service, on the northbound voyage of the East Africa service, approximately 50% of the volumes loaded from Mombasa for the various destinations was diverted through the South African ports as there were capacity constraints on the Mogadishu Express (Mombasa – Dar es Salaam –Mogadishu – Kismayu – Jebel Ali – Karachi – Mundra – Salalah – Mombasa). The cost implications of this deficit in volumes to TPT is detailed below.

Total units as per table 3.4 = 42999 x 20' + 13550 x 40'

Considering only 50% of the volume ex Mombasa being diverted via South African ports,

Adjusted number of units = 27811 x 20' + 8835 x 40'

As per the Transnet tariff structure displayed in Table 3A

1. For 20' x 27811 units = 27811 x ZAR 4113.90 = ZAR 114 411673
2. For 40' x 8835 units = 8835 x ZAR 6155.76 = ZAR 54 386140
3. Total loss incurred over a period of one year = ZAR 168 797813

The shortfall in the volumes handled by TPT has had cost implications in terms of terminal handling charges and cargo dues (in calendar year 2020) for cargo loaded from East Africa and Mozambique to various destinations, to the extent of nearly ZAR 169 million.

3.2.2 Trans-shipment cargo retained through South African ports on the East Africa Express

Table 3.5 below, details the cargo loaded on the East Africa Express, southbound. All the vessels' calls for the entire year 2020 have been enumerated. The cargo loaded from Mombasa + Dar es Salaam is combined and highlighted, and the cargo loaded from Beira is listed separately. The cargo is loaded for the different destinations, but largely for Europe, Far East and Indian sub-continent to be trans-shipped through South Africa. As alluded to earlier, this cargo that is routed via South Africa for the destinations mentioned are for compelling reasons, rather than an obvious choice. This situation still prevails purely as a consequence of space constraints on the northbound string. Of note is that all the high value cargo and consignments from VIP clients is afforded space on the northbound leg of the East Africa Express via Mundra/Colombo due to better transit times and more reliable weekly services from these ports. Caution needs to be exercised in ensuring the cargo that is routed through South African ports does not accumulate delays, thus impacting the transit time adversely, else mitigating measures may be instituted. One simple way to achieve this is by deploying larger vessels to accommodate all the available cargo on the northbound leg of the East Africa Express service. From the table 3.5, a significant volume of a little over 45 000 TEUs in the year 2020 have been registered through South African ports. In order to maintain the existing trans-shipment volumes and seek growth in this sector, quick connectivity has to be perceived by shipping lines to retain or promote this activity. This would largely depend on the quality-of-service delivery by TPT.

Table 3.5 East Africa Express - Cargo loaded from Mombasa + Dar es Salaam and Beira for destinations categorised by service for trans-shipment through South African ports

VESSEL NAME/VOY.		DATE		NWC		INGWE		FEA		WAF		SAF		EMPTY		OTHER		TOTAL		WEIGHT(TONS)		TEUs																			
		20'	40'	20'	40'	20'	40'	20'	40'	20'	40'	20'	40'	20'	40'	20'	40'	20'	40'	20'	40'																				
MSC KERRY OM947R	2020/12/19	44	8	293	16	7	14	17	243	63			2	13	19	4	2	1	32	100	294	49	388	2013.9	8231.8	927.7	9955.9	198	701												
MSC MARIA LAURA OM949R	2020/01/04	101	64	73	87	5	3	98	95	67	113	1	4	24	5	20	105	763	16	1094	185	347	408	4770.1	5645.2	2987.7	7307.3	1322	900												
MSC PAOJIA OM951R	2020/01/24	58	157	6	211	2	212	3	5	12	3	1	3	16	20	24		412	258	2	27	1	21	500	409	308	251	2720.2	11259.5	2200.6	6367	1116	911								
MSC POSITANO OM952R	2020/02/03	94	61	129				80	108				1		297	1	11	1	10	297	304	1	191	651.2	8574.8	4	5026.8	298	686												
OSAKA OM001R	2020/02/05	23	67	28	267	81	14	18	152	81	2	2	7	6	1	69	303	20	22	104	300	456	306	876.4	8388	3162.6	6986.8	853	912												
MSC CHIARA OM005R	2020/02/25	36	96	11	148	131	2	15	70		1		15	12	6	114	2	11	7	4	5	6	171	316	35	176	1344.6	8943.3	611.3	3830.1	234	657									
MSC KERRY OM006R	2020/03/11	26	188	8	51	1	131	35	168	35	1	1	15	19	12	667	2	166	149	3	2	3	717	503	185	288	2363.6	13968.5	1098.8	4185.2	1089	1079									
MSC LEVINA OM007R	2020/03/15	13	71	129	42	2	58	1	66	2	2		3	7	11	486	143		1	504	202	287	45	1457.4	5603.1	1530.6	1184.8	1082	330												
MSC MARIA LAURA OM008R	2020/03/18	14	116	7	184		22	47	83	15	40		1	5	1	332	2	157	10	10	394	212	204	239	2483.3	6658.6	1831.4	6069.3	815	796											
MSC PAOJIA OM009R	2020/03/27	9	74	5	21	4	18	17	10			1	1	5	10	562		216	4	3	2	583	103	252	48	1708.9	2769.3	1619.7	1083.2	1087	199										
OSAKA OM013R	2020/04/14	14	85	2	72	44	2	1	38	20			6		84	38	15	1	1	150	124	42	108	1621.8	3532.6	280.8	2460.1	234	340												
MSC CHIARA OM014R	2020/04/20	23	69	8	31	3	54	3	79	69					159	1	174	22	8	1	193	204	200	126	978.7	5484.8	1228.3	3024.2	593	457											
MSC GINA OM017R	2020/05/10	84	134	21	19	2	122	3	40	208	38	30	1	73	9	222	9	113	18	3	1	421	506	147	76	5018.3	12804.3	1152.1	1703.9	714	654										
MSC MARIA LAURA OM019R	2020/05/19	40	214	13	15	4	33	3	5	502	64	63		18	4	1	13	6	25	245	7	35	9	87	853	54	325	1680.4	22097.3	662.2	3427.9	195	1503								
WIDE JULIET OM020R	2020/02/12	1	132	51	206	31							24	4	7	1	76	11	6	4	1	38	343	80	94	685.1	9460.4	427.3	2209.3	198	531										
MSC SABRINA OM021R	2020/06/11	10	50	8	15	44	140		379	1	4		22	6	106	80	1	2	3	182	571	95	23	2131	14873.4	703.9	615.3	372	617												
OSAKA OM022R	2020/06/19	45	201	14	5	19	23	13	18	73	7	1	2	5	1	235	187	22	2	1	1	321	298	205	53	2486.6	7534.8	1279	880.8	371	404										
CALL OM023R	2020/06/25	19	109	8	9	1	38	29		2			29	8	750	7	141	6	1	1	799	155	162	45	2764.3	3552.1	1042.6	1075.1	1823	245											
LORI OM024R	2020/07/03	44	88	1	8	42	183	1					2	3	3	656	219	4	1	749	272	234	12	3825.1	7219	1219.5	279	1217	296												
MSC GINA OM025R	2020/07/17	54	119	5	46	100	6	5	2				3	179	102	46	35	269	12	1	608	242	191	125	9537.6	5858.3	2053.7	2124.3	990	492											
MSC DIEGO OM027R	2020/07/23	9	110	3	43	4	9	6	1	32			12	6	1	353	51		2	413	126	71	45	2135.1	3475.9	604.2	1088	555	216												
MP THE BROWN OM029R	2020/08/09	10	63	1	54	9	90	16					15	3	174	12	57	1	184	16	1	24	774	167	257	114	6190.5	4351	2220.4	2434.9	2070	395									
MSC JASMINE OM030R	2020/08/20	57	56	7	256		1	2	10				1	2	1	8	10	14	139	1	41	12	4	2	2	208	71	68	281	1815.2	1888.9	683.8	6463.1	344	633						
CALL OM033R	2020/09/04	17	130	4	281	81	1	38	10	466	162	1	20	3	7	1	2	184	5	3	1	220	687	65	494	1887.9	19084.1	853.2	12450.4	350	1675										
MSC ESSENIA ROM035R	2020/09/22	175	120	39	305	7	192	5	33	2	356	1	16	3	51	12	3	96	39	1	5	12	2	333	685	124	360	5984	19065.7	2023.4	8872	581	1405								
MSC MARIA LAURA OM037R	2020/10/11	39	206	17	211	5	59	2	44	20	1	2	9	1	13	12	1	18	1	80	291	100	283	1426.3	7506.7	1262	6372.1	280	854												
LORI OM038R	2020/10/15	4	58	69	293	2	147	23	153	2	1	3	15	7	2	6	56	1	3	70	358	93	324	360.5	10111.5	1314.1	18679.9	256	546												
MP THE BROWN OM039R	2020/10/27	81	138	82	368	1	50	1	79	2	122	30	3	1	2	15	24	4	1	2	5	103	343	90	501	1697.2	9397	1087.3	12175	283	1345										
MP THE LAW OM041R	2020/10/30	58	75	68	218	32	149	34	168	2	1	1	2	13	2	3	7	1	54	38	2	1	150	395	128	256	2264.3	10619.7	1347.8	6290.6	406	907									
OSAKA OM042R	2020/11/09	63	104	25	244	4	64	38	414	21			26	2	15	22	4	56	1	143	583	103	361	1960.5	15705	1814.4	7731	349	1305												
MSC DIEGO OM044R	2020/12/03	273	294	20	312	14	36	56	120	4	175	1	26	2	18	28	141	40	1	311	495	234	630	7124.7	13378.1	4493.6	16320.4	779	1755												
TOTAL		1444	3522	690	4221	367	2450	117	540	281	4077	181	967	20	101	172	75	767	227	472	212	1758	75	3065	803	180	145	170	158	10817	10597	4867	6976	83915	287043	43728	158062	21414	23686		
		9877	3474	5506	368	1678	11701	653	21414	11843	370957.4	572747.1	33257	45100																											

MOMBASA + DAR ES SALAAM
BEIRA (BEV)
MAPUTO

The earnings in South African Rands basis the Transnet tariff structure, Table 3A:

Totals of 20' units and 40' units as per table 3.5

Total 20' units = 21414 + Total 40' units = 11843

1. For 20' x 21414 units = 21414 x ZAR 4113.90 = ZAR 88 095 054.60

2. For 40' x 11843 units = 11843 x ZAR 6155.76 = ZAR 72 902 665.68

3. Total earnings over a period of one calendar year (2020) = ZAR 160 997 720.28

The revenue derived is presented to have an insight into the earnings based on the terminal handling charges and trans-shipment cargo dues, for the calendar year 2020, from the trans-shipment volumes retained through the South African ports on the East Africa Express service, southbound. The revenue earned amounted to over ZAR 160 million.

3.2.3 East Africa/Mozambique (EA/MOZ) cargo loaded from Far East on the INGWE service

The cargo for EA/MOZ that may be retained on the INGWE service for South Africa, is the cargo loaded out of the Far East. This of course depends on several factors:

- the available connecting vessel (East Africa Express) via Colombo,
- the available capacity on the East Africa Express service,
- the available connecting vessel via South African ports
- the tidal constraints in Durban, i.e., if the cargo for EA/MOZ is retained on board, an evaluation needs to be made if the vessel can still enter the port of Durban given the draft limitations; besides, due consideration has to be given to the loading out of Port Louis which is the next port of call after Colombo, before entering Durban.

In essence, the EA/MOZ cargo loaded out of Far East is stowed for optional discharge, either for Colombo or South Africa, depending on the available capacities either on the East Africa Express or the INGWE services respectively, available connecting vessels and transit times. In both cases, the connecting vessel is the East Africa Express service, either from Colombo or South Africa. If this is routed through Colombo, it will add on to the deficit of South African trans-shipment volumes.

Table 3.6 below, details the cargo for Maputo and Beira (Mozambique) loaded on the INGWE service predominantly from the Far East, that is finally retained on board for trans-shipment via South African ports. Most of the volumes are for Maputo as the East Africa Express, southbound is not scheduled to call Maputo. This works in favour of South African ports for the trans-shipment cargo to Maputo, but all the exports out of Maputo are certainly lost, being loaded on the East Africa Express, northbound.

The earnings in South African Rands basis the Transnet tariff per Table 3A is calculated below:

Totals of 20' units and 40' units as per table 3.5

Total 20' units = 5184 + Total 40' units = 1861

1. For 20' x 5184 units = 5184 x ZAR 4113.90 = ZAR 21 326 457.60

2. For 40' x 1861 units = 1861 x ZAR 6155.76 = ZAR 11 455 869.36

3. Total earnings over a period of one calendar year (2020) = ZAR 32 782 326.96

The revenue earned from the trans-shipment cargo to Maputo and Beira, retained on the INGWE service for the calendar year 2020, amounted to over ZAR 32 million.

Table 3.6 INGWE service – Cargo for Maputo and Beira retained on board for trans-shipment via South Africa (calendar year 2020)

INGWE SERVICE - DEPARTURE PORT LOUIS FILE TO SOUTH AFRICA - FINAL PORTS OF DISCHARGE - BEIRA / MAPUTO															
		DEPARTURE	ARRIVED	FPOD		FPOD									
VESSEL NAME	VOY.	PORT LOUIS	SAF	BEIRA	MAPUTO	TOTAL		WEIGHT(TONS)		TEUs					
				20'	40'	20'	40'	20'	40'	BEIRA	MAPUTO	BEIRA	MAPUTO		
MSC DOMITILLE	ZF951A	2020/01/13	2020/01/16	10	16	121	38	131	54	601,8	3809,2	42	197		
MSC ALTAMIRA	ZF952A	2020/01/28	2020/02/03	93	57	171	41	264	98	3583,1	5234	207	253		
MSC DARDANELLES	ZF001A	2020/02/02	2020/02/06	184	51	73	27	257	78	5947,8	2408,3	286	127		
E.R. YOKOHAMA	ZF004A	2020/02/21	2020/02/28	19	23	74	58	93	81	897,7	3506,9	65	190		
MSC ANYA	ZF006A	2020/03/04	2020/03/13	278	102	85	39	363	141	9720,8	2940,6	482	163		
MSC BOSPHOROUS	ZF008A	2020/03/15	2020/03/14	173	29	50	12	223	41	5573,3	1434,1	231	74		
MSC DARDANELLES	ZF010A	2020/04/04	2020/04/13		3	106	21	106	24	91,4	3216,6	6	148		
MH HAMBURG	ZF011A	2020/04/11	2020/04/19	111	28	15	12	126	40	3538,5	578,1	167	39		
NAVARINO	ZF012A	2020/04/15	2020/04/21	258	44	51	103	309	147	8408,3	3570,4	346	257		
EUROPE	ZF013A	2020/04/20	2020/04/27	244	43	15	30	259	73	7781,7	883,4	330	75		
MSC VITA	ZF014A	2020/04/26	2020/05/04	35	14	30	11	65	25	1222,8	846,6	63	52		
MSC ESTHI	ZF016A	2020/05/09	2020/05/12	1		128	59	129	59	13,7	4626,7	1	246		
MSC MICHELA	ZF017A	2020/05/16	2020/05/21			41	9	41	9		1160		59		
MSC AMALFI	ZF018A	2020/05/24	2020/05/28			70	31	70	31		2477,3		132		
MSC SASHA	ZF019A	2020/06/03	2020/06/12		2	62	28	62	30	40	2124,2	4	118		
MSC YASHI B	ZF021A	2020/06/16	2020/06/21			345	46	345	46		10166,9		437		
MSC PALAK	ZF022A	2020/06/22	2020/06/28		9	29	36	29	45	294,5	1512,8	18	101		
MSC ELODIE	ZF023A	2020/06/27	2020/07/07	6		74	27	80	27	134	2320,7	6	128		
NORTHERN JULIE	ZF024A	2020/07/05	2020/07/15			187	57	187	57		6483,1		301		
MSC JULIE	ZF025A	2020/07/14	2020/07/29			77	32	77	32		2400,9		141		
MSC MESSINA	ZF026A	2020/07/17	2020/07/20			33	10	33	10		1036		53		
HYUNDAI LOYALTY	ZF027A	2020/07/25	2020/08/10	8		142	66	150	66	209,4	5436,2	8	274		
SM TACOMA	ZF028A	2020/08/06	2020/08/14			13	17	13	17		671,6		47		
HYUNDAI MERCURY	ZF029A	2020/08/13	2020/08/25			103	33	103	33		3456,7		169		
GSL NICOLETTA	ZF030A	2020/08/21	2020/09/07			67	63	67	63		3123,1		193		
MSC ATHENS	ZF031A	2020/08/31	2020/09/05	10	1	146	40	156	41	257,8	4840,7	12	226		
MSC CANDICE	ZF032A	2020/09/08	2020/09/16			114	46	114	46		3652,3		206		
SEAMAX DARIEN	ZF034A	2020/09/18	2020/09/28			53	26	53	26		1833,6		105		
MSC BILBAO	ZF036A	2020/10/02	2020/10/09	11	1	31	40	42	41	309,8	1445	13	111		
MSC RACHELE	ZF037A	2020/10/11	2020/10/15	2		48	26	50	26	57,8	1708,2	2	100		
MSC BEATRICE	ZF039A	2020/10/26	2020/10/31			150	37	150	37		4720,1		224		
SANTA VANESSA	ZF040A	2020/10/30	2020/11/03			129	13	129	13		3838,5		155		
MSC TERESA	ZF041A	2020/11/08	2020/11/14	10		145	35	155	35	261,6	4786,9	10	215		
MSC STELLA	ZF042A	2020/11/14	2020/11/19			6	11	6	11		460,1		28		
ANTON SCHULTE	ZF043A	2020/11/22	2020/11/26			74	27	74	27		2368,9		128		
MSC IRENE	ZF044A	2020/12/07	2020/12/13			165	74	165	74		6168		313		
MSC VALENCIA	ZF045A	2020/11/29	2020/12/04			175	31	175	31		5233,2		237		
MSC LUDOVICA	ZF046A	2020/12/12	2020/12/16	2	7	54	25	56	32	193,2	1933,1	16	104		
GSL NINGBO	ZF047A	2020/12/15	2020/12/22			141	49	141	49		4663,7		239		
E.R. TEXAS	ZF048A	2020/12/29	2021/01/04	10		126	45	136	45	261	4330,3	10	216		
				1465	430	3719	1431	5184	1861	49400	127407	2325	6581		
TOTAL						1895		5150		7045		176807		8906	

Source: This study

3.3 Angola service



Source: MSC

The proforma rotation of the Angola service until July 2017 was Cape Town - Walvis Bay - Luanda - Lobito - Namibe - Cape Town. All the cargo for Angola and Namibia from the various regions of the world, namely Europe, Far East, Middle East, Indian sub-continent, USA and South America was transhipped via South Africa for many years until this period. The weekly average volumes in trans-shipment were in the range of 600 TEUs. The trans-shipment volumes ex South Africa for a few ships at the time illustrating the same are set out in Table 3.8, below. As it can be seen from these examples, most of the cargo is for Luanda, approximately 400 TEUs. The vessels from Far East arrived Durban loaded to capacity, restricted to the draft limitations at the port of Durban. This being the case, the cargo on the vessels arriving Durban had to be trimmed. This resulted in the cargo for Angola and Namibia being transferred to the following week's sailing, further depending on the available capacity. The cargo interests were unsatisfied with these transit times, specifically for Luanda, consequently compelling the principals to find an alternate solution. Between July 2017 and October 2018, various changes were initiated to offer a more reliable weekly service and enhance transit times. The existing service model was reviewed; the cargo to Luanda was hence loaded on the Africa Express service from Far East calling direct to Lome and transhipped from Lome to Luanda. In July 2017 the pro forma rotation of the existing Angola service changed to Cape Town - Walvis Bay - Lobito - Lome - Luanda - Namibe - Cape Town; the port of Lome was added into the loop, and the call to Luanda was now introduced on the southbound leg. Hence the cargo to Luanda was still carried on the Angola service, but this cargo was now trans-shipped in Lome, representing a further haemorrhage of transshipments from the South African ports.

The addition of the port of Lome into the Angola service from South Africa had its share of advantages and disadvantages for the various entities. The obvious advantage to the shipping line was that the traffic (exports) from South Africa to West African ports via Lome increased

and MSC slowly expanded its footprint in South Africa. But this cargo was already in existence, just handled differently, at times by various other shipping lines that offered a more viable service. In essence, TPT had no additional benefits. Eventually Tincan (Lagos, Nigeria) was also added to the rotation for the same reasons as Lome.

The disadvantage to South Africa for shipments to Angola and Namibia, with specific reference to cargo to Luanda is as follows:

- The cargo for Luanda was earlier transhipped via South Africa on the then existing Cheetah service, plying between Far East and South Africa, discharged in Durban. This cargo for Luanda from Far East is now shipped on the Africa Express service and trans-shipped in Lome (direct call), instead of South Africa (in fact, this cargo was handled twice in South Africa at the time).
- The Angola Express service (Antwerp – Le Havre – Sines – Casablanca – Las Palmas – Conakry – Lome – Luanda – Dakar – Las Palmas – Antwerp) from Europe was extended from Lome to Luanda. This enabled the cargo from Europe to be directly shipped to Luanda, which on earlier occasion was trans-shipped via South Africa.
- The exports out of Walvis Bay that were earlier trans-shipped via South Africa, were now handled via Lome as this cargo was loaded on the Northbound call of the Angola service and transhipped to Europe, Far East and Indian sub-continent through Lome.

In April 2018, the pro forma rotation changed to Cape Town - Walvis Bay - Lobito - Lome - Tincan - Luanda - Namibe - Cape Town. Tincan was added to the ports of call, to trans-ship the cargo from Lome and offer an additional direct service out of South Africa to Tincan (Lagos).

From June 2018 the pro forma rotation changed to Coega - Cape Town - Walvis Bay - Lobito - Tincan - Lome - Luanda - Namibe - Coega. Coega was now included on the pro forma to specifically cater to the trans-shipments that were discharged from the other services into Coega and avoid double trans-shipments within South African ports as far as practicably possible; this further assisted with the elimination of unnecessary additional move counts that the terminals were struggling to cope with.

In October 2018 the proforma rotation changed to Coega - Cape Town - Lobito - Tincan - Lome - Luanda - Namibe - Walvis Bay - Coega. This is when the call to Walvis Bay was revised from Northbound to Southbound. Once again, all the cargo to Walvis Bay from world-wide destinations was now connected via Lome instead of South African ports. Of course, the exports from Walvis Bay returned to via South African ports.

October 2019, the proforma rotation included Durban to rotate, Coega - Durban - Cape Town - Lobito - Lome - Tincan – Luanda - Namibe - Walvis Bay - Coega. Essentially, this was initiated to cater to the slowly advancing exports that were now being shipped by MSC. All the South African container terminals were now being serviced by the Angola service, thus facilitating MSC to secure even more local cargo from Durban to West Africa; additional and larger capacity vessels were deployed on this service to maintain a weekly schedule and cater to the trade requirements, with most vessels sailing at full capacity. MSC's export market share grew from 20% in 2015 to over 50% in 2020

From February 2020 the proforma rotation changed to Coega - Durban - Cape Town - Lobito - Luanda - Lome - Tincan - Luanda - Namibe - Walvis Bay - Coega. This rotation continues till date, double call to Luanda on both the North and Southbound legs, Northbound, to cater to the exports out of South Africa demanding a quicker transit time and Southbound, moving the trans-ships from world-wide destinations via Lome.

In a nutshell, South African ports progressively lost the trans-shipment volumes as a result of significant berthing delays predominantly caused by inefficiencies. The berthing delays automatically manifested themselves as though there were lesser vessels in the loop (as these vessels weren't able to be turned around timeously). The dwell days for the cargo far exceeded the norm. In responding to the plea of the cargo interests, progressive mitigating measures (as referred to in the chronological account) were instituted to remove the trans-shipment cargo from South African ports.

As an example, one of the mitigating factors to afford a better transit time, is the cargo for Namibia and Angola from the Far East and Indian sub-continent that is presently carried on the Africa Express service (westbound), via Lome. This cargo was initially routed via the South African ports, earlier on the Cheetah service and more recently on the INGWE service. Table 3.7 details these volumes that South Africa lost to the port of Lome.

The potential losses in South African Rands (ZAR) as per the Transnet tariff structure, referred in Table 3A is shown hereunder:

Total 20' units = 3758

Total 40' units = 816

For 20' x 3758 units = 3758 x ZAR 4113.90 = ZAR 15 460 036.20

For 40' x 816 units = 816 x ZAR 6155.76 = ZAR 5 023 100.16

Total loss incurred over a period of one year = **ZAR 20 483 136**

The overall revenue loss for the South African ports, calculated on the basis of terminal handling charges and cargo dues potentially lost, therefore amounted to over than ZAR 20 million in calendar year 2020. This loss projected is only pertaining to the cargo for Namibia and Angola now loaded on the Africa Express service from the Far East to Lome (Togo). As alluded in the narrative, this cargo was routed previously through South African ports. The potential losses incurred on this particular service string has been cited as one example only. There are other service strings, where the potential losses may be demonstrated, whereby new services have been added or extended as mitigating strategies to revamp the service modules in order to re-route the trans-shipment cargo, originally routed via South Africa.

Vessels currently deployed on the Angola service have an average capacity of approximately 30 000 tons. On an average the weekly requirement is approximately 25 000 tons. The available capacity would well suffice to load all the local and deep-sea transshipment cargo should the service be afforded a weekly sailing. However, these vessels have been experiencing a delay of 7/10 days (or even more) on almost every call to South Africa; this obviously creates a backlog, and initiates rollovers which is not acceptable to most shippers (especially for deep-sea transshipment cargo).

Table 3.7 Cargo for Namibia and Angola loaded on the Africa Express service for trans-shipment via Lome

AFRICA EXPRESS SERVICE- PORT OF LOAD - COLOMBO(LKCMB) - PORT OF DISCHARGE LOME(TGLFW) - FINAL PORTS OF DISCHARGE - WALVIS BAY(NAWVB) / ANGOLA (LOBITO AND LUANDA)									
VESSEL NAME/VOY.	DEPARTURE DATE	NAWVB		ANGOLA		TOTAL		WEIGHT (TONS)	TEUs
		20'	40'	20'	40'	20'	40'		
MSC CANDICE FY950A	2020/01/09	8	1	108	18	116	19	3313,2	154
MSC MARINA FY951A	2020/01/13	6	6	31	19	37	25	1370,2	87
MSC SAVONA FY952A	1900/01/23	61		118	9	179	9	4613,9	197
CPO HAMBURG FY002A	2020/02/04	28	6	56	5	84	11	2263,1	106
MSC KATIE FY003A	2020/02/16	78	4	21	7	99	11	2477,6	121
MSC ORION FY004A	2020/02/23	60	5	77	1	137	6	3213,2	149
MSC CAPELLA FY007A	2020/03/07	19	37	23	5	42	42	1417,6	126
MSC RENEE FY009A	2020/03/23	25	13	7	2	32	15	980,4	62
MSC ARIES FY011A	2020/04/05	80	4	40	1	120	5	3027,9	130
MSC SAVONA FY012A	2020/04/16	16	8	21	11	37	19	1417,6	75
MSC ALTAIR FY013A	2020/04/18	68	2	3	2	71	4	1774,3	79
MSC ALEXANDRA FY014A	2020/04/28	27	10	30	5	57	15	1638,5	86
MSC SHUBA B FY017A	2020/05/19	61	13	32		93	13	2639,8	119
MSC BERYL FY019A	2020/06/03	75	10	78	1	153	11	4089,8	175
MSC DANIELLA FY022A	2020/06/27	64	13	215	8	279	21	7673,7	321
MSC VIRGO FY024A	2020/07/08	45	11	66	13	111	24	3163,7	159
MSC ALTAIR FY025A	2020/07/18	85	25	53	41	138	66	4749,4	270
MSC LIVORNO FY026A	2020/07/22	70	10	61	3	131	13	3572,7	157
MSC ALEXANDRA FY027A	2020/07/29	60	15	69	10	129	25	3639,5	179
MSC ORION FY028A	2020/08/06	63	9	105	5	168	14	4530,5	196
MSC NATASHA FY029A	2020/08/15	63	5	50	1	113	6	2884,2	125
MSC LUCIANA FY030A	2020/08/18	83	21	66	4	149	25	4002,5	199
MSC GISELLE FY032A	2020/09/01	91	18	29	1	120	19	3352,3	158
MSC JOSSELINE FY033A	2020/09/11	68	3	44	6	112	9	2977,6	130
MSC EMMA FY034A	2020/09/21	74	13	36	10	110	23	3321,8	156
MSC FAITH FY035A	2020/10/03	78	20	42	8	120	28	3579,5	176
MSC SAVONA FY036A	2020/10/11	101	16	64	8	165	24	4631,4	213
MSC TARANTO FY038A	2020/10/22	104	17	19	12	123	29	3831,7	181
MSC NATASHA FY039A	2020/10/27	14	1	23	9	37	10	1062,7	57
MSC ALEXANDRA FY040A	2020/11/01	2	9	73	6	75	15	2216,4	105
NAVIOS UTMOST FY041A	2020/11/08	33	3	15	8	48	11	1348,1	70
MSC ORION FY042A	2020/11/17	24	17	83	14	107	31	3110	169
MSC DANIELLA FY044A	2020/12/03	6	25	81	44	87	69	3443,3	225
MSC FLAVIA FY045A	2020/12/08	23	42	22	31	45	73	2002,5	191
MSC AZOV FY046A	2020/12/15	29	7	23	16	52	23	1776,4	98
MSC SONIA FY047A	2020/12/19	10	12	32	7	42	19	1361,5	80
MSC LA SPEZIA FY048A	2020/12/26	17	13	23	21	40	34	1654,2	109
TOTAL		1819	444	1939	372	3758	816	108122,7	5390

Source: This study

3.4 Cheetah Service



Source: MSC

Before December 2013, the Cheetah service operated by MSC, between Far East and South Africa, rotated Far East – Singapore – Durban – Coega – Singapore – Far East. Within the South African ports, the vessels called the port of Durban before Coega to maximise the vessels' loading out of Coega as there is no draft restriction in Coega. Coega was essentially used to connect the trans-shipment cargo to Far East arriving predominantly from East Africa, Mozambique, Namibia and Angola, and export cargo, mainly minerals (manganese and chrome) arriving by rail from Kalagadi and Bloemfontein.

At the time, there was a substantial amount of cargo for West Africa from the Far East that was routed through Valencia, Spain. Upon lobbying by TPT to attract trans-shipments through South African ports, it was decided by MSC to route the cargo for West Africa via South Africa on the existing Cheetah service. This essentially meant that the port rotation within South Africa had to be reviewed. If the port rotation had to be maintained Durban – Coega, the potential cargo for West Africa through South Africa was no longer an option due to draft restrictions in Durban. The rotation Durban – Coega was in essence necessary to ensure optimisation of the vessels' capacity from South Africa, as the port of Coega had deeper berths. In going ahead with the decision to route the West Africa cargo via South Africa, the port rotation of the Cheetah service had to be revised; the vessels would have to call Coega first as the draft limitations prevented the vessels calling the port of Durban. The disadvantage of course was the vessels would have to sail light out of South Africa, restricted to the draft limitations at Durban, departing with a spare capacity. Huge volumes were hence shipped from Far East through South Africa for West Africa on the Cheetah service. A new service, SAF-WAF was introduced, plying between Coega and West African ports to on-carry this cargo from the Far East. On the return leg of this service, a considerable number of empty units were loaded from West African ports and discharged in Coega for onward trans-

shipment to Far East. On a weekly basis, an average of 7000+ additional TEUs were handled, which was additional business for TPT. The port of Coega was overwhelmed with this additional traffic, triggering huge congestion and colossal delays in berthing and consequently increased transit times, defying the entire concept behind this shift of cargo to South Africa. These delays were primarily caused due to sheer inefficiencies and poor productivity. As a result, by the end of the year 2013, this cargo reverted to the prior re-routing through Valencia. If this cargo had been handled efficiently, Coega could have boasted of handling an additional approximately 300 000 TEUs annually. This indeed had very significant negative consequences for both entities, TPT and TNPA. The annual revenue lost by TPT could be upwards of approximately ZAR 550 million and ZAR 30 million by TNPA by way of cargo dues. TNPA lost an additional approximately ZAR 17 million by way of port dues and marine services revenue (costs). SAMSA lost approximately ZAR 3 million in levies, since the port of Coega was the first and only South Africa port on the SAF-WAF leg.

Table 3.8 Coega calls by vessels deployed on MSC's, SAF-WAF service, selected dates 2013

SOUTH AFRICA(SAF) - WEST AFRICA(WAF) SERVICE IN THE PORT OF COEGA(ZAZBA)		
VESSEL	VOYAGE	DEPARTURE DATE
WESTERTAL	SL343A	2013/11/13
MSC AMERICA	SL342A	2013/10/19
MSC BANU	SL340A	2013/10/10
PRIWALL	SL339A	2013/10/04
NAIROBI	SL338A	2013/09/27
WESTERTAL	SL337A	2013/09/20
MSC AMERICA	SL336A	2013/09/14
MSC ELEONORA	SL335A	2013/09/03
NAIROBI	SL333A	2013/08/30
PRIWALL	SL332A	2013/08/21
WESTERTAL	SL331A	2013/08/10
MSC NICOLE	SL330A	2013/07/28
NAIROBI	SL325R	2013/07/15
WESTERTAL	SL326A	2013/07/05
MSC NICOLE	SL323A	2013/06/17
MSC ELEONORA	SL322A	2013/06/06
WESTERTAL	SL321A	2013/05/26
PRIWALL	SL319A	2013/05/13
NAIROBI	SL318A	2013/05/05
MSC NICOLE	SL317A	2013/04/30
MSC MEDITERRANEAN	SL316A	2013/04/21
WESTERTAL	SL315A	2013/04/14
PRIWALL	SL312A	2013/03/30
NAIROBI	SL311A	2013/03/24
MSC MEDITERRANEAN	SL310A	2013/03/21
LEDA TRADER	SL308A	2013/03/07
MSC JASMINE	SL307A	2013/02/21
PRIWALL	SL306A	2013/02/13
NAIROBI	SL305A	2013/02/08
MSC MEDITERRANEAN	SL304A	2013/02/04
LEDA TRADER	SL303A	2013/01/24
MSC ELEONORA	SL302A	2013/01/21
PRIWALL	SL301A	2013/01/12
NAIROBI	1252A	2013/01/03

Source: This study

Table 3.9 SAF-WAF service - Vessels randomly nominated (six selectees)

Vessel Call Information : PRIWALL (8083) -> 08/03/2016 - 04/10/2013 COEGA - SL339A	Discharged	Terminal	Full		Empty	
			20	40	20	40
	Discharged	NCT	0	2	0	0
	Transshipment Discharge	NCT	236	69	608	265
	Total Discharged		236	71	608	265
Trans-ships recap 1866 x 20' / 611 x 40' 3088 TEUs	Load	Terminal	Full		Empty	
			20	40	20	40
	Transshipment Load	NCT	1022	277	0	0
	Total Load		1022	277	0	0
	Vessel Call Information : NAIROBI (7390) -> 30/01/2014 - 30/08/2013 COEGA - SL333A	Discharged	Terminal	Full		Empty
			20	40	20	40
Discharged		NCT	18	0	0	0
Transshipment Discharge		NCT	172	82	722	545
Total Discharged			190	82	722	545
Trans-ships recap 2020 x 20' / 951 x 40" 3922 TEUs	Load	Terminal	Full		Empty	
			20	40	20	40
	Loaded	NCT	0	3	0	0
	Transshipment Load	NCT	1126	324	0	0
	Total Load		1126	327	0	0
Vessel Call Information : MSC NICOLE (8091) - 17/06/2013 - COEGA - SL323A	Discharged	Terminal	Full		Empty	
			20	40	20	40
	Discharged	NCT	7	0	0	0
	Transshipment Discharge	NCT	171	9	1023	385
	Total Discharged		178	9	1023	385
Trans-ships recap 2334 x 20' / 613 x 40' 3560 TEUs	Load	Terminal	Full		Empty	
			20	40	20	40
	Loaded	NCT	1	8	0	0
	Transshipment Load	NCT	1140	219	0	0
	Total Load		1141	227	0	0
Vessel Call Information : WES TERTAL (8785) -> 29/01/2014 - 14/04/2013 COEGA - SL315A	Discharged	Terminal	Full		Empty	
			20	40	20	40
	Discharged	NCT	0	0	0	0
	Transshipment Discharge	NCT	31	13	790	482
	Total Discharged		31	13	790	482
Trans-ships recap 1920 x 20' / 732 x 40' 3384 TEUs	Load	Terminal	Full		Empty	
			20	40	20	40
	Loaded	NCT	2	3	0	0
	Transshipment Load	NCT	1099	237	0	0
	Total Load		1101	240	0	0
Vessel Call Information : MSC MEDITERRANEAN (8002) - 04/02/2013 - COEGA - SL304A	Discharged	Terminal	Full		Empty	
			20	40	20	40
	Discharged	NCT	0	0	0	0
	Transshipment Discharge	NCT	226	49	466	640
	Total Discharged		226	49	466	640
Trans-ships recap 1856 x 20' / 982 x 40' 3820 TEUs	Load	Terminal	Full		Empty	
			20	40	20	40
	Transshipment Load	NCT	1164	293	0	0
	Total Load		1164	293	0	0
	Vessel Call Information : MSC ELEONORA (8058) - 21/01/2013 - COEGA - SL302A	Discharged	Terminal	Full		Empty
			20	40	20	40
Discharged		NCT	4	0	0	0
Transshipment Discharge		NCT	28	3	484	698
Total Discharged			32	3	484	698
Trans-ships recap 1623 x 20' / 922 x 40' 3467 TEUs	Load	Terminal	Full		Empty	
			20	40	20	40
	Transshipment Load	NCT	1111	221	0	0
	Total Load		1111	221	0	0

Source: This study

In Table 3.9, six of the vessels from Table 3.8 have been randomly selected across the duration of the SAF-WAF service into Coega to establish the average call size per week, by compiling the trans-shipment discharge and load volumes. Table 3.10 is directly extracted from the VCI (Vessel Call Information) system. The only addition is the call average that has been summarised and highlighted for ease of calculations. Vessels have been randomly nominated (six selectees) over the entire duration of the SAF-WAF service.

The average trans-shipment numbers (discharge and load) on **each** of the vessels sum up to 3540 TEUs, which essentially means approximately 7000 TEUs are generated per trans-shipment exchange. In total 34 calls were registered as per the vessels listed above. Thereafter, the service had to be discontinued for reasons mentioned.

The potential additional annual earnings lost by Transnet Port Terminals, is calculated hereunder on the basis that the trans-shipment volumes from Far East to West Africa were maintained via South Africa. The cargo exchange on the randomly chosen six vessels over the entire period of deployment as per Table 3.10, above, has been used to determine the potential volumes and earnings lost annually.

Total 20' units handled on all the tabulated six vessels = 1866+2020+2334+1920+1856 +1623
= 11619 x 20'

Total 40' units handled on all the tabulated six vessels = 611 + 951 + 613 + 732 + 982 + 922
= 4811 x 40'

Taking the average of the six vessels, the units handled on each SAF-WAF vessel
= 1936 x 20' + 802 x 40' = 3540 TEUs

Considering dual moves (discharge from one vessel and load on another), each trans-shipment cycle entails 2x(1936x20'+802x40') moves, that is 3872x20'+1604 x40'=7080 TEUs

Cost of handling the units as per the Transnet tariff book, excerpts expressed in Table A:

1936 (20' units) x ZAR 4113.90 = ZAR 7 964 510

802 (40' units) x ZAR 6155.76 = ZAR 4 936 920

Total potential earnings per trans-shipment exchange = ZAR 12 901 430 (hypothetically this is a weekly earning).

Considering a weekly service, the trans-shipment exchange will have logged 52 events in a year. However, in view of a more realistic and pragmatic approach, 45 such trans-shipment cycles have been considered for the purpose of evaluation of potential loss in volumes and revenue. Therefore, a more realistic outlook on the potential loss in revenue over a period of one year (basis the terminal handling charge and cargo dues), on only one of the services = 45 x ZAR 12 901430= ZAR 580 564328 = **ZAR 580 million**

As detailed previously, the port rotation on the Cheetah service had to be changed to call Coega first followed by Durban, in order to accommodate the West Africa cargo on the Cheetah service as the vessels were not able to enter the port of Durban as the vessels were drawing deeper than the permissible draft at Durban. The vessels hence called Durban after Coega; this being the case, the ships could not be optimised as the vessels had to sail from South Africa underutilised with spare capacity, unless the port of Coega was called twice,

Coega – Durban – Coega. On the first call to Coega, only discharge would be done and loading on the second call. This was done from time to time to clear the backlog, but not as a norm, as this would mean additional two days of steaming (additional consumption of approximately 300 tons @ 150 tons/day; USD 120000 @ USD 400/ton). Besides, introducing an additional unscheduled call would induce additional delays depending on the extent of congestion and berthing delays. Being very conservative, a minimum sailing delay of seven days out of South Africa may be anticipated, putting the vessel out of schedule by a week, further necessitating the introduction of another vessel from the Far East ports to maintain the weekly schedule. Considering an average charter hire of USD 35000/day, additionally an estimated USD 245000 would be expended over a seven-day period. Other related costs have been discussed separately. This exercise of calling the port of Coega twice turned out to be a cost-inefficient affair and did not justify the means, although at times the call had to be induced to meet commitments to cargo interests. Once again, this clearly demonstrates that the port of Durban needs deeper berths in order to accommodate the latest generation of container vessels drawing up to their summer marks, this being the first step to entice the shipping lines into encouraging trans-shipments through South African ports, besides of course inducing a flexibility to optimise cargo.

3.5 Implications of the draft limitations at the port of Durban

3.5.1 INGWE service

The usual port rotation of the INGWE service in South Africa is Durban – Coega.

However, due to the draft constraints in Durban, the following options need to be duly considered and deliberated upon prior finalising the port rotation:

1. adjust the loading out of Colombo and Port Louis, being the two ports prior calling South Africa in order to arrive at the draft aligned to the tidal limitations at Durban. In doing so, the trans-shipment cargo available in these ports may be adjusted accordingly,
2. load all the available cargo, limited to the summer draft, which on these vessels exceed the permissible draft at the port of Durban, and proceed to call Coega prior to calling Durban, as the depth alongside the container berths in Coega is sufficient to accommodate vessels with deeper drafts.

With option 1, the loading out of Colombo and Port Louis will have to be adjusted despite the availability of cargo. In adjusting the cargo, the trans-shipment cargoes are the obvious targets (as an example, per the discussion in the preceding paragraphs, it could be prudent to discharge the East Africa/Mozambique cargo in Colombo to generate capacity).

With option 2, all the available cargo may be accommodated, with the proviso that the vessel will have to rotate Coega – Durban. The depths in Coega are approximately 16m at the berths and can accommodate deep-drafted vessels with ease. In doing so, the problem with regards to imports into and trans-shipment via South Africa might be resolved, but the loading ability of the vessel out of Coega will be restrained and limited to the draft limitations in Durban. Most of the trans-shipment cargo that is loaded out of South Africa is preferably trans-shipped

out of Coega. It is no different on the INGWE service. The cargo to be trans-shipped on the INGWE service arrives predominantly from West Africa, East Africa and Mozambique. The connections work best with the rotation, Durban – Coega. Having reversed the rotation, it might not be possible to load the trans-shipments ex-Coega due to the restrained lifting ability owing to the draft limitations at the port of Durban.

On the INGWE service, the average quantity of cargo that is usually discharged at the port of Coega, which includes the cargo for the Eastern Cape region and the trans-shipments for the various destinations, amount to approximately 15000 tons to 25000 tons per voyage. These volumes when manifested as reduction in the vessel draft after discharge, amount to approximately 125cms/1.25m to 200cms/2.00m, considering an average rise of 120 tons per centimetre, i.e., the tons per centimetre (TPC) value of 120 tons/cm. With an observed average arrival draft of 14.5m into Coega, the loading out of Coega may have to be adjusted to align with the tidal window and draft limitations at the port of Durban. Not only will the loading out of Coega have to be adjusted or completely forfeited, but the total load out of South Africa will have to be restricted to the maximum permissible draft out of Durban.

The advantage of calling the port of Durban prior to Coega is that the vessel can be maximised out of Coega to its loadable draft (Summer Loadline) provided the cargo is available. The cargo loaded from Durban is predominantly export cargo as Durban serves as the main port for gateway cargo into and out of South Africa, connecting the remote regions by comparatively reliable rail and road networks. On this service, the cargo for Durban discharge ranges between 50000 tons to 70000 tons; there is a further option to discharge the trans-shipment cargo in Durban, although originally planned for discharge in Coega, in order to generate more space, should this become essential to cater to the available exports/cargo from Durban. In proceeding from Durban to Coega, the liftings out of South Africa can be optimised by connecting the available cargo (local exports and trans-shipment), without the imposition of draft restrictions. The cargo from the Western Cape region (via Cape Town) is trans-shipped in Coega as the INGWE service does not call Cape Town direct; the cargo to Cape Town may be trans-shipped via Coega or Durban.

There is indeed a demand for space as compared to the available capacity. The demand is indicative of the cargo available to be shipped, whereas the capacity or supply is restrained by the tidal constraints or draft restrictions imposed at the port of Durban owing to depth limitations. The draft limitation is an obvious impediment to the prospective development of the South African ports as a trans-shipment hub. In seeking viable solutions, the Master Plan for the port of Durban has included the berth-deepening project to cater to this shortfall, which is fairly crucial to the envisaged port expansion plan. This project needs to be executed in a very phased and planned manner ensuring the existing demand is catered to by creating an alternate capacity prior to relinquishing the berths for development. For example, if the berths at the North Quay are allotted in a phased manner for the purpose of deepening, the inherent capacity lost due to this should be compensated by creating additional similar capacity. In order to ensure that the berth-deepening project is carried out without much impact to the existing demand, a few strategies need to be implemented prior to embarking

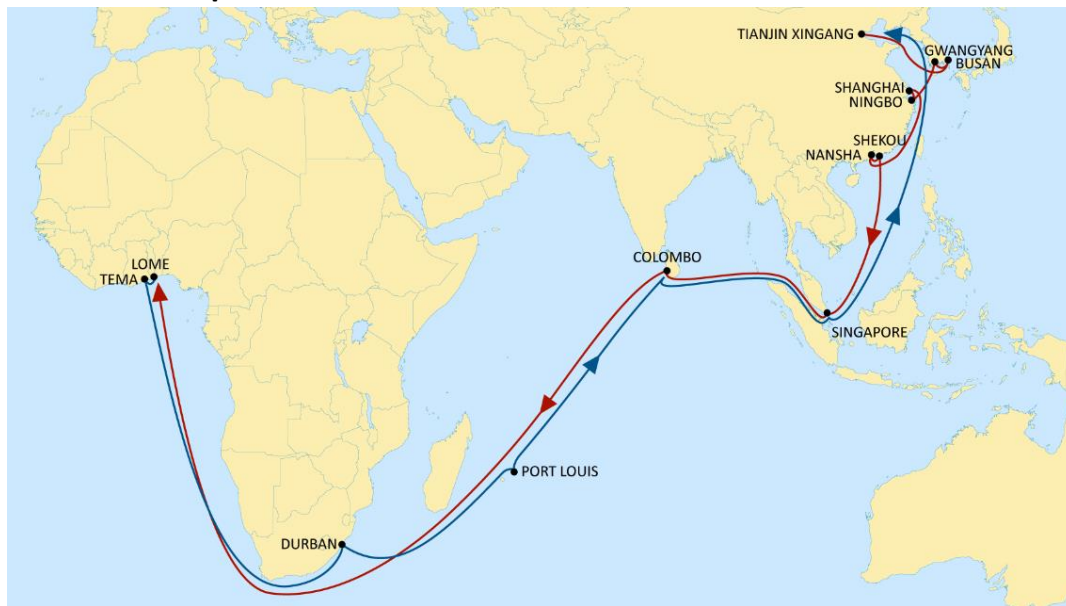
on this project to ensure that this does not induce congestion and waiting period/berthing delays. If such delays are experienced, this will trigger a ripple effect resulting in colossal, compounded delays. In essence, the shortfall of losing a berth or berths must be compensated to maintain the existing fluidity, and this is a critical aspect that needs to be emphasized upon. To mitigate the anticipated dilemma in operations, the following may be considered:

- To create additional capacity at the Multi-Purpose Terminal (DRT) in the Point/City Terminal precinct in the port of Durban. The existing large cargo sheds at DRT should be assessed for their usability; if these sheds are not being utilised, they should be demolished and used for container stacking to increase capacity. With the migration from the breakbulk/unitised and general cargo concept to containerisation, these sheds are almost certainly surplus to requirements. Additionally, the terminal must be sufficiently resourced with equipment and manpower to take on the additional volumes. The multi-purpose terminals have not been upgraded to meet modern cargo-handling norms, with the result that productivity levels have lagged significantly. Therefore, there is a potential for upscaling the ability to handle additional volumes and quicker turnaround of vessels;
- To enhance efficiencies at DCT by increasing the productivity sharply. The spare resources from the berth relinquished for deepening, both equipment and personnel, must be re-directed towards effective re-deployment and driving better output in the remaining operational berths;
- The features provided within the NAVIS system used by the terminal for stack and yard planning remain largely underutilised; proper utilisation provides for further efficiencies, allowing for amongst other features, Expert Decking and Prime Route. Expert Decking is an automated yard planning program that dynamically assesses the container volumes and state of the yard real-time to provide efficient stacking. Prime Route monitors the locations of the container handling equipment in real-time and issues instructions accordingly to optimise the number of moves executed. Yard planning is the core to efficient terminal operations; it is vital that this link of operations is developed to enhance productivity;
- To request shipping lines to mobilise trans-shipment volumes to Coega if practically feasible; and
- To increase capacity on the rail link to Coega from Pretoria and Johannesburg.

With deeper berths made available, the problems will certainly be resolved to a great extent, extending avenues for a larger appetite for trans-shipment cargo through South African ports. Ships with deeper drafts could call Durban, chiefly for the purposes of gateway cargo and proceed to Coega mainly for trans-shipment. Coega was established with the intention of developing it as a trans-shipment hub. Rightly so, the Port of Ngqura (Coega) has a tremendous potential for many reasons. It is well placed in the global arena with regards to its geographical location and is best suited to be promoted as a trans-shipment hub. The single most cogent argument to promote South African ports as a trans-shipment hub is that vessels are not specifically required to call for the purpose of trans-shipments only, but are obliged to call due to gateway cargo to and from South Africa connecting the various global destinations. There is not a need for additional infrastructure specifically for the purpose of dealing with trans-shipments. The Port of Ngqura boasts of a world-class container terminal

with world-class equipment. The container terminal is a straight stretch with four berths at present, making it much easier for yard/stack planning. The rail head also runs parallel to the container berths and is in close proximity. Of course, the South corridor serving the container traffic has been allocated very little capacity and needs to be developed. The terminal is secluded and built in an industrial zone away from the CBD.

3.5.2 Africa Express service



Source: MSC

The Africa Express service called South Africa (Durban) from Lome (Togo), rotating Lome – Durban - Port Louis – Colombo – Singapore – Far East (Tianjin/Xingang – Busan – Ningbo – Shanghai – Nansha – Shekou) – Singapore - Lome. This service called Durban weekly since September 2015. Neo-Panamax size vessels were deployed on this service. These vessels were usually straight loaders. Besides the gateway cargo, the trans-shipments to the Far East mainly from Namibia, Angola and Mozambique were loaded on this service. However, the available capacity on these vessels ranged from 20000 tons to 50000 tons depending on the quantity loaded out of West Africa and limited to the draft restrictions in Durban, being approximately 13.30m, subject to various factors. The gateway cargo out of Durban in most instances surpassed this capacity leaving no space for the trans-shipment cargo. It is important to note that the neo-Panamax vessels can draw between 15.0m to 16.0m at full-load displacement and therefore these vessels perforce operate with significant unutilised spare capacity as result of water-depth restrictions at the container berths in the port of Durban. This spare unutilised capacity between the loadable draft at Durban and the summer draft ranges between 25000 tons and 40000 tons, equivalent to approximately 1000 and 2000 containers, depending on the weight of the containers. Besides the loss in freight earnings for the shipping lines, the inability to utilise the spare capacity despite availability of cargo implies that draft limitations and tidal constraints have hampered the growth prospects of the port of Durban. These imposed limitations have triggered the shipping lines to divert the

prospective trans-shipment cargo through other ports that are able to handle this cargo without the imposition of any restrictions, thereby providing a secured connection and reliable service. Besides the trans-shipment cargo, there is a certain exodus of gateway cargo due to the capacity constraints from Durban owing to the draft limitations. The gateway cargo that has been historically shipped via the port of Durban is finding alternate routes. (A more detailed account will be provided in Chapter 5). Part of the gateway cargo is now moved via Maputo, Beira, Dar es Salaam and Walvis Bay. The capacity constraints on the **Africa Express** service have also prompted the introduction of the **East Africa Express** service to move the Far East cargo from Mozambique and the East African ports via Mundra and Colombo on its north bound string.

Due to the recurrent delays on the Africa Express service, arising from port congestion resulting out of sheer inefficiencies, berth restrictions for neo-Panamax size vessels, and draft limitations, it was decided to discontinue the service into South Africa. The issues relating to the size of these vessels limited their placement on the North Quay of DCT (berths NP 203 and NP 204) where the gantries have a comparatively better outreach, up to 22 rows across and with an accessible height of 43m from the quay rail to the base of the spreader. Another factor that contributed to discontinuing the service was that the vessels had to limit the loading from the port of Lome taking into account the draft restrictions at the port of Durban. The Africa Express vessels sailing out of Lome, directly to the Far East, have been either full on tonnage sailing at the summer marks or full on TEU capacity.

As an example of excessive total time spent at the port of Durban, the MSC Livorno, a 13000 TEU vessel, with a length of 366m and a beam of 51m, arrived on 23rd August 2020 and sailed on 6th September 2020. The vessel spent a colossal 14 days at the port of Durban; such delays are unacceptable and upset the scheduling at all the subsequent ports. Substantial costs are associated with such delays (as detailed in Appendix 4.4, Case Study 4). These delays provoked an immediate decision on the part of the principals to discontinue Durban port calls on the Africa Express service. The port-stay of the vessels deployed on the Africa Express service for the year 2020 is detailed in Table 3.10, below. These vessels averaged eight days at the port of Durban. Table 3.10 enumerates the vessels that called Durban on the Africa Express and the total number of days each vessel spent in Durban. These vessels were straight loaders, without any discharge, total move count ranging between 1500 and 2000 and hypothetically should have taken a maximum of two days in port, although three days was allocated, as per the schedule. With an average stay of eight days, each time the vessels called Durban, another vessel had to be injected into the system from the load ports (Far East), to mitigate the delays and maintain the schedule integrity of a weekly service. Maintaining the schedule integrity at the Far East ports is crucial as the impact of not being able to move cargo in time has an adverse influence on the entire supply chain owing to sheer volumes handled, bearing in mind that the business concept in the Far East is moving volumes at lower margins with little tolerance for bottlenecks in the supply chain. Within the scheduling itself, there is not much buffer provided as there is a dearth of appropriate vessels available for varying reasons. The vessels that are deployed on a particular service must be suitable and meet the criteria for all the scheduled ports of call. Besides, a greater part of the year 2020 had vessels undergoing

scrubber installation on a massive scale and therefore logged a significant idle time. This resulted in increased charter hire, amounting to approximately US\$ 45000 per day (refer to Appendix 4.4, Case study 1). Summarising, the economies of scale dictated that the vessels deployed on the Africa Express service plying between Far East and West Africa and back, with a scheduled stopover at Durban (East bound), rather bypass the port of Durban. As evidenced by Table 3.10, only 13 vessels called Durban during the year 2020, although the service offered a notional weekly deployment; this irregular deployment was influenced by a combination of factors, as stated in the narrative. The cargo that was previously uplifted on the Africa Express service is now carried on the INGWE service. However, capacity constraints continue to remain a daunting issue, further exacerbated by a global shortage of available tonnage, thus warranting the deployment of vessels in a more lucrative market. Draft restrictions at the port of Durban thus further exacerbate the existing issues as full available capacity cannot be utilised.

Table 3.10 Africa Express service – Durban vessel calls in the calendar year 2020

Vessel	Voyage	Departure WAF	Actual ETA Durban	Berthed Durban	Sailed Durban	Time spent in Durban
MSC Savannah	FY951R	23/12/2019	30/12/2019	10/01/2020	11/01/2020	12d
MSC Josseline	FY002R	17/01/2020	24/01/2020	28/01/2020	30/01/2020	6d
MSC Perle	FY003R	19/01	26/01	04/02	07/02	12d
MSC Candice	FY004R	02/02	09/02	18/02	19/02	10d
MSC Katie	FY010R	09/03	16/03	18/03	21/03	5d
MSC Savona	FY018R	09/05	16/05	25/05	27/05	11d
MSC Alexandra	FY020R	25/05	01/06	01/06	06/06	5d
MSC Aries	FY029R	27/07	04/08	05/08	09/08	5d
MSC Altair	FY031R	09/08	16/08	18/08	22/08	6d
MSC Livorno	FY032R	15/08	22/08	30/08	06/09	15d
MSC Alexandra	FY033R	24/08	31/08	03/09	05/09	5d
MSC Luciana	FY036R	15/09	22/09	28/09	02/10	10d
MSC Beryl	FY037R	21/09	28/09	02/10	04/10	6d

Source: This study

3.6 Comparison of overall trans-shipment volumes with MSC trans-shipment volumes

Table 3.11 below draws together and presents the total trans-shipment volumes moved by all the shipping lines (including MSC) handled at all the South African ports versus the total trans-shipment volumes handled collectively in all ports by MSC alone. Of note is that MSC contributes some 60% of the total trans-shipment volumes handled in South Africa. A yearly projection starting from 2011 to date has been summarised to evaluate the trend. This trend reveals a steady erosion of trans-shipment volumes. These volumes could either be retained or grown, merely by maintaining an average performance standard. For the sake of argument, the difference between the maximum and minimum volumes handled by MSC, in the financial years 2013/14 (723 730 TEUs) and 2020/21 (386 072 TEUs), respectively, is 337 658 TEUs. Considering a combination of twenty feet (20') units and forty feet (40') units, this aggregates to an amount of approximately ZAR 500M, representing the significant revenue foregone as a consequence of port infrastructure limitations and poor terminal performance.

Table 3.11 Total container trans-shipment volumes handled in TEUs across all the terminals versus MSC volumes

	DCT	PIER1	NCT	PECT	CTCT	MPT	TOTAL TEUs	MSC TEUs	VOLUME %
2011/12	335248	93664	313818	134905	112276	21829	1011740	602039	59.5%
2012/13	225392	35197	356669	136168	141379	20430	915235	610 505	66.7%
2013/14	278641	24067	420087	143955	182212	17970	1066932	723 730	67.8%
2014/15	353120	28810	388517	134417	149859	20311	1075034	704 199	65.5%
2015/16	345783	36778	292284	97383	158601	12213	943042	519 105	55.0%
2016/17	379180	60849	278125	81439	175773	12843	988209	497399	50.3%
2017/18	278999	31011	501799	100872	132586	24941	1070208	633 221	59.2%
2018/19	222772	29207	419402	147715	103760	17087	939943	509 283	54.2%
2019/20	229665	37277	372833	13789	93775	26468	773807	426202	55.1%
2020/21	196033	41451	316141	39644	42827	26850	662946	386072	58.2%

Source: Transnet Port Terminals; MSC

3.7 Impact on South African trans-shipment business

Once new or changed routings and services are established for compelling operational reasons, it becomes very difficult to convince the principals to re-instate the original routing even if the circumstances normalise, by way of improved efficiencies. The opportunities and cargo lost as a result of an inability to handle the same in a manner deemed essential, may therefore well be lost permanently, or almost permanently. Markets are aggressive and unforgiving, and are driven by commercial imperatives, to which ports and trading regimes must align, to avoid traffic and revenue losses. Many opportunities that have been afforded to mobilise the South African ports as more viable trans-shipment hub have not been seized, much to the detriment of South African economy.

3.8 Summary

This chapter has sought to set out, in quite broad terms, some of the losses in trans-shipment traffic through the South African ports, based on the experiences of the largest single container carrying line to those ports. The economic consequences of those traffic losses have also been estimated, in terms of revenue losses to the South African ports system, principally in the form of losses in terminal handling revenue to TPT, but also at times in the form of lost marine revenue to the Ports Authority (TNPA).

A number of liner trade routes have been considered, and although these are not exhaustive, they provide a robust indication of the nature of the problem associated with an eroding trans-shipment traffic base. The overall monetary magnitudes are quite significant, and have been calculated on the basis of actual data drawn from the voyage and cargo database of the Mediterranean Shipping Company (MSC), and from contemporary TPT and TNPA tariff levels. On a route-by-route basis, these order-of-magnitude revenue losses have been estimated to be:

- ZAR 24 million annually in respect of cargo loaded in the Mozambican port of Nacala, and previously trans-shipped through South African ports, but now lost to Port Louis, Mauritius;
- ZAR 32 million annually in respect of cargo destined for discharge in Nacala, and previously trans-shipped through South African ports;
- ZAR 173 million in respect of cargo from south-east Asia for East Africa and Mozambique, previously trans-shipped in South Africa, but now carried directly from Mundra, India and Colombo, Sri Lanka on the East Africa Express service;
- ZAR 169 million annually in respect of cargo loaded in East African ports for northbound transport to Europe, south-east Asia, the Far East and other destinations, now routed via Mundra and Colombo and not via South Africa;
- ZAR 20.5 million in respect of cargo from the Far East and Indian sub-continent for Namibia and Angola, now trans-shipped via Lome in Togo and not via South African ports; and
- a more significant potential haemorrhage of 300 000 TEUs annually from a somewhat earlier period, or translating into some ZAR 580 million, in respect of trans-shipment cargo from the Far East to West Africa service, handled previously through the port of Coega.

The cumulative potential annual losses of trans-shipment opportunities associated with a single shipping line, albeit one with a substantial market share on the relevant trade routes, therefore aggregate to some ZAR 1 billion. Across a fuller spectrum of carrying lines, these magnitudes would clearly be larger. The real losses, however, are imposed on the wider South African economy, in the form of lost economic activity and above all lost employment. This research has sought to demonstrate that these negative economic consequences arise principally from infrastructural deficiencies in the port of Durban, most notably draft limitations at the container berths at this port, and from systematic inefficiencies in cargo handling and terminal operations within the South African ports.

CHAPTER FOUR

MITIGATING TIDAL CONSTRAINTS: IMPLICATIONS OF INADEQUATE MARINE INFRASTRUCTURE AND APPLICABILITY OF NAABSA PRACTICES

The Port of Durban is quite peculiar, insofar as water-depth at the quay and alongside berths is shallower than the depth in the basin and in the considerably deeper port entrance channel. In most tidal ports of the world the reverse is true, whereby the depths alongside quay-walls and berths is generally greater than the depths in the channel. Some examples are the ports of Beira, Dar es Salaam, Walvis Bay, Mundra, Nhava Sheva and Shanghai (MSC). Situations where berths are deeper are better manageable as the sailing draft is pre-determined by the available depth in the channel, depending on the height of the high tide and the permissible under keel clearance (UKC) as mandated by the port regulations. In essence, the vessels do not have to be managed at the berth during loading operations; the operations continue uninterrupted until the vessel loads to a pre-determined draft and awaits the suitable depth in the channel, in relation to the draft, to sail. Similarly, if the ship is subject to tidal berthing, the vessel will transit the channel at the earliest available suitable depth during high tide; once berthed, the planned operations carry on unhindered. The tidal window for sailing or berthing depends on the draft in relation to the depth available in the channel. The determination of the mandated under-keel clearance will predominantly take into consideration various factors, more specific to the region, for example, the nature of the seabed, the width of the channel, the radius of the turning basin, the availability and the capacity of tugs and weather conditions, amongst other local features having a bearing on safe operations.

In the case of the Port of Durban, the intricacies are both different and complex, if the intention is to optimise cargo. Further, there is a degree of uncertainty and looming apprehension over the predictability of berthing projections given the various dynamics involved, *inter alia* inconsistency in operational output, interruptions due to adverse weather, equipment breakdown, unavailability of sufficient supporting equipment, and unavailability of personnel. To this effect, seven case studies of tidal vessels, describing the diverse perspectives at the Durban Container Terminal are referred under Appendix 4.4. These studies are not exhaustive, but fairly representative of some of the relative aspects, which includes the losses incurred by shipping lines, amongst others.

In Durban, the depths at the container berths read 12.80m at chart datum (CD), whereas the channel entrance is maintained at 16.0m; therefore, the sailing or berthing drafts are predominantly guided by the minimum stipulated UKC of 0.60m by TNPA. The pilots often seek more than the stipulated 0.60m clearance and would like to berth or sail the vessels on a rising tide only, which imposes further restrictions in terms of management of time and optimisation of cargo. Ideally, if cargo has been optimised, it would be incumbent to berth or

sail a tidal vessel at the peak of the high tide, having optimised the load, in relation to the draft having due regards to the depth at the high tide and the mandatory UKC.

Under ordinary circumstances, the berthing or sailing drafts on tidal vessels are dictated by:

- the height of tide (H.O.T.) at high water (HW) on the projected day of the vessel's sailing or berthing;
- available tidal range;
- whether spring tides or neap tides, or tides ranging between the two phenomena are experienced;
- the working efficiencies of the terminal;
- the number of gantries deployed and the resources supporting the gantries;
- for berthing vessels that have arrived with a heavy draft, whether the port will be able to lighten the vessels during the available window, without jeopardising the mandatory UKC; and
- for sailing vessels, whether cargo can be safely booked for loading without having to short-ship the planned cargo, and yet sail at a suitable pre-planned time, respecting the stipulated norms.

These factors predominantly dictate the draft the vessels could arrive at or sail with; careful management and close monitoring are the key features in optimising cargo. It is vital to manage the operations very closely, ensuring that the vessels always maintain the mandatory UKC dictated by the Port Authorities. In doing so, the maximum draft at low water must be pre-determined, whereby the vessel will be required to stop cargo operations partly or fully in order to maintain the UKC; the cargo operations may then resume on the rising tide. This in all probability will be during the final phase of the loading operations, with the vessel having to sail on the high tide, or during the very early phases of discharge, if the vessel arrives in a laden condition. The final leg is critical in optimising the load, as the period in which this requires to be achieved, is limited from the time of resuming operations, which is most likely to be immediately after the time of the low water, until a particular time on the curve of the high tide having due regards to the draft in relation to the available depth and UKC. It is hence imperative that the terminal is advised of this operation well in advance and maximum resources are deployed in order to achieve the planned and projected handling rates. The maximum draft that can be achieved for the purpose of sailing on the day has to be aligned to the time of highest water of the day, loading to a draft that leaves UKC of 0.60m. If this can be achieved, the vessel would have been optimised. In fact, this seldom is the case and almost never achieved, unless the neap tides are experienced, whereby the range of the tide is the least. The same applies for vessels arriving laden and need to be lightened within the fixed time frame.

At springs, the range of the tide is maximum, which warrants a comparatively greater rate of loading to arrive at a maximum draft, with UKC of 0.60m at high water, in a bid to optimise cargo intake. This is unlikely to be achieved under the current circumstances due to the stipulated recommendations governing the UKC requirements. Furthermore, there is no

tolerance to inefficiencies given the limited period available to complete the final leg of operations, beyond which the vessel has to sail, regardless. This is seldom the case, and in its absence poses a challenge to the cargo optimisation plan.

At neaps, however, the cargo that is planned to attain the maximum hypothetical draft is achievable with more ease. The reasons are obvious; the low water at the neap tides is higher than the Mean Low Water (MLW). This affords an opportunity to continue loading to a deeper draft, before a suspension in cargo operations is possibly warranted, owing to the requirement of the mandatory 0.30m UKC at berth per directives from TNPA. Thereafter, upon resuming cargo operation on the rising tide, the pre-conceived draft is relatively easily achievable as the differential in the increase in draft that is being sought is smaller, having maintained UKC of 0.60m for sailing. This is due to the fact that the height of tide at high water is lower than the Mean High Water (MHW).

The above can be further illustrated by citing the hourly predictions from the tide tables specifically pertaining to the tidal variation for the neap tide and spring tide as per Appendix 4.1. The tidal predictions are chosen for the dates of extreme springs and neaps, and the period chosen for this purpose is November 2020. As demonstrated, at neap tides, due to the lower range in tidal variation (nearly 0.40m at extreme neaps), the vessels can be optimised without issues, loading to the maximum permissible draft in respect to the available depth and stipulated UKC of 0.60m for sailing. At springs, however, due to higher range between the heights at high and low tides (around 2.00m at the extreme springs), it is not possible to optimise the load aligned to maximum permissible draft. This may only be achieved if the TNPA's recommendations on UKC whilst alongside the cargo berths is relaxed to the extent of adopting the NAABSA principle. This being the case, an additional tonnage of 10 000 tons to 14 000 tons may be handled, depending on the size of the vessels and more specifically the TPC at the respective draft. Considering an average weight of 20 tons per container unit, the additional volumes that may be handled ranges between 500 and 700 containers. All the stakeholders in the chain stand to benefit. For the shipping line, this translates into a freight earning of USD 500 000 to USD 700 000 if the freight is calculated at a modest rate of USD 1000 per unit (case studies 2 and 3 in Appendix 4.4 have reference). For TPT, the additional terminal handling charges (THC) including 10% surcharge towards the berth reservation and performance, would generate additional revenue between ZAR 1 million and ZAR 2 million. TNPA stands to earn cargo dues between ZAR 1 million and ZAR 2 million if the units are imports, and between ZAR 200000 to ZAR 500000 for exports. The above earnings relate to a single vessel working during a period of spring tides. Appendix 4.2 sets out hypothetical cases to illustrate the improvement in cargo liftings that could be achieved during spring tides.

In the absence of deep-water berths at the port of Durban, the authorities could possibly consider the option of incorporating the NAABSA concept that is recognised by the Classification Societies (Refer DNV-GL Rules for NAABSA vessels), Protection & Indemnity Clubs and the Charter Party clauses governing this prospect, as an alternative to compensate the shortcomings. NAABSA operations may be permitted at the port of Durban given the suitability of the port for such a consideration. In doing so, the port might absolve itself from

any liability whatsoever, leaving the options with the shipping lines by signing a Letter of Indemnity, similar to the one that is currently used for tidal vessels drawing in excess of 12.40m. Some lines choose this option by signing the letter whilst other lines do not indemnify the port and hence do not exceed the draft beyond 12.40m. The authorities in dealing with such sensitive issues may draw Standard Operating Procedures to place a limit to the transference of displaced weight to the seabed, bearing in mind the tidal limitations for berthing and sailing vessels and other limitations it may deem essential. The fitness of the seabed for such operations is effectively established by the studies undertaken by the TNPA's engineering division on a continual basis. Image 4.1 displays an aerial view of the various stations from where the sediments were extracted for analysis. Table 4.1 must be read in conjunction with Image 4.1, where the areas of particular relevance for container vessels are U, V, W, 6 and 8. The composition of the sediments as seen from table 4.1 is predominantly medium grained sand, averaging to 37%, fine grained sand, averaging to 35% and mud, averaging to 20%. As presented in Drawings 4.1 and 4.2, details of the wash boring profiles at the container berths going down to 80 feet below the seabed predominantly show sand and clay. Drawing 4.1 displays the various locations from where the wash bore samples were drawn, while Drawing 4.2 presents the composition of the bore samples at the various levels up to 80 feet below the seabed. The profile at the different levels primarily displays a configuration of sand and clay, which is in complete conformity with the requirement of a NAABSA berth that warrants a soft seabed.

Image 4.1 Aerial view of the various stations sampled for sediment quality



Aerial view of Durban Bay, showing the positions (stations) where sediment was sampled for physical and chemical analysis and toxicity testing in June 2019. Sediment sampled at each station was analysed for its grain size, total organic content and the concentrations of 15 metals, while that sampled at stations denoted in pink was also analysed for polycyclic aromatic hydrocarbons, organochlorine pesticides, polychlorinated biphenyls and/or butyltins. Elutriates prepared from sediment sampled at stations denoted in pink-orange were also tested for toxicity to sea urchin gametes.

Source: TNPA

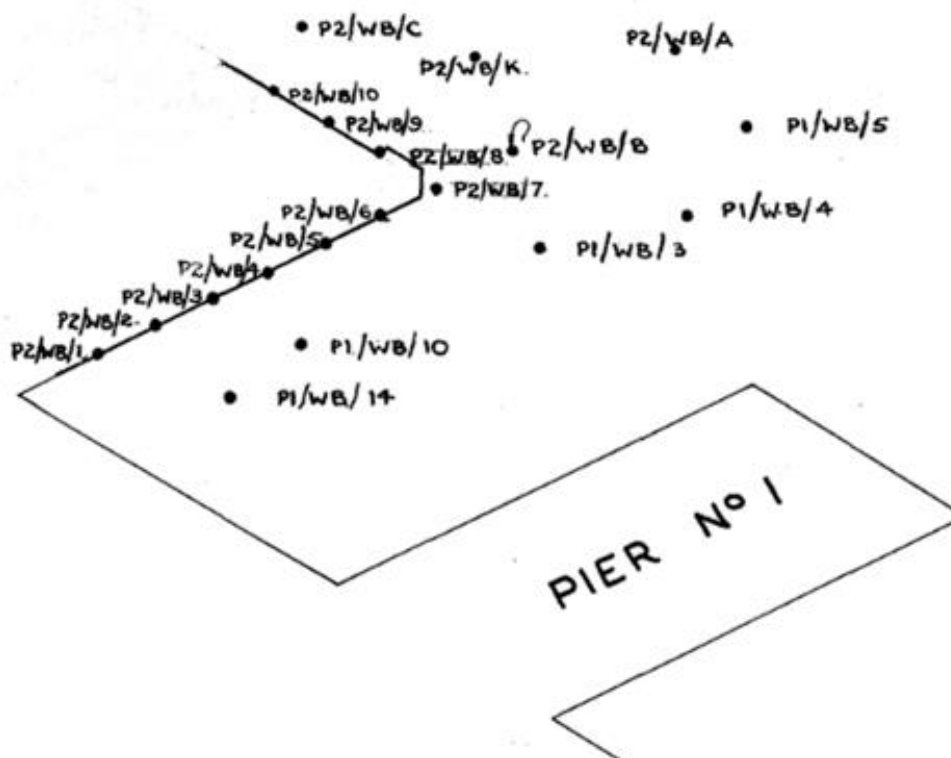
Table 4.1 Composition of the sediment at the relevant berths only - Percentage of grain size fractions and total organic content to the bulk weight and mean grain size (mm) of sediment sampled in Durban Bay.

Station	Gravel	VCS	CS	MS	FS	VFS	Mud	Mean	TOC
U	0.00	0.02	0.41	35.62	42.93	5.30	15.72	0.16	0.77
V	0.24	0.29	1.18	24.32	37.51	6.09	30.38	0.18	0.99
W	0.26	0.10	0.64	40.41	40.64	2.96	14.99	0.13	0.96
6	0.04	0.14	1.97	47.03	32.69	2.40	15.73	0.17	0.71
8	1.02	2.83	9.64	36.81	21.32	3.25	25.13	0.16	1.67

Source: Assessment of Sediment Quality in Durban Bay – 2019 (CSIR for TNPA)

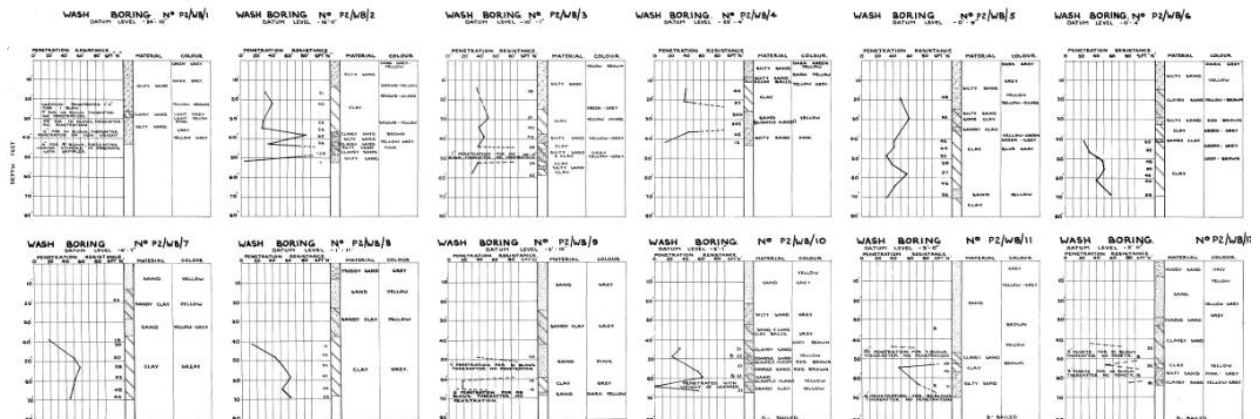
Notation VCS: very coarse-grained sand; CS: coarse-grained sand; MS: medium-grained sand; FS: fine-grained sand; VFS: very fine-grained sand; TOC: total organic content

Drawing 4.1 Positions of wash bore profiles in relevant berth areas



Source: TNPA Engineering

Drawing 4.2 Wash bore profiles (Also refer to Appendix 4.3 for enlarged view)



Source: TNPA Engineering

TNPA’s Engineering division carries out an assessment of the Durban Bay seabed at intervals deemed necessary. To this effect, the sediment quality is analysed, the percentages of the contents are measured with reference to the grain size and type, and the samples are drawn from below the sea floor to determine the configuration of the soil. The data extracted on the characteristics of the seabed by regular profiling, have clearly established that the application of well-managed NAABSA practices executed in the various ports of the world present no obstacle at the port of Durban.

CHAPTER FIVE

POTENTIAL LOSS OF GATEWAY AND OVERBORDER CARGO TO THE PORT DURBAN

This research has sought to identify and quantify some of the substantial losses of trans-shipment cargo to the South African ports in general, and to the port of Durban in particular, that arise from marine infrastructural limitations and cargo-handling inefficiencies. A potential haemorrhage of cargo volumes is not, however, limited to trans-shipment flows, and also may threaten the retention of gateway cargoes to/from cargo sources and sinks in Southern Africa. This chapter explores this theme: section 5.1 identifies the frailty and poor operating performance of rail services to the port of Durban as an area of concern; section 5.2 explores some of the cost disadvantages of Durban when measured against regional competitor ports; and section 5.3 interrogates the attributes and development plans of these principal competitor ports in some detail.

5.1 Weaknesses of rail connectivity to the port of Durban

The current rail network and infrastructure servicing the exit port of Durban is plagued with poor performance, due to continuous vandalism of the rail infrastructure, primarily cable theft along the rail network. Consequently, the cargo that is planned and mobilised for a nominated vessel may not be able to be connected. The result is a total short shipment of consignment or partial short shipment, the former in the case where a Letter of Credit is involved. If the consignment comprising a bill of lading is partially shipped, there could be issues at the ports of discharge, being unable to release the containers until the entire consignment is reconciled. The Bill of Lading, too, cannot be released until the entire consignment is shipped. In the interim period, the payment from the shipper to the carrying line is withheld. The consignee also does not release the payment to the shipper until the entire shipment is in possession, which has an impact on the business. The matter is further complicated as the part shipments attract storage cost at the ports of discharge until the entire booking on a Bill of Lading is reconciled. In case of the total short-shipment of cargo at the port of load, in the event of outstanding cargo by rail, there are punitive tariffs applicable for short-shipments of the portion of cargo that is stacked and not loaded. Additionally, as the units are stacked in the yard per port of discharge, this execution of placing line holds on the individual units initiates a substantial quantity of shuffles and rehandles in the yard. Owing to this dilemma, TPT declines the shipping lines' request to hold the units back in the terminal; the units that are left behind also block the terminal space contributing negatively to the stack occupancy. Here, the two entities, namely TPT and TFR, although emanating from the same parent organisation (Transnet), do not take responsibility for the shortfall of the other. There could be other Customs-related issues in case of partial shipments resulting in fines. Some ports demand manifesting of cargo before the units are shipped; with uncertainties around

the connectivity, this could result into more complex situations. This is a recurrent issue and the fact that the nominated cargo was planned for a particular vessel, which is unable to connect, results in the space reserved for this cargo remaining unutilised. Table 5.1 below details the container units shortshipped on some of the MSC vessels in 2020, due to issues with rail. Even though the units were stacked during the prescribed period in the inland terminals of City Deep (Johannesburg) or Pretoria, these units did not arrive in time at DCT to be loaded due to the problems encountered. This is despite the inland terminal stacks close five days prior the DCT stacks. As Table 5.1 indicates, the volumes short-shipped due to the recurring rail issues are quite substantial, having huge financial implications on the business. Unless the train arrives within the stipulated period at the railhead in the container terminal (DCT), and all the containers that are intended to be loaded are stacked, there are uncertainties over the shipments transported by rail, whether these containers will be loaded on the nominated carrier. The percentage of failed rail connections amount to 20% of the total railed volume (MSC).

The vessels are managed and planned to the optimum capacity; the cargo that could not be connected onto the nominated vessel needs to be imperatively connected to the next, imposing a need for short-shipments of the booked/planned cargo on the subsequent vessel, in order to accommodate the prior short-shipped cargo. This triggers a resonating effect of short-shipments and failing trust amongst shippers, seeking reliable solutions which are being offered by other regional ports, further crafted to suit the shippers' requirements in an attempt to secure cargo through those regional ports. The draft restrictions at the port of Durban and the constrained capacity as a result, has a fair share into compelling the shippers to seek alternative measures.

Transnet Freight Rail used to deploy 11 trains per day between Johannesburg and Durban until 2017. Since then and until present, the number of trains deployed per day on the NATCOR corridor has reduced to seven. There are various reasons for this reduced deployment, the main reason being the imbalance of containers available on both legs. The other contributory factors are the various rail sidings for specific produce, etc. There are issues with ageing locomotives not being replaced, and telemeter challenges which are used to establish communication between the locomotive and the wagons of the train, hence trains being cancelled due to failure of these equipment. The rails are ageing and require regular service and maintenance. Various trains, such as passenger, bulk (mainly minerals), cars, fuel/gas, besides containers run on the NATCOR sector whereby certain trains are given preference over others.

There has been a drive by Transnet to convince clients to convert from road to rail to optimise usage of the infrastructure and earn additional revenue. With the recurrent problems encountered, and the vulnerabilities that TFR is exposed to, this initiative will be a difficult target to achieve, at least in the near future. South Africa has a major rail network with a wide coverage across the country. The lack of strategic investment over the years and the neglect of the existing assets has had an adverse impact on the rail performance. The freight transported by road amounts to 89% of the of the total merchandise and only 11% is assigned to rail (Department of Transport, The Green Paper on Rail Policy). Substantial volumes of

goods, for which rail may be the preferred mode of transportation, are being road hauled, having an adverse impact on the rail freight earnings and the road infrastructure. Besides being unable to compete with the other modes of transportation, this deficit is not able to support the exports into the global markets. The decline in service reliability across the rail network motivated the Department of Transport to review the rail segment and subsequently publish the Draft Policy White Paper, which concluded that rail's competitive position has been jeopardised by lack in infrastructural upgrades, comparatively less effective equipment and poor security resulting in vandalism of overhead cables, etc., thus triggering general inefficiencies, unreliability in service and capacity constraints. The draft of the South African rail policy was published in 2017, and signalled an intention to refurbish the rail network, by way of investments in the infrastructure, to re-instate competition to the existing preferred mode of road transportation. A considerable scope for the expansion and development of rail in this arena was recognised. The propositions in the National Rail Policy were drafted with the intention to revive the rail transportation network by 2050 in a phased manner to support the economic recovery of the country. The proposed changes are to introduce a standard rail gauge on the national rail network in a bid to increase the general capacity by increasing the load, train length (by adding additional wagons), and speed. Further aims are to reduce harmful emissions and preserve the road infrastructure which is already subjected to extensive usage by freight carriage. The rail policy paves the way for concessions to private partnerships under the regulatory ambit of TFR, thus opening avenues for private sector investments and third-party access in areas where it may be collectively deemed appropriate, more specifically to revamp the branch lines. The plan is also to introduce a regulated competition in the freight rail sector, overseen by a Single Transport Economic Regulator. The Green Paper aims at facilitating the advancement of appropriate policies drafted in the White Paper on National Rail Policy (Department of Transport Green Paper August 2015; White Paper June 2017)

Some estimation of the extent of the short-shipped volumes is set in Table 5.1, overleaf, on a selected vessel-by-vessel basis during the course of calendar year 2020, in each case setting out the number of container units affected and the reasons for the short shipment.

Table 5.1 Planned rail volumes shortshipped

INGWE / AFRICA EXPRESS - RAIL SHORT SHIPMENTS							
VESSEL	VOY	DATE	BOOKING REF	BKG QTY	UNITS	CTO PORT	REASON FOR RAIL SHORT SHIPMENT
MSC PARIS	FY951R	2020/01/13	031DBI1904151	50	1X40'	SINGAPORE	REQUESTED PHYSICAL ONBOARD, AWAITING FEEDBACK
			031DBI1905129	28	1X40' + 2X40'	SINGAPORE	RAIL UNITS NOT IN STACK
			031DBI1905130	50	3X40'	SINGAPORE	RAIL UNITS NOT IN STACK
			031DBI1905181	2	1X40'	SINGAPORE	RAIL UNITS NOT IN STACK
			031DBI2000026	1	1X40'	SINGAPORE	RAIL UNITS NOT IN STACK
			031DBL2000054	1	1X20'	XINGANG	RAIL UNITS NOT IN STACK
			031DBL1923672	201	81X20'	XINGANG	RAIL UNITS NOT IN STACK
			031DBL1924340	150	66X40'	NINGBO	RAIL UNITS NOT IN STACK
			TOP UP	450	2X40'	NINGBO	UNABLE TO LOCATE RAIL UNITS AT TIME OF LOADING
TOP UP	9X40'	NINGBO	RAIL UNITS TOO DEEP IN STACK - UNABLE TO REACH FOR SHIPMENT				
MSC PERLE	FY003R	2020/02/10	031DBL2001038	1	1X20'	NINGBO	RAIL UNIT NOT IN STACK - NOT RAILED FROM CITY DEEP
			031DBL1923670	123	4X20'	XINGANG	RAIL UNITS NOT IN STACK - NOT RAILED FROM CITY DEEP
MSC DARDANELLES	FY005R	2020/02/11	031DBI1905152	43	43X40'	QINGDAO	RAIL UNITS NOT IN STACK - NOT RAILED FROM CITY DEEP - DUE TO SHORTAGE OF WAGONS - REDUCE BOOKING TO 20X40'
			031DBI1905161	57	57X40'	QINGDAO	RAIL UNITS NOT IN STACK - NOT RAILED FROM CITY DEEP - DUE TO SHORTAGE OF WAGONS - REDUCE BOOKING TO 36X40'
			031DBI2000183	76	76X40'	QINGDAO	RAIL UNITS NOT IN STACK - NOT RAILED FROM CITY DEEP - DUE TO SHORTAGE OF WAGONS - REDUCE BOOKING TO 51X40'
			031DBL1922716	20	9X40'	QINGDAO	RAIL UNITS NOT IN STACK - NOT RAILED FROM CITY DEEP - DUE TO SHORTAGE OF WAGONS - REDUCE BOOKING TO 9X40'
			031DBL2000105	50	50X40'	ABU DHABI	RAIL UNITS NOT IN TERMINAL - NOT RAILED FROM CITY DEEP DUE TO SHORTAGE OF WAGONS
			031DBL2000801	40	40X20'	ABU DHABI	RAIL UNITS NOT IN TERMINAL - NOT RAILED FROM CITY DEEP DUE TO SHORTAGE OF WAGONS
			031DBL2000802	40	40X20'	ABU DHABI	RAIL UNITS NOT IN TERMINAL - NOT RAILED FROM CITY DEEP DUE TO SHORTAGE OF WAGONS
SM VANCOUVER	ZF006R	2020/02/17	031DBL2001791	5	1X20'	ABU DHABI	RAIL UNIT NOT IN STACK
			031DBI2000199	37	1X40'	HAZIRA	RAIL UNIT NOT IN STACK
			031DBL1923503	6	1X20'	MUNDRA	RAIL UNIT NOT IN STACK
			031DBL2000843	179	21X20'	SINGAPORE	RAIL UNITS NOT IN STACK
SEAMAX BRIDGEPORT	ZF022R	2020/06/22	046JHL2004623	52	30X20'	ABU DHABI	RAIL UNITS NOT IN TERMINAL - REDUCE BOOKING TO 22X20'
			031DBL2010623	1	1X40'	COLOMBO	RAIL UNITS NOT IN TERMINAL - DUE TO CABLE THEFT
			032CAL2009061	6	6X20'	COLOMBO	RAIL UNITS NOT IN TERMINAL - DUE TO CABLE THEFT
			046JHL2005505	1	1X20'	COLOMBO	RAIL UNITS NOT IN TERMINAL - DUE TO CABLE THEFT
			031DBL2007829	1	1X40'	COLOMBO	RAIL UNITS NOT IN TERMINAL - DUE TO CABLE THEFT
			046JHL2005737	1	1X20'	MUNDRA	RAIL UNITS NOT IN TERMINAL - DUE TO CABLE THEFT
			046JHL2005283	50	50X20'	SHANGHAI	RAIL UNITS NOT IN TERMINAL - REDUCE BOOKING TO 41X20'
			046JHL2005296	50	50X20'	SHANGHAI	RAIL UNITS NOT IN TERMINAL - REDUCE BOOKING TO 47X20'
			046JHL2005292	22	22X40'	SHANGHAI	RAIL UNITS NOT IN TERMINAL - REDUCE BOOKING TO 9X20'
			046JHL2005560	40	40X20'	SHEKOU	RAIL UNITS NOT IN TERMINAL - DUE TO CABLE THEFT - REDUCE BOOKING TO 16X20'
			031DBL2000824	23	23X20'	QINGDAO	RAIL UNITS NOT IN TERMINAL - DUE TO CABLE THEFT - REDUCE BOOKING TO 14X20'
MSC AVNI	ZF024R	2020/06/25	031DBI2001751	38	38X40'	QINGDAO	TRANSNET FREIGHT RAIL (TFR) DID NOT RAIL UNITS DUE TO INBALANCE OF WAGONS AND LOCOMOTIVES
			031DBI2002872	28	28X40'	QINGDAO	TRANSNET FREIGHT RAIL (TFR) DID NOT RAIL UNITS DUE TO INBALANCE OF WAGONS AND LOCOMOTIVES
			031DBI2002872	38	38X40'	QINGDAO	TRANSNET FREIGHT RAIL (TFR) DID NOT RAIL UNITS DUE TO INBALANCE OF WAGONS AND LOCOMOTIVES
			031DBI2002878	57	57X40'	QINGDAO	TRANSNET FREIGHT RAIL (TFR) DID NOT RAIL UNITS DUE TO INBALANCE OF WAGONS AND LOCOMOTIVES
			031DBI2002978	38	38X40'	QINGDAO	TRANSNET FREIGHT RAIL (TFR) DID NOT RAIL UNITS DUE TO INBALANCE OF WAGONS AND LOCOMOTIVES
			046JHL2005630	3	3X20'	QINGDAO	TRANSNET FREIGHT RAIL (TFR) DID NOT RAIL UNITS DUE TO INBALANCE OF WAGONS AND LOCOMOTIVES

			046JHL2005634	2	2X20'	QINGDAO	TRANSNET FREIGHT RAIL (TFR) DID NOT RAIL UNITS DUE TO INBALANCE OF WAGONS AND LOCOMOTIVES
			046JHL2006075	7	7X20	QINGDAO	TRANSNET FREIGHT RAIL (TFR) DID NOT RAIL UNITS DUE TO INBALANCE OF WAGONS AND LOCOMOTIVES
			046JHL2006489	37	37X20'	QINGDAO	TRANSNET FREIGHT RAIL (TFR) DID NOT RAIL UNITS DUE TO INBALANCE OF WAGONS AND LOCOMOTIVES
MSC LUDOVICA	ZF007R	2020/02/26	031DBI2000425	2	2X20'	ABU DHABI	RAIL UNITS NOT IN TERMINAL
			031DBL2002388	16	16X40'	ABU DHABI	RAIL UNITS NOT IN TERMINAL
			031DBL2002825	20	20X20'	COLOMBO	RAIL UNITS NOT IN TERMINAL - DUE TO DERAILMENT
			031DBI2000239	25	25X40'	HAZIRA	RAIL UNITS NOT IN TERMINAL - REDUCE BOOKING TO 22X40'
			031DBI2000227	76	26X40'	SHANGHAI	RAIL UNITS NOT IN TERMINAL - DUE TO DERAILMENT
			031DBL2000802	40	40X20'	SHANGHAI	RAIL UNITS NOT IN TERMINAL - REDUCE BOOKING TO 38X20'
AMERICA	ZF027R	2020/07/07	031DBL2001250	12	2X20'	BIN QASIM	RAIL UNITS NOT IN STACK
			046JHL2008023	1	1X20'	JEBEL ALI	RAIL UNIT NOT IN STACK
			046JHL2008057	1	1X20'	JEBEL ALI	RAIL UNIT NOT IN STACK
			046JHL2008165	1	1X20'	JEBEL ALI	RAIL UNIT NOT IN STACK
			031DBL2011438	2	1X40'	MUNDRA	RAIL UNIT NOT IN STACK
			031DBL2010913	40	40X20'	NHAVA SHE	RAIL UNITS NOT IN TERMINAL - DUE TO CABLE THEFT
MSC SASHA	ZF035R	2020/07/09	031DBI2004135	38	1X40'	SINGAPORE	RAIL UNIT ARRIVED LATE AT THE TERMINAL
			031DBI2004140	38	12X40'	SINGAPORE	RAIL UNIT NOT IN STACK - NOT RAILED FROM CITY DEEP
			031DBI2004168	76	26X40'	SINGAPORE	RAIL UNIT NOT IN STACK - NOT RAILED FROM CITY DEEP
			AP001	1	1X40'	SINGAPORE	RAIL UNIT ARRIVED LATE AT THE TERMINAL
NORTHERN JULIE	ZF028R	2020/07/21	046JHL2008020	2	2X20'	ABU DHABI	RAIL UNITS NOT IN STACK
			031DBL2008285	170	1X20'	COLOMBO	RAIL UNIT DAMAGED
			046JHL2007994	39	14X20'	COLOMBO	RAIL UNITS ARRIVED LATE AT THE TERMINAL
			031DBL1924384	17	3X20'	MUNDRA	RAIL UNITS ARRIVED LATE AT THE TERMINAL
			046JHL2007534	2	2X20'	NINGBO	RAIL UNITS ARRIVED LATE AT THE TERMINAL
			046JHL2007957	1	1X20'	SHEKOU	RAIL UNIT ARRIVED LATE AT THE TERMINAL
			046JHL2006049	2	2X20'	SINGAPORE	RAIL UNITS ARRIVED LATE AT THE TERMINAL
			046JHL2006100	7	4X20'	SINGAPORE	RAIL UNITS ARRIVED LATE AT THE TERMINAL
			046JHL2006542	130	18X20'	SINGAPORE	RAIL UNITS ARRIVED LATE AT THE TERMINAL
			046JHL2007269	2	1X20'	SINGAPORE	RAIL UNIT ARRIVED LATE AT THE TERMINAL
			046JHL2007540	1	1X20'	SINGAPORE	RAIL UNIT ARRIVED LATE AT THE TERMINAL
CONTI LYON	ZF029R	2020/08/05	031DBL2015615	3	3X40'	ABU DHABI	RAIL UNITS NOT IN STACK
			031DBL2013785	10	10X20'	COLOMBO	RAIL UNITS NOT IN STACK - DUE CABLE THEFT
			031DBI2003334	38	38X40'	HAZIRA POR	RAIL UNITS NOT IN TERMINAL - TRAIN STUCK IN WITBANK
			031DBI2003842	11	11X40'	HAZIRA POR	RAIL UNITS NOT IN TERMINAL - TRAIN STUCK IN WITBANK
			046JHL2007661	114	47X20'	HAZIRA POR	RAIL UNITS NOT IN TERMINAL - TRAIN STUCK IN WITBANK
			031DBL2015610	9	5X40'	JEBEL ALI	RAIL UNITS NOT IN STACK - DUE TO CABLE THEFT
			047PRL2000698	2	2X40'	JEBEL ALI	RAIL UNITS NOT IN STACK - DUE TO CABLE THEFT
			031DBI2003843	129	54X40'	MUNDRA	RAIL UNITS NOT IN STACK - DUE TO CABLE THEFT
			031DBL2015099	24	24X20	MUNDRA	RAIL UNITS NOT IN STACK - DUE TO CABLE THEFT
HYUNDAI LOYALTY	ZF031R	2020/08/17	046JHL2008366	111	49X20'	COLOMBO	RAIL UNITS NOT IN TERMINAL - DUE TO DERAILMENT
			046JHL2009746	36	33X20'	COLOMBO	RAIL UNITS NOT IN TERMINAL - DUE TO DERAILMENT
			031DBL2014375	3	1X40'	SINGAPORE	RAIL UNIT NOT IN TERMINAL
			031DBL2015088	1	1X20'	SINGAPORE	RAIL UNIT NOT IN TERMINAL
			046JHL2005448	112	112X20'	XINGANG	RAIL UNITS NOT IN TERMINAL - DUE TO DERAILMENT
MSC CANDICE	ZF036R	2020/09/28	031DBI2004571	38	1X40'	HAZIRA	RAIL UNIT NOT IN STACK
			032CAL2023918	1	1X20'	SHANGHAI	RAIL UNIT NOT IN STACK
			031DBL2016938	10	5X20'	NHAVA SHE	RAIL UNITS NOT IN STACK - DUE TO DERAILMENT AND CABLE THEFT
			031DBL2017341	182	91X20'	NHAVA SHE	RAIL UNITS NOT IN STACK - DUE TO DERAILMENT AND CABLE THEFT
			031DBL2018130	16	11X20'	NHAVA SHE	RAIL UNITS NOT IN STACK - DUE TO DERAILMENT AND CABLE THEFT
MSC VANESSA	IW102F	2021/02/01	046JHL2018779	5	5X20'	ABU DHABI	RAIL UNITS NOT IN STACK - NOT RAILED FROM CITY DEEP
			046JHL2019581	5	5X20'	ABU DHABI	RAIL UNITS NOT IN STACK - NOT RAILED FROM CITY DEEP
			046JHL2100292	2	2X20'	ABU DHABI	RAIL UNITS NOT IN STACK - NOT RAILED FROM CITY DEEP
			031DBI2100070	57	10X40'	SINGAPORE	RAIL UNITS NOT IN STACK - NOT RAILED FROM CITY DEEP
			031DBI2100122	5	1X40'	HAZIRA	RAIL UNIT NOT IN STACK - NOT RAILED FROM CITY DEEP

Source: MSC / Transnet Freight Rail (TFR)

5.2 Landside cost comparisons between Durban and regional competitor ports

Traditionally, Durban was the primary exit port of choice for SADC countries; over the last decade, this perception has radically changed. For example, copper from the Copperbelt, Zambia and the DRC has now migrated to the exit ports of Walvis Bay and Dar es Salaam, considering the exit port charges and logistic cost are lower and there is regular bi-directional cargo to the transporters. This bi-directional traffic is one of the strategic incentives used by other ports to attract business. Pre-carriage and port charges via Beira (Mozambique), Walvis Bay (Namibia) and Dar es Salaam (Tanzania) are also substantially lower when compared to Durban. Import cargo via Durban into Botswana, Zimbabwe and Zambia is being lost to Beira, Walvis Bay, and Dar es Salaam for the same reason. Import cargo via Beira into Zimbabwe and Zambia is coupled with bi-directional export cargo of copper, manganese and tobacco. Import cargo via Dar es Salaam into the Copperbelt of Zambia and Democratic Republic of Congo is coupled with bi-directional export cargo of copper from Ndola and Kitwe, respectively. When there is consistent bi-directional cargo to/from the ports of Walvis Bay, Beira and Dar es Salaam, which has been the case in the latter decade, the on-carriage and pre-carriage cost to/from these entry ports to the consignees or from the shippers is automatically reduced. On this basis, coupled with lower port charges, and uncertainties within South African ports, it is obvious that economies of scale dictate that the cargo will be routed via these other African ports of entry, with less favourable interest in the South African ports.

Below is the total cost of import or export of a 40' unit from Beira, Dar es Salaam, Walvis Bay and Durban to Lusaka, Zambia

Ex Beira = USD 4800 per 40'

Ex Walvis Bay = USD 5500 per 40'.

Ex Dar es Salaam = USD 5500 per 40'.

Ex Durban = USD 6500 per 40'

Source of information: Walvis Bay Corridor Group

For Harare, Bulawayo, and Mutare in Zimbabwe, the preferred corridors are Beira over Durban.

Beira-Harare = USD 1400

Durban-Harare = USD 2200

Beira-Bulawayo = USD 2200

Durban-Bulawayo = USD 2600

Beira-Mutare = USD 800

Durban is not an option for Mutare

Transport cost from Matsapha, Swaziland to Durban and Maputo

Road haul ex Matsapha to Durban = USD 1800/20'; USD 1800/40'

Rail ex Matsapha to Maputo: 20' < 22tons = USD 760; 20' > 22 tons = USD 800

40' < 26Tons = USD 950; 40' > 26 tons = USD 1015

From the Copperbelt/DRC to Durban and Walvis Bay

Ndola/ Kitwe/ Chingola (Copperbelt/DRC) to Durban via Johannesburg

= USD 4800/20'; USD 5500/40'

Ndola/ Kitwe/ Chingola (Copperbelt/DRC) to Walvis Bay (Namibia)

= USD 4400/20'; USD 5000/40'

From Botswana and Lesotho, most of the traffic is via Durban.

Source: This study

The tariffs quoted are dynamic and depend on a number of factors, most importantly the place of registration of the transporter and the availability of bi-directional load. The transport companies are usually based at the seaports, and hence charge a premium on the import leg originating at the seaport of discharge to the hinterland destinations. The tariff on the return load could be negotiated at a discounted rate depending on the demand. It is vital that the ports system have a good connectivity with the road and rail network to demonstrate that the port offers a facility of choice for both the import and export leg, thus maintaining a sustainable cost of the overall business module, which is quite competitive. There are other issues involving Customs and Home Security with regards to trans-border movements which could be quite overwhelming and may have a direct implication on the tariff.

With the envisaged berth deepening project at DCT, TFR had equalised the rail rate ex Gauteng to Coega with a view to regulate the container traffic into Durban container terminal during the proposed construction phase when berths would be taken out service in sequence. Little insight was given to the fact that equalising the rail tariff without due consideration to the inadequate rail network to/from Coega to Gauteng would not support the migration of significant container volumes from the NATCOR. The vast majority of the rail network does not have sufficient rail loops along the network to support the increased container volumes into Coega. Additionally, this rail network into Coega also supports the bulk manganese trains and containerised rail traffic from Bloemfontein. A deviation of container traffic from Gauteng to Cape Town is uneconomical based on an additional transshipment cost and lengthy transit time, further impacted by unreliability of the rail service. Lack of locomotives or crew resources have been a recurring reason for some of the failures along this route. With a failing port-rail network, besides being one of the ten most expensive in the world, it is unlikely that TPT or TFR will attract additional cargo away from other developing African ports, unless a reliable network is capacitated and established to collectively regain the confidence of the market.

5.3 Comparator and potentially competitive ports in Southern Africa

The following notes set out developments that are gaining pace in the neighbouring ports around South Africa and the plans laid out for the future. This evolution will have an impact on the volumes of cargo emanating from and destined for the hinterland of the Southern African regions, which earlier was predominantly routed through the port of Durban. This section provides a brief description of these potential competitor ports, their present status and their prospects.

5.3.1 Maputo

The port of Maputo has an excellent connectivity by road to South Africa, Swaziland and Zimbabwe and exceptional direct sea links to the Far East and Middle East, besides connections to the other ports of the world. The waiting period for a berth is almost non-existent and the terminal is efficient with regard to cargo handling, resulting in quick turnaround times. The port of Maputo hence comes across as an attractive option. Maputo is equipped with three mobile harbour cranes. The productivity achieved by the mobile harbour cranes averages a GCH of 16-18 moves per hour (as per the productivity report on ships of Mediterranean Shipping Company calling the port of Maputo). At chart datum, the depth in the channel in Maputo is 14.2m and that at the berth is 12.0m. Vessels exceeding a draft of 12.2m need to apply to the Harbour Master's Office for due consideration, depending on the tide and other relevant factors. The height of the high tide at springs averages to approximately 3.2m and at neaps, 2.5m. The height of the low tide at springs averages to approximately 0.5m and at neaps, 1.5m. The maximum length of vessels handled at the port of Maputo is 300m. The limitation remains the outreach of the cranes that are not able to handle beyond 15 rows across. In fact, full containers can only be handled up to 13 rows and beyond the 13th row, up to the 15th row, only empty units may be handled (This study, based on MSC data; Port of Maputo Handbook and Directory).

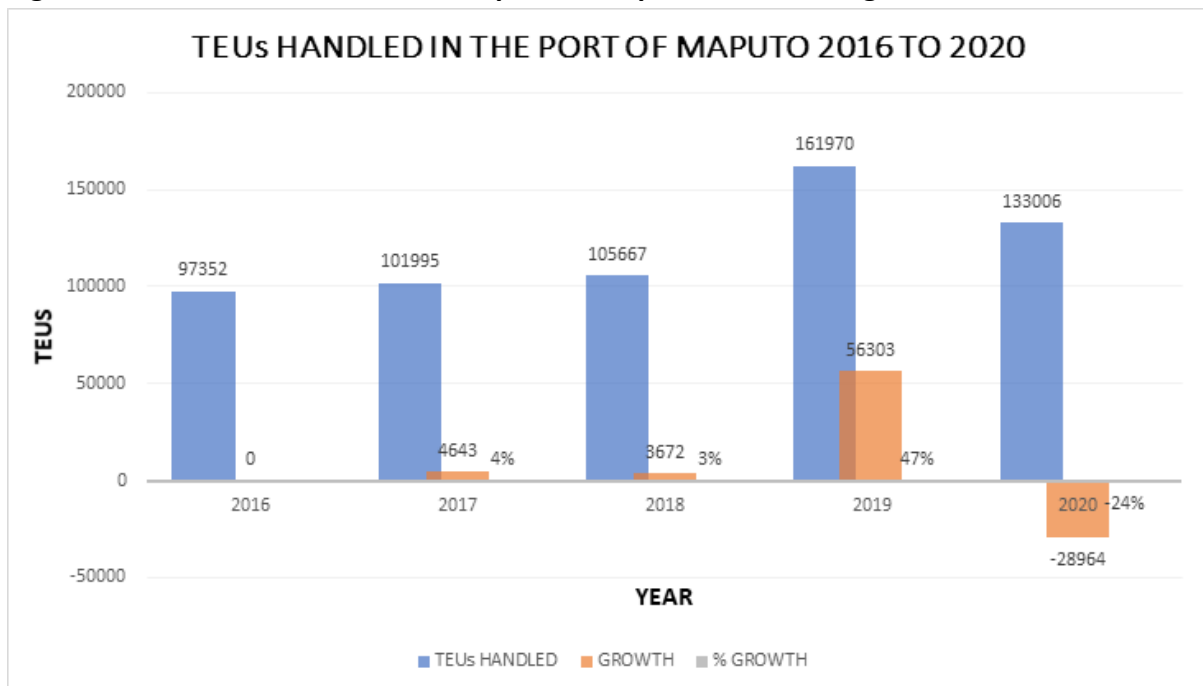
The year 2020 recorded a throughput of 133 006 TEUs, but the nominal annual terminal capacity is 350 000 TEUs. Maputo Container Terminal, run by DP World, has been canvassing relentlessly, inviting volumes to increase its throughput. Table 5.2 and Figure 5.1 display the volumes handled for the last five years, and demonstrate the considerable volume growth, notably to 2019. The last year, 2020, has been hit with the COVID-19 pandemic and consequently the upward trend could not be maintained.

Table 5.2 Containers handled in the port of Maputo and annual grow

YEAR	TEUs HANDLED	GROWTH	% GROWTH
2016	97352		
2017	101995	4643	4%
2018	105667	3672	3%
2019	161970	56303	47%
2020	133006	-28964	-24%

Source: DP World Maputo

Figure 5.1 Containers handled in the port of Maputo and annual growth



Source: DP World Maputo

In the recent past, DP World has been extensively involved in capacity enhancement with specific focus to cater to the hinterland destinations. It has plans to deploy/invest in gantry cranes, but the project has been deferred due to COVID-19. The refurbishment of the yard pavement is in progress with the initial phase comprising an area of 10 hectares. Upon completion, the terminal capacity will increase by 200 000 TEUs annually. A new rail siding with four tracks, each with a length of 375m, has been very recently constructed. The year 2020 registered a significant growth of 33% in the rail traffic. Most of the cargo is still moved by road, with the rail constituting approximately 30% of the total volume (DP World Maputo). This steady growth in volumes have prompted the terminal operator to invest in capacity enhancement and upgrading of the port’s infrastructure; the plan of note is the berth rehabilitation project with the intention to deepen the berths to 16m. Table 5.3 gives an indication of the phased development programme for the port of Maputo. The port of Maputo comes across as a more viable option when a comparison is drawn with the port of Durban for three main reasons, namely:

- No waiting period for a berth
- Consistency in productivity and hence greater performance predictability
- Significant advantages over Durban in respect of shorter landside distances from Maputo to several inland destinations of note, as set out in Table 5.4.

Table 5.3 Port of Maputo: Phased development programme

Terminal Specification	Completed	Phase 3a (2020)	Phase 3b (2022)
Capacity	0.35 million TEUs	0.50 million TEUs	1 million TEUs
Quay Length	308 metres	655 metres	655 metres
Max LOA	330 metres	330 metres	330 metres
Terminal Size	15 Hectares	17 Hectares	30 Hectares
Depth Alongside	12 Metres C.D.	16 Metres C.D.	16 Metres C.D.
Container Yard	2450 TEUs Ground Slots	2450 TEUs Ground Slots	5000 TEUs Ground Slots
Rail Siding	4 x 375m	4 x 375m	4 x 750m
Reefer Points	600 Points (415V, 3 Phase AC)	600 Points (415V, 3 Phase AC)	800 Points (415V, 3 Phase AC)
Quay Cranes	3 MHC	3 STS (65m outreach), 3 MHC	6 STS (65m outreach)
Rubber Tyre Gantry Cranes	6 RTG	12 RTG	24 RTG

Source: DP World Maputo

Table 5.4: Comparison of rail distances between Maputo and Durban

Rail distances		
Location	Maputo	Durban
City Deep, Johannesburg (South Africa)	581 km	741 km
Witbank (South Africa)	437 km	819 km
Polokwane (South Africa)	550 km	935 km
Gweru (Zimbabwe)	967 km	1764 km
Bulawayo (Zimbabwe)	1083 km	1880 km
Matsapha (Swaziland)	228 km	544 km

Source: DP World Maputo

5.3.2 Beira

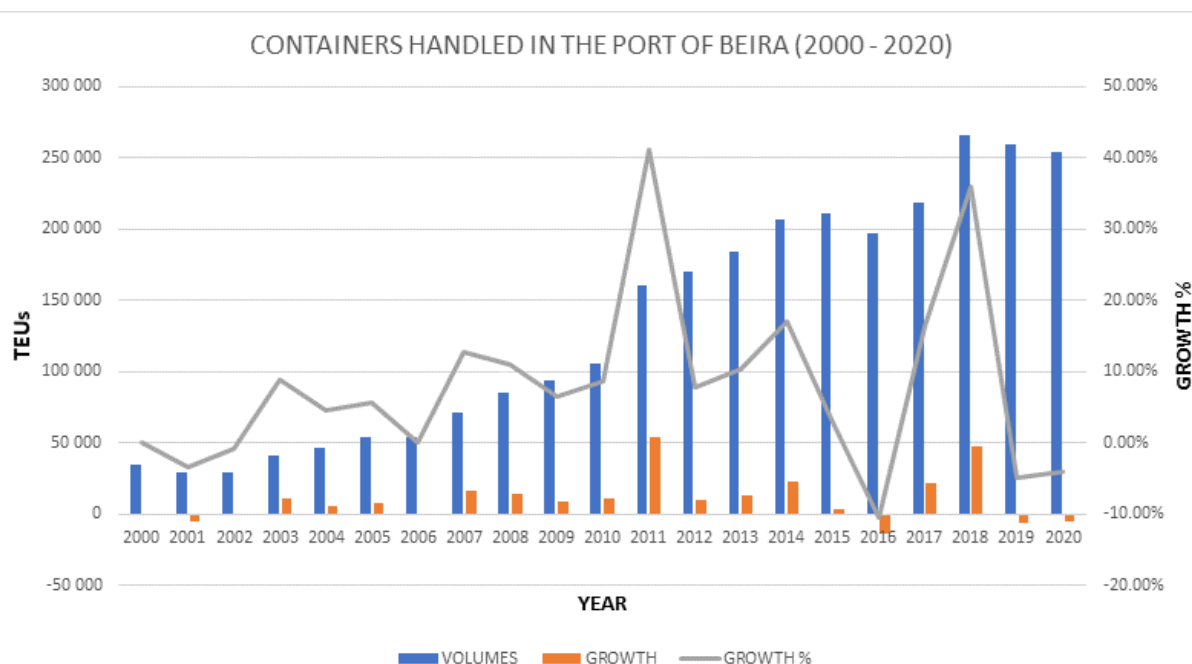
Beira is strategically placed in the middle region of Mozambique, with direct links, by road or by rail, to the commercial zones of the southern African hinterland, namely Zimbabwe, Botswana, Malawi, Zambia and Democratic Republic of Congo. The container terminal at the port of Beira has a quay length of 645m, equipped with four gantries, two of which are fairly new post-Panamax gantries, commissioned in 2013. The depth in the channel in Beira is maintained at 8.0m and the depths at the berths are maintained at 12.0m at chart datum (Cornelder de Mozambique). The range of tides in Beira is quite substantial, making it possible to berth much deeper vessels up to 13.5m, depending on the day and height of tide. The height of the high tide at springs averages to approximately 6.5m and at neaps is 4.5m. The height of the low tide at springs averages to approximately 1.0m and at neaps is 2.5m. The port has a comparatively large yard capacity of 17 636 TEUs with an annual capacity throughput of 300 000 TEUs. The continual investment programme will boost this capacity to 700 000 TEUs in a phased manner. As it can be seen from Table 5.5 and Figure 5.2, the terminal has logged a steady increase in container volumes, which is evidence of the increased shipping activity and shift of preferences. Further, Table 5.6 makes a comparison of the distances by road to hinterland cargo sources and destinations; this confirms that the port of Beira is clearly placed more advantageously when compared to Durban (South Africa) and Dar Es Salaam (Tanzania) with regards to the distances to the inland destinations of Zimbabwe, Malawi, Zambia and Democratic Republic of Congo.

Table 5.5 Containers handled at the Port of Beira: 2000-2020

YEAR	VOLUMES	GROWTH	GROWTH %
2000	34 500	-	-
2001	30 000	-4 500	-3.40%
2002	29 100	-900	-0.68%
2003	40 800	11 700	8.85%
2004	46 800	6 000	4.54%
2005	54 300	7 500	5.67%
2006	54 300	-	-
2007	71 200	16 900	12.78%
2008	85 700	14 500	10.96%
2009	94 300	8 600	6.50%
2010	105 700	11 400	8.62%
2011	160 200	54 500	41.21%
2012	170 600	10 400	7.86%
2013	184 500	13 900	10.51%
2014	207 200	22 700	17.17%
2015	211 000	3 800	2.87%
2016	197 200	-13 800	-10.44%
2017	218 800	21 600	16.33%
2018	266 300	47 500	35.92%
2019	259 900	-6 400	-4.84%
2020	254 700	-5 200	-3.93%

Source: Cornelder de Mozambique

Figure 5.2 – Containers handled at the Port of Beira: 2000-2020



Source: Cornelder de Mozambique

Table 5.6 Comparison of distances to the hinterland destinations

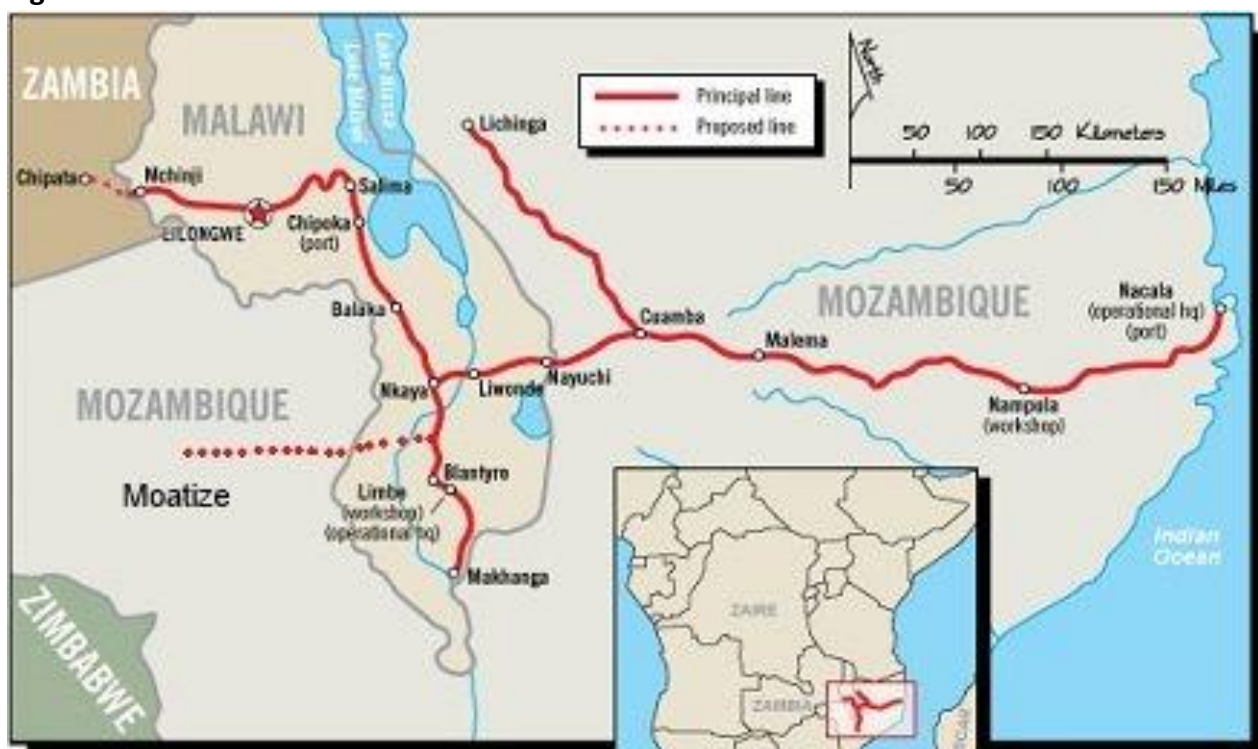
ROAD DISTANCES IN KM							
PORTS	HARARE ZIMBABWE	BULAWAYO ZIMBABWE	LUSAKA ZAMBIA	KITWE ZAMBIA	LUBUMBASHI DRC	BLANTYRE MALAWI	LILONGWE MALAWI
BEIRA	559	726	1054	1370	1600	812	950
DURBAN	1711	1454	2380	2707	2611	2323	2678
DAR ES SALAAM	2634	3028	1985	1951	2290	2031	1667

Source: Cornelder de Mozambique

5.3.3 Nacala

The port of Nacala (Mozambique) caters to its own hinterland as well as landlocked Malawi, served by a 900km rail link, as shown in Figure 5.3. The cargo exported from Nacala is quite diverse and of substantial value, namely tobacco, cotton, tea, cashew nuts, groundnuts, sisal, timber, maize, and hides. The port of Nacala is the foremost deep water natural harbour in Africa with channel depth of 65m and with the channel width suitable to accommodate vessels in excess of post-Panamax dimensions. The depths at the container berths are 15.0 m. The terminal can handle up to 100 000 TEUs annually, with a storage capacity of 10 000 TEUs (Corredor do Norte).

Figure 5.3 - Rail link to Malawi from Nacala



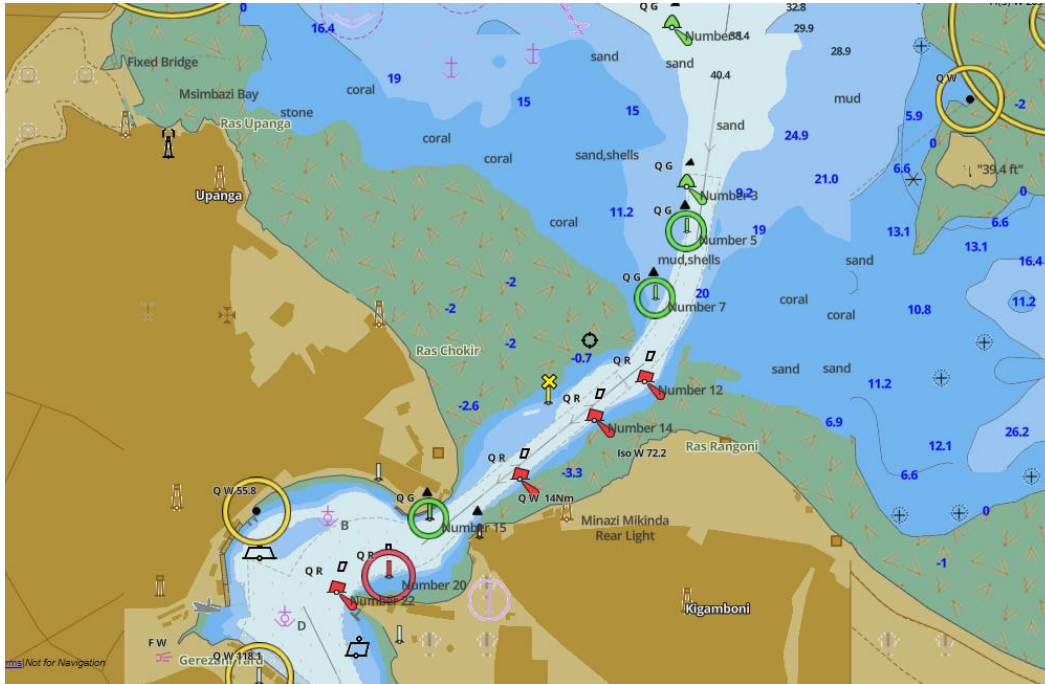
Source: Nacala port and rail corridor

5.3.4 Dar es Salaam

The Dar es Salaam container terminal is owned by the Tanzania Ports Authority, operated under a private lease agreement by Tanzania International Container Terminal Services Ltd (TICTS), run by the Hutchison Group. The depth in the channel at Dar es Salaam is 10.20m and at the container berths is 12.0m, at chart datum. The height of the high tide at springs averages to approximately 3.5m and at neaps is 2.4m. The height of the low tide at springs averages to approximately 0.3m and at neaps is 1.4m (Admiralty Tide Tables). The total quay length is approximately 700m. The terminal operates with a fleet of 6 gantry cranes; 4 Panamax gantries were commissioned in a phased manner between 2010 and 2014, and 2 new post-Panamax gantry cranes were commissioned in 2016 to boost the capacity further. The terminal has a storage capacity of approximately 16 000 TEUs. The port handled approximately 600 000 TEUs in 2020. The port's capacity growth plan includes dredging and widening the entrance channel and the turning basin. The existing container berths are planned to be dredged to 14m, and two additional deeper container berths will be constructed, increasing the capacity by 750 000 TEUs (TICTS; Africa Ports and Ships, Tanzania Ports Authority; Port Strategy, Gateway to Africa, May 2019; PIDA, Dar es Salaam Port Modernisation). The port is strategically placed to serve the landlocked countries of Malawi, Zambia, Democratic Republic of Congo, Burundi, Rwanda and Uganda. The port also serves as an opportune freight linkage not only to and from the countries listed, but also to the rest of the world owing to its ideal location along the Indian Ocean routes. Although the port handbook stipulates the maximum size of container vessels that may be handled as 250m,

container vessels of up to 300m LOA and 13.5m draft are handled at the port of Dar es Salaam (This study). Images 5.1 and 5.2 show the approaches into the port of Dar es Salaam. The depths are displayed in feet. (SEARATES by DP World, Port of Dar es Salaam; Tanzania Ports Handbook 2019-2020)

Image 5.1: Nautical Chart of Dar es Salaam port approaches



Source: ENC CELL - Tanzania - Dar Es Salaam (Marine Chart : MU_GB54232A)

Image 5.2: Nautical Chart of Dar es Salaam internal channel and berths

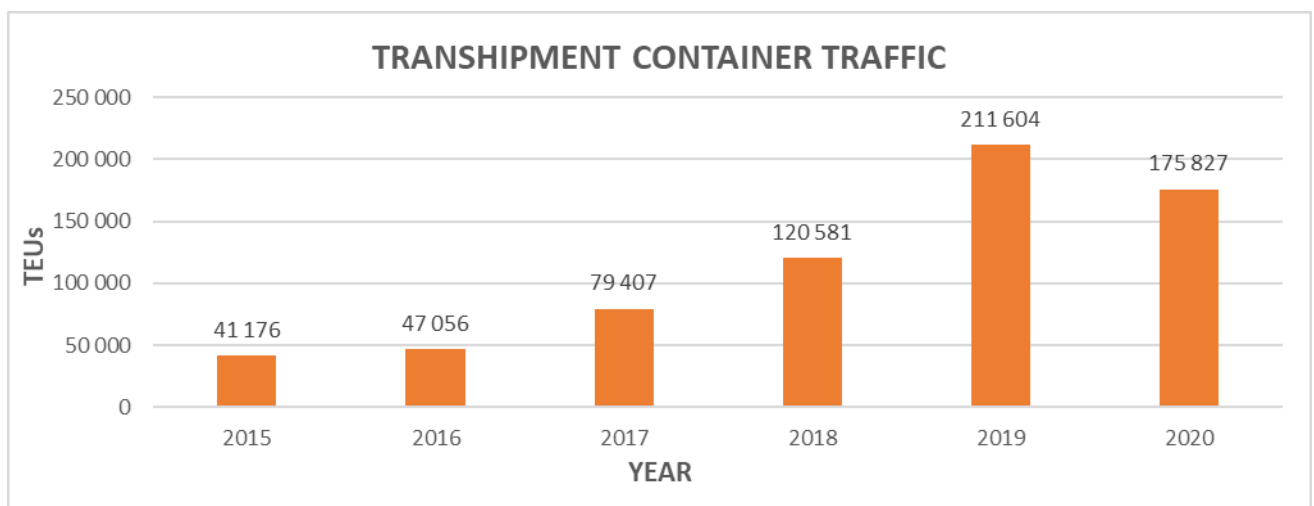


Source: ENC CELL - Tanzania - Dar Es Salaam (Marine Chart: MU_GB54232A)

5.3.5 Mombasa

Mombasa is by far the largest port on the East African coast and is managed by Kenya Ports Authority. It is a naturally deep-water port with the controlling minimum depth at the outer channel maintained at 17.5m at chart datum. The port has two container terminals, namely *Terminal 1* and *Terminal 2*. *Terminal 1* has a length of 840m, and *Terminal 2* has a length of 560m. The depth at *Terminal 2* is 15.0m at chart datum (Kenya Ports Authority). The terminal has an annual throughput capacity of 2.65 million TEUs. The total containers handled in 2018 registered approximately 1.304 million TEUs, and in 2019, 1.416 million TEUs. In 2020, there was a slump in the volumes handled due to the COVID-19 pandemic; the annual volumes handled were 1.358 million TEUs. However, the first quarter of 2021 has registered a significant increase in volumes as compared to the similar period in 2020 (Kenya Ports authority). Figure 5.4 displays the annual evolution of trans-shipment container traffic. The year 2019 recorded a noteworthy increase of 74% with 211 204 TEUs as compared to the trans-shipment traffic of 121 577 TEUs registered in 2018. In 2020, there was a slump in the trans-shipment volumes due to the pandemic, with a volume throughput of 175 827 TEUs, a decline of 17% as compared to 2019. The transshipment volumes constituted approximately 9% of the total TEUs handled in 2018, approximately 15% in 2019 and approximately 13% in 2020. [Kenya News Agency (KNA); Kenya Ports Authority (KPA); Shippers Council of Eastern Africa, 15April 2021; Hellenic Shipping News; News Africa]

Figure 5.4 Trans-shipment volumes through Mombasa



Source: Kenya Ports Authority

Further construction and developments are in progress in 2021, most notably of another container terminal to cater to the increasing demand (Image 5.3). This project is due to complete in November 2021. This project is expected to add an additional annual capacity of 450 000 TEUs. Currently, the container berths operate with a total of 13 Neo-Panamax gantry cranes. The port of Mombasa is one of the busiest ports in Africa with a huge growth potential.

Image 5.3 New container terminal under construction at Mombasa



Source: Kenya Ports Authority

The Port of Mombasa serves as a gateway to Kenya, Uganda, Rwanda, Burundi, Democratic Republic of Congo, Tanzania, South Sudan, Somalia and Ethiopia. Uganda maintains its dominance in transit traffic arriving through Mombasa, controlling approximately 82% of the 10 million tons of transit cargo, equivalent to 23.6% of the total throughput. The total cargo throughput through the port of Mombasa was 34.4 million tons in 2019 (Hellenic Shipping News, Aug 2020; Kenya Ports Authority)

In order to cope with mounting traffic, Kenya has commissioned double-stack trains to speed up the evacuation of containers from the port. These units are transferred to the recently The evolution of the ICD and the speedy evacuation of the containers has enhanced efficiencies within the terminal. In 2019 the ICD handled 418 830 TEUs, notably a 62% growth compared to the same period in the previous year; during the year 2019, 4225 trains were serviced at the ICD, 2668 of which were import trains and 1587 were export trains (KPA). The rail operations to and from the ICD has greatly contributed in decongesting the port (The Maritime Executive, Feb 2021; Kenya Port Authority)

5.3.6 Port Louis

Port Louis has made significant strides in the last 3-4 years, specifically in the container business. The terminal underwent a berth-deepening project and commissioned three additional Super Post Panamax ship-to-shore gantries in addition to the five Post Panamax gantries that were already in operation. The total quay length is 800m with a depth of 17.5m at chart datum alongside the quay. The terminal storage capacity is approximately 20 000 TEUs. With the recent developments, the terminal throughput has increased from 550 000 TEUs to 1 million TEUs annually (Mauritius Ports Authority).

The Government of Mauritius is planning to venture into a public-private partnership to build another container terminal off the existing terminal by reclaiming land to cater to the forecast volumes ahead of demand. There are also plans to construct a breakwater with the view to have a sheltered basin as a strategy to mitigate the downtime logged during the several storms experienced by the exposed island port (Mauritius Ports Authority).

5.3.7 Walvis Bay

In August 2019, Namport (Namibian Ports Authority) constructed and commissioned a state-of-the-art container terminal in Walvis Bay having a quay length of 600m, with the intention to capture a greater share of the gateway cargo emanating from the western and southern African regions. With the construction of the new terminal, the annual throughput capacity that the terminal will be able to handle will have increased to 750 000 TEUs with a capability to substantially increase its capacity further. The new terminal is equipped with four Neo-Panamax gantry cranes (ZPMC), besides the existing seven mobile harbour cranes (Liebherr), with an outreach of 17/18 rows. The depth in the channel is maintained at 14.0m at and at the berths at 16.0m at chart datum (Admiralty Nautical Charts; Port Strategy; Harbour Master's office).

Image 5.4 New container terminal at Walvis Bay

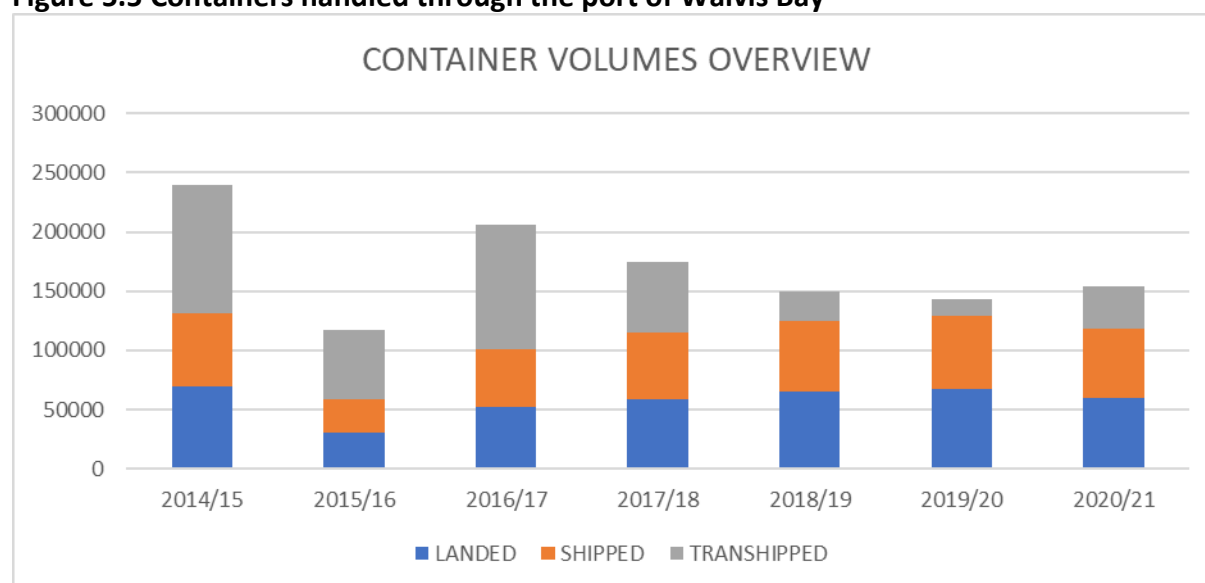


Source NAMPORT; Picture by WSP Global Inc.

Essentially, the port of Walvis Bay has been gearing itself with capacity ahead of demand. Cross-border through volumes through the port of Walvis Bay have steadily increased. A total of 149 464 TEUs were handled in the year 2018/19, a decrease of 18 percent from the previous year. However, the annual import and export container volumes increased by 11 percent and 6 percent respectively (NAMPORT). The reason for the overall decline in volumes was due to the decrease in the trans-shipment volumes by 63 percent. At the time, some shipping lines (MAERSK/CMA-CGM) reviewed their strategies and eventually moved the trans-shipments that was originally routed via Walvis Bay (on the Far East to West Africa service) to Pointe Noire. In 2019/20, the total volumes handled were 142 957 TEUs; a further increase of approximately 4% in the import and export volumes were noted, however the

trans-shipment took a further dip by a substantial 46%. In the following year 2020/21, the imports and exports were marginally impacted largely due to the COVID-19 pandemic, but the trans-shipments resurged by 168% as compared to the previous year, but still could not match the level achieved prior to 2017/18 (refer to Figure 5.5 and Table 5.7). The port of Walvis Bay has a good infrastructure which can be rated among the best in Africa with an added advantage of competitive tariffs. The congestion and poor productivity in the African Ports (Mozambique, Angola and to a lesser extent South Africa) further promotes Walvis Bay as a port of choice. South Africa risks losing traffic generated in Gauteng province, and transshipment traffic via Coega to the port of Walvis Bay. The Namibian roads are still in fairly good condition, as compared with African standards; the enhancement in the cross-border facilitation procedures has assisted in simplifying the custom procedures, and provided further fillip in boosting the trade through Walvis Bay, as these procedures could be quite daunting and time consuming. The Walvis Bay corridor has been highlighted in Figure 5.6. With active participation and initiatives to address the cross-border issues, Walvis Bay could possibly attract a fair share of the hinterland volumes (African Development Bank Sept 2020; Port Strategy Sept 2020; WSP Global Inc).

Figure 5.5 Containers handled through the port of Walvis Bay



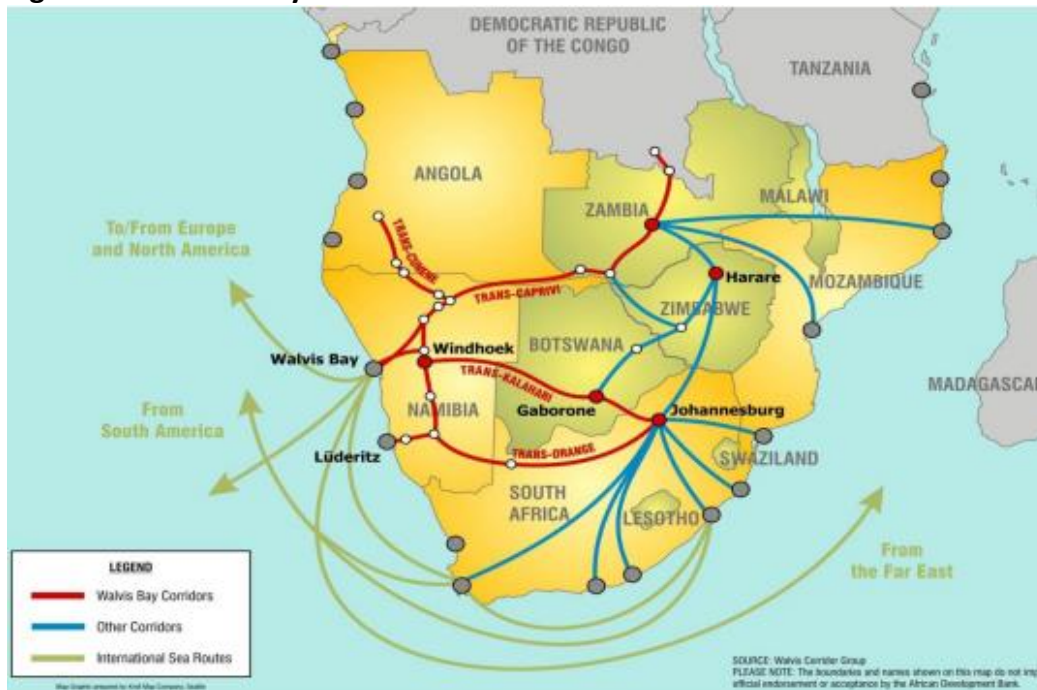
Source: NAMPORT

Table 5.7 Containers handled at Walvis Bay

	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21
LANDED	69 036	30 032	51 851	58 591	64 846	67 704	59 701
SHIPPED	61 975	28 449	48 575	56 095	59 676	61 792	58 326
TRANSHIPPED	108 851	58 648	105 565	59 676	24 942	13 461	36 180

Source: NAMPORT

Figure 5.6 Walvis Bay corridor



Source: Walvis Corridor Group

5.4 Chapter overview

Although the Mozambican ports of Maputo, Beira and Nacala might seem to be handling much lower volume as compared to the port of Durban, these ports in a combined capacity have logged substantial annual throughput increases in volumes. All the Mozambiquan ports are hence re-modelling the infrastructure to create capacity ahead of demand. Extensive rehabilitation and construction works are ongoing in these ports to align their infrastructure and enhance connectivity, in a bid to divert the cargo from hinterland destinations that have historically been routed through the port of Durban. Similarly, the ports of Dar es Salaam and Mombasa are currently engaged in extensive construction works. Walvis Bay and Port Louis can each boast of a new terminal with deeper berths and state of art equipment. These continuous upgrades in infrastructure in the neighbouring countries' ports pose a significant threat to South Africa's growth potential.

CHAPTER SIX

CLOSING REMARKS

This short final chapter seeks to draw together the principal research themes highlighted in this study. The limitations of the port of Durban that have been identified in this research exercise are set out within the changing sea trading context in which Durban and other South African ports find themselves faced with an imperative to accommodate larger and more economically efficient container vessels. The chapter then highlights the study's major findings, which are that short-term constraints could be addressed by allowing NAABSA operations in Durban port, whereby otherwise tidally-restricted vessels may sustain continuous cargo operations while alongside at depth-limited berths without any potential jeopardy to either the vessels or the port. These operations may stem a loss of trans-shipment opportunities in the short term, while longer-term retention (and at best growth) of trans-shipment and gateway cargo is viewed here as requiring the provision of a deeper-water marine infrastructure and more efficient cargo-handling and distribution systems.

6.1 The nature of the problem in the port of Durban

The port of Durban has historically played a significant role as a leading regional port, handling diverse types of cargoes, and it continues to maintain its dominance as the busiest and largest container terminal in the southern African sub-continent. But this role is now threatened by regional competitor ports, which are fast developing, and making notable strides that conspire to threaten the port of Durban and the South African ports system. In appreciation of the continual progression of container ship sizes, these ports have been re-assessing their marine infrastructure and equipment, upgrading as deemed essential. Leading multi-national companies operating terminals in these ports are seen to be quite aggressive in their business approach in seeking to attract additional container volumes, and in a bid to achieve this, are building capacity ahead of demand. Within the current port of Durban, the main restriction is limited water depth alongside cargo-working berths, notably alongside the berths in the container terminal, and a mismatch with the greater depths in the approach channel and the harbour basin. This mismatch introduces complexities, and in many respects sets Durban apart from most other tidal ports, where water depths alongside major berths are generally greater than in approach and internal channels. The latter generally imposes less constraints on continuous cargo working of deeper-drafted vessels. In Durban, these larger container vessels are consequently relegated to tidal windows in terms of vessel movements and further subjected to a stop-start cargo operation to maintain the recommended under keel clearance. Poor productivity during cargo-handling operations has a further impact on vessel turnaround times, increasing vessel and cargo costs, more seriously for the larger category of container callers, as the running costs including the charter hire are significantly higher. Besides the hire cost, there are supplementary costs incurred by way of additional fuel expended in steaming at increased speed to mitigate the delays, etc. Not only terminal under-performance, but also inefficiencies in landside connectivity to/from hinterland destinations and cargo sources, notably rail connectivity, have had an adverse impact on gateway cargo.

Relative through-transport cost analysis from inland destinations to foreign seaports suggests a pricing structure that militates against the port of Durban, as a comparator regional port. Pending a reliable rail network with timeous service delivery and secure connectivity, if the same is not ramped up, the cargo originating from the inland depots are at a severe threat of being lost to neighbouring foreign ports.

6.2 The sea trading context

There has been a significant advance in the evolution of container vessels with the last decade witnessing the introduction of ultra-large container vessels (ULCVs) with a carrying capacity of over 20 000 TEUs. This unrelenting trend towards the construction of ever-larger container vessels is driven by the dictates of economies of scale, predicated on many components of cost. Of these, manning scales and resultant costs are little affected by vessel size alone, and vessel construction costs increase less than proportionately with vessel size, as do fuel costs. To illustrate the latter, a 3000 TEU vessel typically consumes approximately 100MT of fuel per day, as compared to a 19000 TEU vessel that consumes 300MT per day. This implies that the relative consumption on the vessels with smaller capacities is almost double, besides the other related overhead expenditure of handling multiple vessels to match the capacity. These ULCVs are predominantly deployed on the Far East-Europe and the Far East-USA trade routes. A subsequent cascading of the fairly larger neo-Panamax size of container vessels to “thinner” trade routes, including southern African and other southern hemisphere trades, has been an inevitable consequence.

Whilst many of the ports in the southern African sub-continent lack the marine infrastructure to accommodate these large container vessels, they do call at the Durban Container Terminal (DCT), albeit their full design capacities cannot be explored to its fullest due to the inherent limitations, notably the water depths along the container berths. Their cargo lifting capability is therefore severely compromised with the loadable quantity forfeited to the extent of approximately of 40 000MT to 50 000MT, equivalent to approximately 1500 TEUs to 2500 TEUs of full container loads. In tangible commercial terms, these constraints translate into a potential loss of revenue for Transnet and loss of freight earnings for shipping lines. To a large extent, the absence of deeper container berths in Durban also prevents the port of Coega into being potentially transformed to a major trans-shipment hub. Deeper berths at Durban will enable deep-drafted vessels with an enhanced cargo carriage capacity to call the port of Durban, thus having an overall influence on the cargo that can transit through the South African terminals as these ports serve as a complementary system. Essentially, the capacity constraints have a direct bearing over the growth of trans-shipment volumes.

6.3 Research focus and findings

The specific focus of this research has been on the larger container vessels constrained by draft due to the lesser water depths alongside the cargo-working berths at the port of Durban. To have a better perspective, the depths alongside the container berths at DCT read 12.8m at

chart datum and need to be increased to 17.0m at chart datum to accommodate a fully-laden modern generation container vessel, and this must surely be the long-term goal of port planning to secure the ability of the port of Durban to attract the most capable port callers. It would also realign the port's berth infrastructure with the deeper water already available in port approaches, fairways and channels.

Until such time as this more optimal end state is achieved, this research study makes specific recommendations to optimise the cargo lifting under the varying conditions of tides, springs or neaps, within the existing configuration of the port. In this specific regard, this study proposes that the implementation of NAABSA operations be considered, whereby vessels may be permitted to "take the bottom" while alongside and working cargo at the port of Durban, as this is a widely accepted practice in many ports of the world. Consenting to this specific operation will alleviate the need to interrupt cargo operations to maintain the stipulated under keel clearance, thus expediting cargo operations and optimising liftings to the extent possible.

This research study has interrogated the practicability of NAABSA operations in some considerable technical detail, notably in Chapter Two. This exercise has examined the design features of modern container ships in general, and their structural hull strength and integrity in particular. In this context, a simple reference has been made to vessels in dry-docking facilities, when vessels bear their full light displacement. These exercises have shown that modern container vessels are manifestly able to withstand the quite modest forces and stresses that may result from continuing to conduct orderly cargo-handling operations on an even keel, at all stages of the tide in a port where the seabed is conducive to such operations. Indeed, this research has shown that vessels are able to sustain considerably greater dynamic forces without discernibly negative structural consequences. The feasibility of NAABSA operations in the port of Durban then rests on the characteristics of the seabed in this port. This has been addressed in Chapter Four, which demonstrates that the inherent characteristics of the seabed at the port of Durban, being soft, plane, and homogeneous, are immediate qualifiers to determine an efficacious NAABSA operation without presenting any challenges.

One of the principal findings of this research, therefore, is that while in the short term, constrained movements of the deep-drafted vessels may be difficult to overcome, interruptions in cargo operations, and the elimination of stop-start cargo handling may be easier to mitigate, through the feasibility of NAABSA operations. In fact, this work is aimed at introducing the NAABSA operations that are customarily deemed practicable and safe by the ordinary practice of seamanship. This manoeuvre is safely executed in many ports, the world over, and the port of Durban has been shown here to be no exception

A second major research objective in this study, explored more fully in Chapter Three, has been to explore the consequences for containerised cargo volumes, and indeed for port traffic in general, that result from restrictions imposed by way of draft limitations at the port of Durban. Notably negative consequences have been identified in the realm of trans-shipment

volumes, resulting in cargo haemorrhage through other foreign ports. This study has set out to articulate the strategic approach adopted by a major shipping line to re-direct the trans-shipment volumes in a phased manner, that were earlier effected through the South African ports, and to quantify the extent of this cargo loss, in both tonnage and revenue terms. In routing the trans-shipment volumes through other foreign ports, the potential revenue losses incurred by Transnet, triggered by the single largest container carrying line serving the southern African ports, has been shown to amount to some ZAR 1 billion annually. This implies that the shipping lines are swift to respond to the inefficiencies within the port system seeking alternative mitigating measures. It is also important to note that once the trans-shipment volumes are lost to another port, it is very difficult to recapture these volumes owing to the contracts and commitments in place.

The South African ports have an inherent locational advantage to serve as major trans-shipment hubs. This arises from the command the ports exercise over gateway cargo originating from cargo sources in the southern African hinterland itself, or destined for consignees within the same hinterland. This establishes a rationale for vessels to call at the South African ports as terminal ports in their own right, and this in turn opens up trans-shipment opportunities for these vessels, most notably if larger vessels capable of exploiting their full cargo-carrying capacity may be accommodated in the ports. Trans-shipment may then be capitalised on as an additional revenue-generating stream, both for the ports and the carrying lines. That said, even the gateway cargo itself is not immune to migration to other better-performing or lower-cost sub-regional ports and transport corridors, such that the retention of this cargo is not a given, but rather is predicated on the establishment of appropriate port infrastructure, able to service the most efficient vessels, and the provision of efficient cargo-handling and cargo-distribution services, most particularly rail services, across the full hinterland of the South African ports system. Uncertainties over available capacity may be sharpened further if the planned cargo cannot be uplifted due to the tidal restraints and sailing compulsions. If Transnet loses focus on retaining the volumes which are presently channelled through South African ports, these volumes could be lost to neighbouring foreign ports offering better integrated services and more attractive tariff regimes. A critical impediment in this regard is the performance by Transnet Freight Rail (TFR), which is perceived as providing increasingly unreliable services, and which exacerbates the impetus on shippers to pursue alternative routes for their shipments.

6.4 Outlook, recommendations, and the way forward

NAABSA operation, as recommended for the port of Durban is a short-term remedy for partial recovery with regards to optimisation in cargo liftings. However, the concept of NAABSA could be extended to other ports within South Africa with similar characteristics conducive to such operations. In the longer term, preferably in the near future, the provision of deeper berths at Durban's container terminals, at least reading 17.0m at chart datum, is a dire necessity to permit the full-load deployment of larger vessels. This will facilitate non-restrictive opportunities to the larger vessels in terms of utilisation of capacity, creating a platform for

greater volume influx thus enhancing the potential for trans-shipment flow through South African ports. The provision of deeper berths alone will not suffice, and will have to be supplemented by considerably improved terminal productivity to ensure quicker turnaround times of vessels. Additionally, the increase in container volumes will have to be dealt with by devising means to create capacity within and outside the terminal premises, such as the establishment of off-dock facilities and inland dry-port depots with efficient rail connectivity, thus alleviating the congestion on the entrance routes to the terminals. The issue of performance can be resolved to a great extent by incentivising productivity. Most ports around the world work around this principle and hence are able to achieve high performance levels. Efficiencies must be introduced on the landside too, to ensure better and reliable connectivity with the inland destinations. It is crucial that efficiencies remain the key focus in the entire supply chain, all with a view to lower the costs of doing business in Durban and the South African ports, to restore their inherent locational advantages.

Appendix 2.1 Calculation of the ship's (MSC Beatrice) flat bottom area from the Shell Expansion Plan using Simpson's Rules

MSC Beatrice

Length: 366m

Beam: 48m

Capacity: 13798 TEU

Lightship Displacement: 46080 tons

Summer Deadweight: 156 301 tons

Summer Displacement: 202 381 tons

Summer draft: 16m

The area of the flat bottom structure has been calculated using the Simpson's Rule, the measures have been extracted from the Shell Expansion Plan. The calculated flat bottom area is 5585m² and the displacement (weight) in the docking condition (as shown in the Appendix) is 55850MT. This deciphers that the weight borne per area of square metre in the docking condition is 10 tons.

Using the Simpson's Rule to calculate the area of the flat bottom structure of the MSC Beatrice, from Frame No. 36 to Frame No. 415

On the Shell Expansion Plan, the scale used is 1:200

At a distance of 50 mm, from frame no. 36 to frame no. 415, perpendiculars are raised from the base line on the shell expansion plan to the bottom tangent line defining the outer periphery of the ship's flat bottom.

Sr. No. = Serial number of the perpendicular from the base line

P = Measurement of the perpendicular in mm on the Shell Expansion Plan from the base line

W = Actual width of the perpendicular in meters (m) $[P \times 200/1000]$; Scale of plan is 1:200

Sr. No	1	2	3	4	5	6	7	8
P (mm)	1.5	1.5	2.2	4.2	8.2	14.5	24.2	37.5
W (m)	0.30	0.30	0.44	0.84	1.64	2.90	4.84	7.50

Sr. No	9	10	11	12	13	14	15	16
P (mm)	52.5	69.2	84.5	96.1	103.2	105.0	105.0	105.0
W (m)	10.50	13.84	16.90	19.22	20.64	21.00	21.00	21.00

Sr. No	17	18	19	20	21	22	23	24
P (mm)	102.4	97.2	89.0	78.0	64.6	50.3	36.8	24.6
W (m)	20.48	19.44	17.80	15.60	12.92	10.06	7.36	4.92

Sr. No	25	26	27	28	29	30	31	32
P (mm)	15.1	8.3	4.5	2.8	2.68	2.8	2.8	0
W (m)	3.02	1.66	0.90	0.56	0.56	0.56	0.56	0

Area = Length of the interval x (1/2 sum of the first and last perpendicular + sum of all the perpendiculars)

$$\text{Area} = 10 \times \left\{ \frac{1}{2}(0.30+0) \right\} + \{0.30 + 0.44 + 0.84 + 1.64 + 2.90 + 4.84 + 7.50 + 10.50 + 13.84 + 16.90 + 19.22 + 20.64 + 21.00 + 21.00 + 21.00 + 20.48 + 19.44 + 17.80 + 15.60 + 12.92 + 10.06 + 7.36 + 4.92 + 3.02 + 1.66 + 0.90 + 0.56 + 0.56 + 0.56 + 0.56\} = 2791.1\text{m}^2$$

Area of the remaining portion in excess of the 10m interval,

$$L = 21\text{mm} \times 200 = 4200\text{mm} = 4.2\text{m}$$

$$B = 1.5\text{mm} \times 200 = 300\text{mm} = 0.3\text{m}$$

$$\text{Area} = L \times B = 4.2 \times 0.3 = 1.26\text{m}^2$$

$$\text{Total Area of the half flat bottom} = 2791.10 + 1.26 = 2792.36\text{m}^2$$

$$\text{Total Area of the full flat bottom} = 2792.36 \times 2 = 5584.72\text{m}^2$$

$$\text{Total Area of the flat bottom (rounded off)} = 5585\text{m}^2$$

Dry-docking condition

Lightship = 46080 tons

Ballast = 9770 tons

Displacement in the docking condition = 55850 tons

The weight borne by a unit area (1sq.m) of the flat bottom surface in the docking condition
= Displacement in the docking condition/Total Flat Bottom Area = 55850/5585 = 10 tons/m²

Appendix 2.2 Calculation of the ship's (MSC Judith) flat bottom area from the Docking Plan using Trapezoidal Rules

MSC Judith

Length: 325m

Beam: 43m

Capacity: 8034 TEU

Lightship Displacement: 39284 tons

Summer Deadweight: 105 083 tons

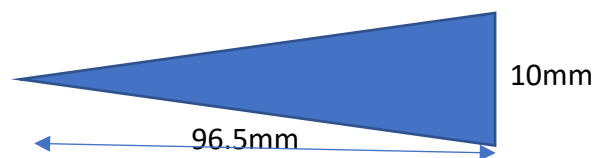
Summer Displacement: 144 367 tons

Summer draft: 14.5m

The flat bottom area has been calculated from the superimposed docking plan sections between the frames. The profiles of the various sections are so chosen such that they are either triangular, rectangular, or trapezoidal.

Scale = 1 : 300

Section 1: Flat bottom areas between frames 15 to 25 (triangular profile)



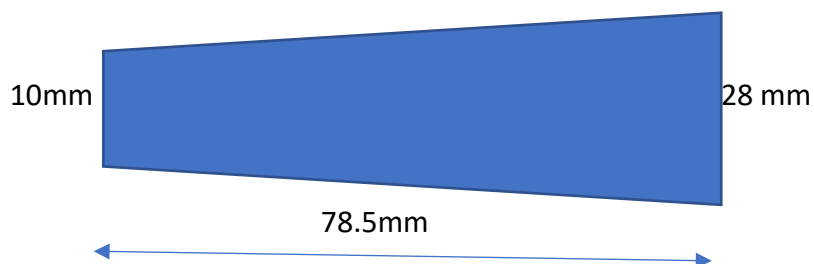
Area of a triangle = $\frac{1}{2} b \times h$

$b = 10 \times 300 = 3000\text{mm} = 3.0\text{m}$

$h = 96.5 \times 300 = 28950\text{mm} = 28.95\text{m}$

Area = $\frac{1}{2} \times 3 \times 28.95 = 32.45\text{m}^2$

Section 2: Flat bottom areas between frames 25 to 51 (trapezoidal profile)



Area of a trapezoid = $\frac{1}{2} h \times (a + b)$

“a” and “b” are the lengths of the parallel faces of the trapezium and “h” is the perpendicular distance between the parallel sides

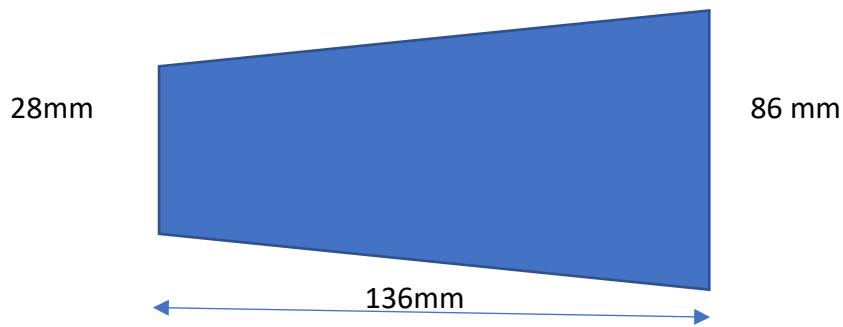
$a = 10 \times 300 = 3000\text{mm} = 3.0\text{m}$

$b = 28 \times 300 = 8400\text{mm} = 8.4\text{m}$

$h = 78.5 \times 300 = 23550\text{mm} = 23.55\text{m}$

Area = $\frac{1}{2} h \times (a + b) = \frac{1}{2} \times 23.55 \times (3.0 + 8.4) = 134.235\text{m}^2$

Section 3: Flat bottom areas between frames 51 to 65 (trapezoidal profile)



Area of a trapezoid = $\frac{1}{2} h \times (a + b)$

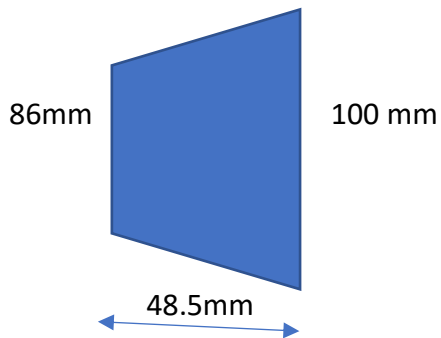
$$a = 28 \times 300 = 8400\text{mm} = 8.4\text{m}$$

$$b = 86 \times 300 = 25800\text{mm} = 25.8\text{m}$$

$$h = 136 \times 300 = 40800\text{mm} = 40.8\text{m}$$

$$\text{Area} = \frac{1}{2} h \times (a + b) = \frac{1}{2} \times 40.8 \times (8.4 + 25.8) = 697.7\text{m}$$

Section 4: Flat bottom areas between frames 65 to 70 (trapezoidal profile)



Area of a trapezoid = $\frac{1}{2} h \times (a + b)$

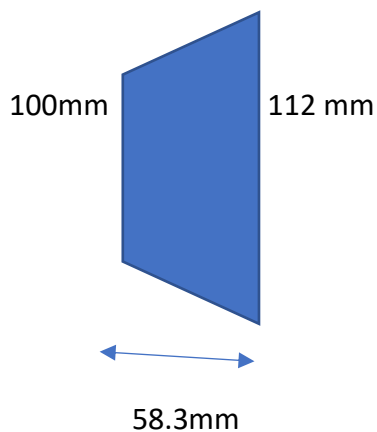
$$a = 86 \times 300 = 25800\text{mm} = 25.8\text{m}$$

$$b = 100 \times 300 = 30000\text{mm} = 30.0\text{m}$$

$$h = 48.5 \times 300 = 14550\text{mm} = 14.55\text{m}$$

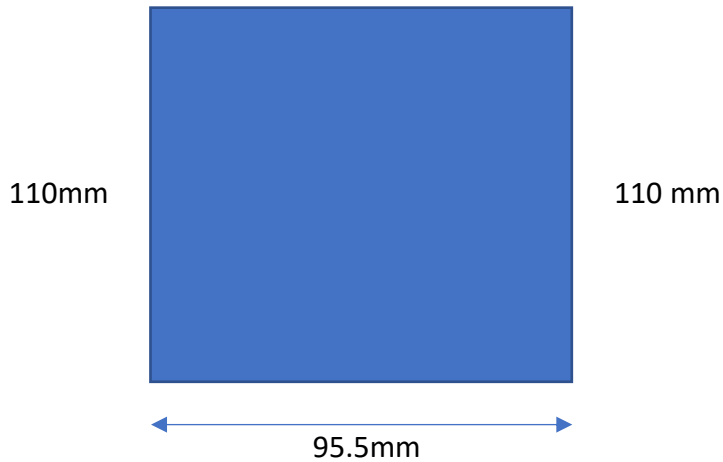
$$\text{Area} = \frac{1}{2} h \times (a + b) = \frac{1}{2} \times 14.55 \times (25.8 + 30.0) = 406\text{m}^2$$

Section 5: Flat bottom areas between frames 70 to 76 (trapezoidal profile)



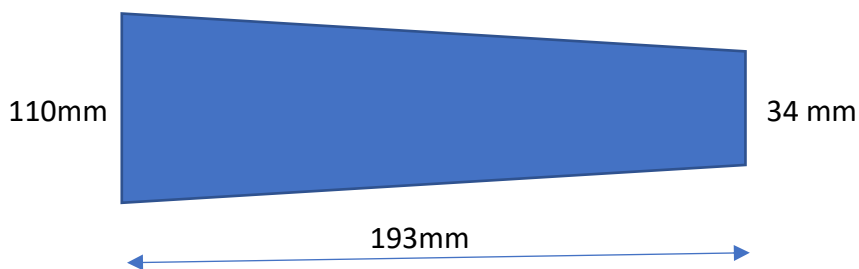
Area of a trapezoid = $\frac{1}{2} h \times (a + b)$
 $a = 100 \times 300 = 30000\text{mm} = 30.0\text{m}$
 $b = 112 \times 300 = 33600\text{mm} = 33.6\text{m}$
 $h = 58.3 \times 300 = 17500\text{mm} = 17.5\text{m}$
 $\text{Area} = \frac{1}{2} h \times (a + b) = \frac{1}{2} \times 17.5 \times (30.0 + 33.6) = 556.5\text{m}^2$

Section 6: Flat bottom areas between frames 76 to 86 (rectangular profile)



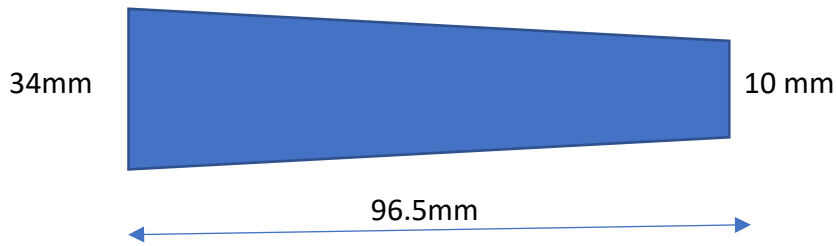
Area of a rectangle = $l \times b$
 $l = 110 \times 300 = 33000\text{mm} = 33.0\text{m}$
 $b = 95.5 \times 300 = 28950\text{mm} = 28.95\text{m}$
 $\text{Area} = l \times b = 33.0 \times 28.95 = 955.35\text{m}^2$

Section 7: Flat bottom areas between frames 86 to 106 (trapezoidal profile)



Area of a trapezoid = $\frac{1}{2} h \times (a + b)$
 $a = 110 \times 300 = 33000\text{mm} = 33.0\text{m}$
 $b = 34 \times 300 = 10200\text{mm} = 10.2\text{m}$
 $h = 193 \times 300 = 57900\text{mm} = 57.9\text{m}$
 $\text{Area} = \frac{1}{2} h \times (a + b) = \frac{1}{2} \times 57.9 \times (33.0 + 10.2) = 1250.64\text{m}^2$

Section 8: Flat bottom areas between frames 106 to 116 (trapezoidal profile)



Area of a trapezoid = $\frac{1}{2} h \times (a + b)$

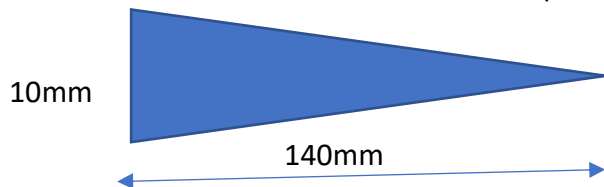
$$a = 34 \times 300 = 10200\text{mm} = 10.2\text{m}$$

$$b = 10 \times 300 = 3000\text{mm} = 3.0\text{m}$$

$$h = 96.5 \times 300 = 28950\text{mm} = 28.95\text{m}$$

$$\text{Area} = \frac{1}{2} h \times (a + b) = \frac{1}{2} \times 28.95 \times (10.2 + 3) = 191.07\text{m}^2$$

Section 9: Flat bottom areas between frames 116 to 134 (triangular profile)



Area of a triangle = $\frac{1}{2} b \times h$

$$b = 10 \times 300 = 3000\text{mm} = 3.0\text{m}$$

$$h = 140 \times 300 = 42000\text{mm} = 42.0\text{m}$$

$$\text{Area} = \frac{1}{2} \times 3 \times 42 = 63.0\text{m}^2$$

Total flat bottom area is the sum of all the sections:

$$32.45 + 134.235 + 697.7 + 406 + 556.5 + 955.35 + 1250.64 + 191.07 + 63 = 4287\text{m}^2$$

Dry docking condition

Displacement at Dry docking condition (as per the Docking plan) = 39284 tons

Total flat bottom area = 4287m^2

Therefore, a weight of 39284 tons is supported by a flat bottom area of 4287m^2

Weight distribution per square meter in the docking condition = $39284 / 4287 = 9.2 \text{ tons/m}^2$

Appendix 4.1: Optimisation of cargo liftings at neap tide and spring tide

Exhibit 4.1 Predicted hourly heights of tide (m), Durban, November 2020

	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Sun 8	0.88	0.78	0.76	0.82	0.94	1.08	1.22	1.33	1.38	1.37	1.30	1.19	1.08	0.98	0.92	0.92	0.97	1.05	1.14	1.23	1.30	1.32	1.30	1.23
Sat 14	1.18	1.59	1.87	1.94	1.78	1.43	0.97	0.54	0.24	0.15	0.32	0.70	1.19	1.68	2.05	2.20	2.08	1.74	1.25	0.74	0.33	0.13	0.17	0.45

The extract from the tide tables for the month of November 2020 has been reproduced for ease of reference. The dates are intentionally chosen such that the tidal range in minimum for neap tides and maximum for spring tides. The two dates of relevance are:

- Sunday 8 November 2020 displaying neap tides
- Saturday 14 November 2020 displaying spring tides

8 November 2020

Range of tide = Difference in the H.O.T. at high water (21h00) and low water (15h00)
= 1.32m – 0.92m = 0.40m

8 November 15h00: H.O.T. at lowest water = 0.92m

Depth = Chart Datum + Height of Tide
= 12.80m + 0.92m = 13.72m

Minimum UKC required at berth by TNPA = 0.30m

Therefore, the maximum draft the vessel can be loaded to until 15h00 = Depth – Min UKC
= 13.72m – 0.30m = 13.42m

8 November 21h00: H.O.T. at highest water = 1.32m

Depth = Chart Datum + Height of Tide
= 12.80m + 1.32m = 14.12m

Minimum UKC required for sailing by TNPA = 0.60m

Therefore, the maximum draft the vessel can be loaded to sail at 21h00 = Depth – Min UKC
= 14.12m – 0.60m = 13.52m

From the point of resuming operations at the lowest water at 15h00 (draft 13.42m) to the maximum permissible draft (13.52m) for sailing at 21h00 opens a potential cargo-operational period of six hours.

The difference in the drafts = 13.52m – 13.42m = 0.10m = 10cms

Consider an average TPC (tonnes per centimetre immersion) for sinkage as 120 tons/cm

Sinkage = Difference in drafts in centimetres x TPC = 10 x 120 = 1200 tons

To load 1200 tons at an average unit load of 24 tons/unit container = 1200/24 = 50 containers.

Time taken to load 50 containers with an average of three gantries at an average rate of 17 moves per hour = 1 hour (approximately)

Although the vessel would have loaded until the permissible sailing draft within an hour, the vessel could only sail at 21h00, six hours later, hence, in this instance, the pre-conceived sailing draft is easily achievable when neap tides are experienced.

14 November 2020

Range of tide = Difference in the H.O.T. at high water (15h00) and low water (09h00)
= 2.20m – 0.15m = 2.05m

14 November 09h00: H.O.T. at lowest water = 0.15m

Depth = Chart Datum + Height of Tide
= 12.80m + 0.15m = 12.95m

Minimum UKC required at berth by TNPA = 0.30m

Therefore, the maximum draft the vessel can be loaded to until 09h00 = Depth – Min UKC
= 12.95m – 0.30m = 12.65m

14 November 15h00: H.O.T. at highest water = 2.20m

Depth = Chart Datum + Height of Tide
= 12.80m + 2.20m = 15.00m

Minimum UKC required for sailing by TNPA = 0.60m

Therefore, the maximum draft the vessel can be loaded to sail at 21h00 = Depth – Min UKC
= 15.00m – 0.60m = 14.40m

From the point of resuming operations at the lowest water at 09h00 (draft 12.65m) to the maximum permissible draft (14.40m) for sailing at 15h00, we have a period of 6 hours

The difference in the drafts = 14.40m – 12.65m = 1.75m = 175cms

Consider an average TPC (tonnes per centimetre immersion) as 120 tons/cm

Increase in draft = Difference in drafts in centimetres x TPC = 175cms x 120 tons/cm = 21000 tons

To load 21000 tons at an average unit load of 24 tons/unit container
= 21000/24 = 875 containers

Time taken to load 875 containers with an average of three gantries at an average rate of 17 moves per hour = 17 hours (approximately)

It is clear that the vessel would require approximately 17 hours at the averages achieved by DCT, whereas, in actual fact, the vessel would have a few hours prior to sailing before the tide recedes. Working on the situation with the vessel sailing at the highest water of the day, at 15h00, the vessel would have to stop cargo operations at 14h00, in preparation for sailing at 15h00. This affords the vessel a five-hour period for loading, from the time operations would resume at 09h00.

Considering the loading operations to resume with three gantries at the nominal rate of 17 moves per hour, the vessel would have loaded 3 gantries x 17 mph x 5 hours = 255 units. At the rate of 24 tons per unit, total tonnage anticipated to be loaded = 255 x 24 = 6120 tons
Increase in draft at a TPC of 120 tons/cm = weight/TPC = 6120/120 = 51cms

Therefore, expected draft at 14h00 = 12.65m + 0.51m = 13.16m

UKC at the projected sailing time of 15h00 = Depth at 15h00 – Draft at 15h00
= 15.00m – 13.16m = 1.84m

The UKC at 15h00 is 1.84m, much in excess of the stipulations by TNPA. Therefore, progressive hourly loading must be taken into account to optimise cargo intake, to finally maintain an UKC of $\geq 0.60\text{m}$ as stipulated by TNPA, for sailing.

Consider another hour of operations, additional cargo that can be loaded

= 3 gantries x 17 mph x 24 tons = 1224 tons

Increase in draft = Weight/TPC = 1224/120 = 10.2cms = 0.10m

The anticipated draft at 15h00 = 13.16 (draft at 14h00) + 0.10 = 13.26m

At 16h00, depth = CD + H.O.T. = 12.8 + 2.08m = 14.88m

UKC at 16h00 = Depth – Draft = 14.88 – 13.26 = 1.62m

Here again at 16h00, the anticipated UKC of 1.62m is in excess of the TNPA requisites.

At 17h00, depth = CD + H.O.T. = 12.8 + 1.74m = 14.54m

Consider an increase in draft of 10cms (0.10m) after every hour of loading as per above,

sailing draft at 17h00 = 13.26m (draft at 16h00) + 0.10m = 13.36m

UKC at 17h00 = Depth – Draft = 14.54 – 13.36 = 1.18m, which is more than required UKC

At 18h00, depth = CD + H.O.T. = 12.8 + 1.25m = 14.05m

Considering an increase in draft of 10cms (0.10m) with every hour of work progression,

sailing draft at 18h00 = 13.36m (draft at 17h00) + 0.10m = 13.46m

UKC at 18h00 = Depth – Draft = 14.05 – 13.46 = 0.59m = approximately required UKC

As illustrated, the vessel could sail with a draft of 13.45m, latest by 18h00.

In the above illustration, vessel will be required to sail with a spare capacity as per below calculations:

On Sat 14 Nov 15h00 at high water, H.O.T. = 2.20m

Total depth = CD + H.O.T. = 12.8 + 2.2 = 15.00m

Required UKC = 0.60m

Maximum permissible sailing draft = Depth – UKC = 15.00 – 0.60 = 14.40m

At 14 Nov 09h00 at low water, H.O.T. = 0.15m

Therefore, maximum permissible draft at the time indicated (09h00), must not exceed, 12.65m as per below calculations to maintain the stipulated UKC of 0.30m.

Depth at 09h00 = CD + H.O.T. = 12.8 + 0.15m = 12.95m

Required UKC = 0.30m

Draft = Depth – UKC = 12.95 – 0.30 = 12.65m

Hence, operations to be suspended when the vessel attains a draft of 12.65m to resume at 09h00

Difference in drafts at the hypothetical sailing condition at high water(15h00) and low water (09h00) = 14.40m – 12.65m = 1.75m = 175cms

Projected scope of increase in draft for sailing at 15h00 = 1.75m or 175cms

TPC (tons per centimetre) = 120 tons/cm

Therefore, projected scope for the intake of cargo at the sailing time of 15h00 =

$$\text{Permissible increase in draft} \times \text{TPC} = 175\text{cms} \times 120 \text{ tons/cm} = 21000 \text{ tons}$$

Taking the average performance of TPT as per calculations cited above, the maximum cargo that could be loaded between 09h00 and 17h00 for sailing at 18h00, with a draft of 13.45m, and an UKC of 0.60m, is show below.

Number of hours worked = 17h00 – 09h00 = 8h

Average Productivity = 17 moves per hour

Number of gantries deployed = 3

Unit weight of each container = 24 tons

$$\begin{aligned} \text{Total cargo weight} &= 3 \text{ gantries} \times 17 \text{ mph} \times 24 \text{ tons (unit weight)} \times 8 \text{ h} \\ &= 9792 \text{ tons} \end{aligned}$$

Corresponding sailing draft = 13.46m

Therefore, vessel could be maximised with a load of 9600 tons of cargo from the time of resuming operations until the latest possible sailing time, 18h00 in this instance.

As it can be inferred, there is a spare capacity and substantial scope to maximise the cargo intake, when the hypothetical upliftment of cargo at maximum possible capacity is compared to what can be achieved under the prevailing circumstances.

$$\text{Difference} = 21000 - 9600 = 11400 \text{ tons.}$$

In this illustration, there was an additional scope for 11400 tons of cargo that could have been loaded. This could only be achieved if the vessel was permitted to safely sit on the seabed whilst the cargo operations progressed, in this case loading operations, and wait for a suitable height of tide to sail.

In conclusion, the optimum calculated sailing draft can most certainly be achieved when neap tides are experienced, whereby the range of tide is low, as compared to spring tides with a significantly higher tidal range. However, given the present scenario, in both the cases, the maximum draft attained is almost similar, 13.52m in the case of neap tides and 13.45m in the case of spring tides, although the draft is attained with greater ease during neap tides.

$$\begin{aligned} \text{Range of tide at neaps} &= \text{Difference in the H.O.T. at high water and low water} \\ &= 1.32\text{m} - 0.92\text{m} = \mathbf{0.40\text{m}} \end{aligned}$$

$$\begin{aligned} \text{Range of tide at springs} &= \text{Difference in the H.O.T. at high water and low water} \\ &= 2.20\text{m} - 0.15\text{m} = \mathbf{2.05\text{m}} \end{aligned}$$

Appendix 4.2: Hypothetical considerations at spring tides

It is now clear that the focus must shift towards mobilising means of enhancing cargo intake during spring tides, especially during the final leg of operations. In a bid to achieving this, the following may be of valid consideration:

- Weather forecast to determine if cargo operations may not be interrupted in the final leg (duration between the lowest water and calculated sailing time)
- Maximum deployment of gantries with an even gantry split
- Maximum resources deployed behind the gantries to support operations
- A well prepared and organised yard without having the need to execute reshuffles and consequently hold back feed to the gantries.
- Essentially, the objective is to increase efficiencies in achieving optimal Ship Working Hour (SWH) performance.

For example, in extending the above case studies, the implications could be interrogated in the context of enhanced terminal performance norms, or more relaxed limitations, such as:

- a deployment of four gantries instead of three gantries
- work rate of 22 moves per hour instead of 17 moves per hour
- Disregarding the mandated UKC of 0.30m whilst the vessel is at berth and considering an UKC = 0

Exhibit 4.1

PREDICTED HOURLY DEPTHS IN METRES
DURBAN
NOVEMBER 2020

	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Sun 8	0.88	0.78	0.76	0.82	0.94	1.08	1.22	1.33	1.38	1.37	1.30	1.19	1.08	0.98	0.92	0.92	0.97	1.05	1.14	1.23	1.30	1.32	1.30	1.23
Sat 14	1.18	1.59	1.87	1.94	1.78	1.43	0.97	0.54	0.24	0.15	0.32	0.70	1.19	1.68	2.05	2.20	2.08	1.74	1.25	0.74	0.33	0.13	0.17	0.45

14 November 2020 - Spring tide

Disregarding the UKC of 0.30m, i.e., UKC = 0, at 09h00, the vessel can be loaded to a draft of
= CD + H.O.T. = 12.80 + 0.15 = 12.95m

Considering a deployment of four gantries, a work rate of 22 moves per hour per gantry and unit weight of 24 tons between 09h00 and 14h00 (period of 5 hours)

Total tonnage anticipated to be loaded = 4 gantries x 22 mph x 5 h x 24 tons
= 10560 tons

Increase of draft at a TPC of 120 = Weight/TPC = 10560/120 = 88cms

Draft at 14h00 = 12.95 + 0.88 = 13.83m (in due consideration for sailing at 15h00)

Depth at 15h00 = CD + H.O.T. = 12.8 + 12.2 = 15.00m

UKC = Depth – Draft = 15.00 – 13.83 = 1.17m (more than the stipulated UKC)

Consider hourly progressive loading to optimise cargo intake:

As deciphered from the above calculations increase in draft per hour is approximately 0.176m or 17.6cms

Increase of draft per hour = 0.176m = 17.6cms

Draft at 15h00 = 13.83m (draft at 14h00) + Increase of draft per hour
= 13.83m + 0.17m = 14.00m (in preparation for sailing at 16h00)

At 16h00, depth = CD + H.O.T. = 12.8 + 2.08m = 14.88m

UKC = Depth – Draft = 14.88 – 14.00 = 0.88m

The UKC at 16h00 is still more than the stipulated UKC of 0.60m)

Progressing further, in order to optimise load:

Draft at 16h00 = 14.00m (draft at 15h00) + Increase of draft per hour
= 14.00 + 0.17 = 14.17m (in preparation for sailing at 17h00)

At 17h00, depth = CD + H.O.T. = 12.8 + 1.74m = 14.62m

UKC = Depth – Draft = 14.62 – 14.17 = 0.45m (less than the stipulated 0.60m)

Therefore, in order to maximise the load, by maintaining the UKC of the stipulated 0.60m, the sailing time has to be in between 16h00 and 17h00

Considering sailing for 16h30 as the slots for berthing and sailing are booked every 30 minutes.

Draft at 15h30 (in consideration for sailing at 16h30, leaving one hour for departure preparations)

Tonnage loaded from the time of resuming operations, at 09h00 to 15h30
= 4 gantries x 22 mph x 24 tons x 6.5 hours = 13728 tons

Increase in draft = Weight/TPC = 13728 tons/120 tons/cm = 114cms = 1.14m

Draft at 15h30 = Draft at 09h00 + Increase = 12.95m + 1.14m = 14.09m

At 16h30, depth = CD + H.O.T. = 12.8 + 1.91m = 14.71m

UKC = Depth – Draft = 14.71 – 14.09 = 0.62m

In this situation, sailing could be fixed for 16h30 with a sailing draft of 14.09m, with 13728 tons of cargo loaded from the time of resuming operations. The vessel may hence stop cargo operations at 15h30 to sail at 16h30, leaving an hour for sailing formalities with an UKC of 0.62m as stipulated by TNPA.

As demonstrated, the vessel in this case has been hypothetically optimised as the TNPA stipulated UKC at the berth has been reduced to zero, whilst the vessel is still under operations. Besides, the work is executed deploying four gantries and the productivity has been increased to align with the average productivity in relevant comparator ports such as Antwerp (Belgium), King Abdullah Port (Saudi Arabia), Shanghai (China), Abu Dhabi (UAE), Mundra (India) and Barcelona (Spain) (Source: MSC)

Further to above, if the vessel was permitted to safely take the bottom, by transferring a weight equivalent to an increase in draft by 0.57m or 57cms, equivalent to approximately

7000 tons, the vessel could have been completely maximised to sail at a draft of 14.40m at 15h00. This account can be supported by the following:

As per the hypothetical consideration (UKC=0 / 4 gantries / 22 mph), the calculated draft at 14h00 in preparation for sailing at 15h00, as per the preceding notes, is 13.83m
Further, as mentioned earlier, the vessel could sail with a maximum draft of 14.40m at 15h00 by maintaining an UKC of 0.60m as per TNPA directives. This being the case, the difference between the maximum possible sailing draft (14.40m) and hypothetically arrived draft (13.83m) = $14.40\text{m} - 13.83\text{m} = 0.57\text{m}$. Consequently, if the vessel is permitted to safely sit on the seabed at the port of Durban having regards to its soft and plane composition, with the transference of displacement equivalent to an increase in draft of 0.57m corresponding to approximately 7000 tons, the vessel can sail completely optimised with a maximum possible draft of 14.40m at spring tide.

Comparison:

Cargo loaded over and above the base draft of 12.65m is as follows:

Case I: Vessel's sailing draft is 13.45m at 18h00; cargo loaded: 9600 tons

Case II: Vessel's sailing draft is 14.09m at 16h30; cargo loaded: 17280 tons

Case III: Vessel's sailing draft is 14.40m at 15h00; cargo loaded: 21000 tons

A comparative analysis on the additional cargo loaded, in the different cases is done to evaluate the revenue lost by TPT, TNPA and shipping lines.

The difference between Case 1 and Case 2

The difference in cargo loaded = $17280\text{ tons} - 9600\text{ tons} = 7680\text{ tons}$

Considering a unit weight of 24 tons, number of containers = 320 units

Considering all the units are 20' units, THC is $\text{ZAR } 2178 + 10\% \text{CTOC} = \text{ZAR } 2396$

Cargo Dues = $\text{ZAR } 458$ per 20' unit

THC lost = $320\text{ units} \times \text{ZAR } 2178 = \text{ZAR } 766720$

Cargo Dues lost = $320\text{ units} \times \text{ZAR } 458 = \text{ZAR } 146560$

Freight earning lost by shipping lines, at the rate of USD 1000, per unit

= $320\text{ units} \times \text{USD } 1000 = \text{USD } 320000 = \text{ZAR } 4.8\text{ million}$

The difference between Case 1 and Case 3

The difference in cargo loaded = $21000\text{ tons} - 9600\text{ tons} = 11400\text{ tons}$

Considering a unit weight of 24 tons, number of containers = 475 units

Considering all the units are 20' units, THC is $\text{ZAR } 2178 + 10\% \text{CTOC} = \text{ZAR } 2396$

Cargo Dues = $\text{ZAR } 458$ per 20' unit

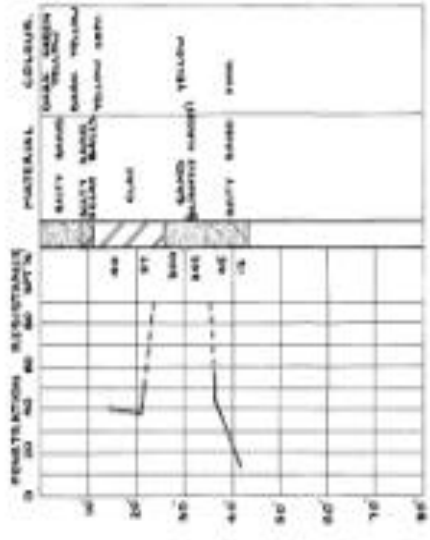
THC lost = $475\text{ units} \times \text{ZAR } 2396 = \text{ZAR } 1\,138\,100$

Cargo Dues lost = $475\text{ units} \times \text{ZAR } 458 = \text{ZAR } 217\,550$

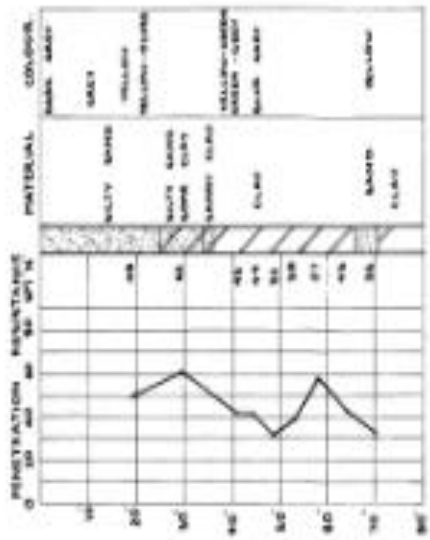
Freight earning lost by shipping lines, at the rate of USD 1000, per unit

= $475\text{ units} \times \text{USD } 1000 = \text{USD } 475\,000 = \text{ZAR } 7.1\text{ million}$

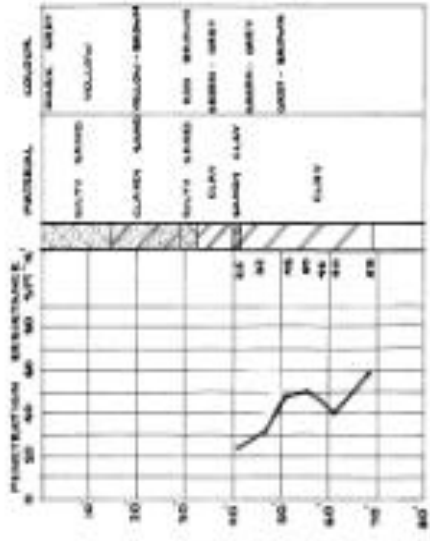
WASH BORING. No P2/WB/4
DATUM LEVEL - 53.4



WASH BORING. No P2/WB/5
DATUM LEVEL - 51.9



WASH BORING. No P2/WB/6
DATUM LEVEL - 51.2



WASH BORING. No P2/WB/10
DATUM LEVEL - 51.1



WASH BORING. No P2/WB/11
DATUM LEVEL - 51.0



WASH BORING. No P2/WB/13
DATUM LEVEL - 50.9



Appendix 4.4 Case Studies

Case study 1 - MSC Beryl

Voyage Number: FY037R // Durban

Length: 366m

Beam: 48m

Capacity: 12400 TEU

Summer Deadweight: 154792 tons

Summer Displacement:

Summer draft: 16.50m

Arrived: 29 September 2020 12h50

Berthed: 02 October 2020 16h30

Sailed: 04 October 2020 16h00

Arrival draft: F 10.55 / A 10.80

Vessel is a straight loader

First lift: 2 October, 17h00

Position on 3 October, 06h00

Balances on 3 October 06h00: 297 / 246 / 238 / 230 - Split on four gantries

At 14h00, 3 October, it was established that the vessel will not be able to sail by 19h00, 3 October, as the last available tidal window was at 19h00, 3 October. Thereafter, the tide would be receding for the vessel to consider sailing. Instructions were hence issued to stop cargo operations at a draft of 12.95 m, having due regards to the lowest water at 23h00, 3 October, with height of tide (H.O.T.) 0.25m.

Balances at 18h00, 3 October: 118 / 125 / 102 / 91 - Split on four gantries

Moves performed in the 12 hours shift (0600–1800) (weekend shift Saturday): 179 / 121 / 136 / 139

Productivity: 15 / 10 / 11 / 12

The depth of water at low tide at berth NP 203 (DCT) = *Charted Depth* (CD) + *Height of Tide* (H.O.T.) = 12.80m + 0.25 = 13.05m (at 23h00 / 3 October 2020)

TNPA recommends an under-keel clearance (UKC) of 0.30m at the berth at all times during cargo operations. Therefore, cargo operations would have to be stopped at a draft of 12.75m and resumed at 23h30 on the rising tide. However, in this instance, a substantial amount of cargo would have had to be short shipped, should the vessel have to stop operations at a draft of 12.75m given the recommended UKC of 0.30m. Instead of stopping operations at a draft 12.75m to maintain the stipulated UKC of 30cm or 0.30m, the vessel stopped at 12.95m gaining 20cm. If the sinkage per centimetre is effected by 150 tons, i.e., the tons per centimetre (TPC) is 150 tons/cm, with an immersion of a further 20cm, the additional cargo uplifted is 20cm x 150 tons/cm = 3000 tons. Considering an average weight of 20 tons per unit, number of additional units that would have to be further short shipped is 3000/20 = 150 units. These 150 units would have been in addition to the balances at 06h00. The sailing time, then targeted, was at 04h30, on 4 October, prior TNPA shift-change for pilotage services (TNPA does not provide pilotage services between 04h30 and 06h30).

However, the planned cargo operations weren't complete, and the sailing time had to be deferred to 07h00, 4 October, being the cut-off time for taking pilot. Unfortunately, the planned cargo operations weren't complete prior shift change at 06h00, 4 October.

Balances at 06h00, 4 October: 11 / 4

Moves performed in 12 hours shift (1800 – 0600) (weekend shift): 168 / 119 / 139 / 139

Productivity: 14 / 10 / 12 / 12

As can be seen, the productivity was far below norm; the targeted sailing for 04h30, 4 October, could not be achieved; the sailing window was until 07h30. However, the cut off time for sailing was between 07h00 to 07h30, 4 October; pilot services were booked for 07h30 owing to the balances at 06h00, being (11 / 2) and 6 gear boxes, that were still on the quay. Despite the pilot being booked for 07h30, DCT only resumed operations at 07h05 after shift change as against 06h00 (which should have been the case). Pilot refused to provide service at 07h30 due to the receding tide and the services were hence deferred to the next available window. At this stage, MSC Beryl, had a draft of 13.05m E.K. The next low tide at 11h00 was 0.24m, which essentially meant that the vessel would touch the bottom.

Depth at 11h00 = CD + H.O.T. = 12.80m + 0.24m = 13.04m

Draft of vessel = 13.05m

UKC = Depth – Draft = 13.04m – 13.05m = -0.01m

Cargo operations were stopped at this stage; plan was to resume at 11h30, with the rising tide, complete by 14h00, sail at 15h00 (earliest tidal window).

Owing to the delayed sailing, taking advantage of the next available window, additional 42 units were planned at this stage, that were earlier unplanned owing to tidal restrictions. This was an opportunistic strategy to optimise load as it was deemed possible at that stage, prior the earliest sailing time of 1500.

Vessel finally had pilot at 15h10 and unberthed at 15h40.

The vessel was allocated four (4) gantries throughout its operational span.

The heaviest hook had approximately 400 units at the beginning of operations (2 October 17h00)

At the rate of 20 moves per hour, the cargo operations should have taken 20 hours from the first lift on 2 October 17h00, ETS 3 October 14h00, being the earliest tidal window. In this instance, sailing was deferred by a complete day (24 hours).

General Comments

Cost and other implications of delays

The charter hire on vessels of this size is approximately USD 50 000 per day.

In order to mitigate the delays and arrive in her window in the subsequent ports, the vessel will have to steam full speed, consuming additional fuel.

Exercise to demonstrate recovery of a 24 hours delay in relation to fuel consumption

Consider a voyage at economical speed and at full speed.

As per Table

Fuel consumption at full speed, and maximum draft is 270 tons per day @25 knots

Fuel consumption at eco speed, and maximum draft is 90 tons per day @17 knots

Difference in fuel consumption per day = 180 tons

At a speed of 25 knots distance covered per day = 600nm

At a speed of 17 knots distance covered per day = 408nm

Difference in distance covered over 24 hours = 192nm

In order to recover a day, the ship will have to recover 408nm (distance per day at eco speed)

To recover 408nm the ship will have to steam at full speed for $408/192 = 2.125$ days

Additional fuel consumed in 2.125 days is difference in the fuel consumption at full and economical speed = 180 tons x 2.125 days = 382.5 tons

At the rate of USD 400 per ton, additional cost of fuel = $382.5 \times 400 = \text{USD } 166\,400$

Therefore, to recover one day, the additional expenses on fuel consumed amounts to USD 153 000

Below is the MSC Beryl's Energy Efficiency – Consumption Curves

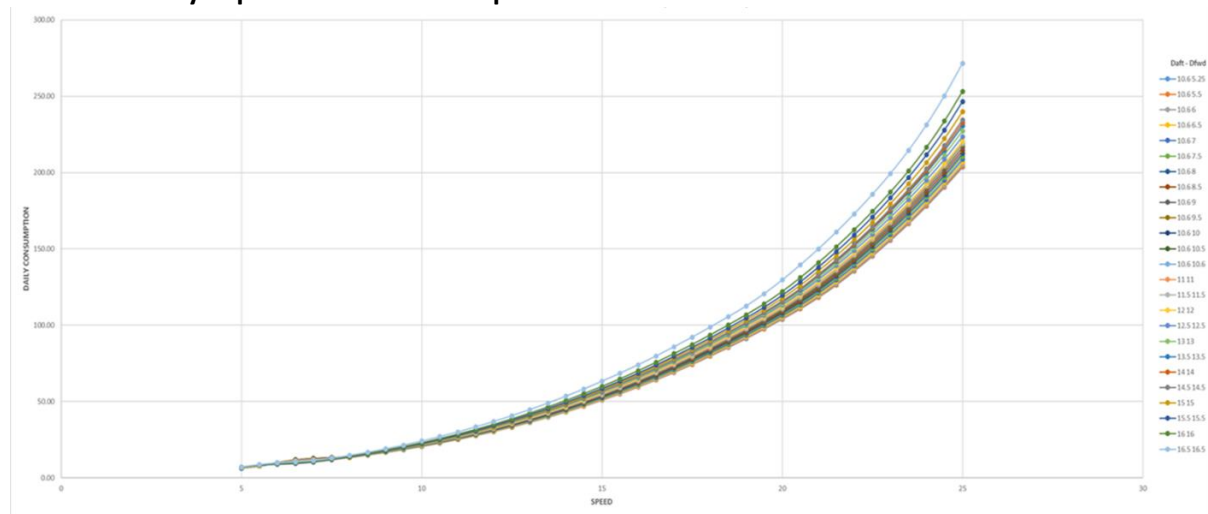
The curve displays the fuel consumption at the various speeds and varying conditions of loading.

Consumption at 17 knots is 90MT

Consumption at 21 knots is 155MT

Consumption at 25 knots is 270MT

Table MSC Beryl: Speed vs Fuel Consumption curves at various drafts



Source: MSC

There could be a possibility of omission of one or more ports in order to restore the schedule. This essentially translates that the (import) cargo destined to the ports omitted, will have to be trans-shipped from another port at an additional cost; the (export) cargo from the port/s that are omitted will either have to be trans-shipped or incur a delay (shipped on the next available vessel). In both cases, this translates into additional handling and re-nomination cost, without mentioning the delayed service provided, consequently, losing credibility as a reliable service provider.

Inference

- Vessel spent a total of little over five days at Durban
- Whereas the actual cargo operations should have taken no more than 24 hours, the vessel spent two days at berth. A total of 24 hours was lost, partly due to the tidal restraints (**eight hours lost awaiting a tidal window for sailing**) and partly due to the snag in delivering the productivity perceived by basic standards.
- If cargo operations were to stop at the TNPA recommended norms, maintaining the UKC of 30cm at berth, **the vessel would have had to short ship over 150 units planned units.**
- **This case study carries out an exercise to explicitly detail the additional fuel that the vessels of this class (MSC Beryl) will have to consume to recover a single day, being USD 153 000 as elaborated above.**

Case study 2 - MSC Bettina

Voyage Number: FY907R // Durban

Length: 366m
Beam: 51m
Capacity: 13798 TEU
Summer Displacement: 201510 ton
Summer DWT: 155438 tons
Summer Draft: 15.63m

Arrived: 28 February 2019 18h30
Berthed: 4 March 2019 11h00
Berthing delay: 3.5 days
Arrival draft: F 11.00m / A 11.30m
Departure Draft: F 13.20m A 13.20m
Sailed: 7 March 2019 07h00

Discharge total: 195 (79 x 20' + 116 x 40')
Load total: 1350 (720 x 20' + 630 x 40')

Position on 6 March 2019 01h30

Drafts F 11.8m A 13.12m; *Height of Tide* H.O.T. = 1.36m

Terminal (DCT) was instructed by MSC to stop loading with the aft gantry and continue with the forward gantry, as the forward draft was reading 11.80m and the aft draft was reading 13.12m, with a trim of 1.32m by the stern. The trim on tidal vessels must be closely monitored and preferably maintained at an *even keel*, especially on a falling tide and at low water. This is to prevent damage to the rudder and propeller, should any eventuality arise, owing to any unforeseen circumstances, compelling the vessel to take the bottom. As can be observed from the tide tables, the action to mitigate the trim had been taken in good time on a rising tide.

At 03h00, Chief Officer was requested to pump in some ballast in the forward tanks. After taking in approximately 3000 tons, drafts at 04h30 read, F 12.40m A 12.90m.
Aft gantry was reinstated to carry out load operations.

Balances at 06h00: 111/224/145

The mid-gantry had much higher balances; this was due to a breakdown on the middle gantry, with the spreader of the gantry stuck with containers within the cell guides, presumably due to the gantry operator trying to unlock the spreader before relieving the weight off. There was no work logged on this gantry from the 5 March 18h00 to 6 March 06h00 for a duration of 12 hours. The cargo planned for loading in this bay (bay 26) could not be moved to any other bays as the port rotation did not facilitate this transfer.

Lowest water was at 10h00, 6th Mar, H.O.T. = 0.33m.

Draft at 14h00: F 12.90m A 13.05m

Point to note is that cargo operations continued without maintaining the 0.30m UKC as stipulated by TNPA as this would further slow-down the operations.

Balances at 14h00: 59 / 224 / 47

The middle gantry was re-instated back into service.

In order to reduce the move count on the middle gantry (152 full units + 72 empty units), the empty units planned were instructed to be cut/unplanned.

New balances at 14h00: 59 / 152 / 47

At 16h00, the draft read, F 13.12m A 13.03m. This was due to the fact that the forward and middle gantries were loading at the forward of the centre of flotation (F). The Chief Officer was requested to de-ballast the forward tanks that were ballasted earlier due to excessive trim by the stern then, as well as the aft draft reaching 13.12m at the time. At this point, the Chief Officer refused to de-ballast the tanks and remained adamant on his stance, thus making it impossible to continue loading with the forward gantries; the reason quoted was the de-ballasting couldn't be executed due to restrictions imposed by the *Ballast Water Management Plan*. Productive period was lost over deliberations, whilst the operations were forced to be discontinued. The next low tide was at 22h00 with H.O.T., 0.25m, and the anticipated depth of water was 13.05m.

Balances at this stage were 23 /137/ 47

Vessel was further advised of the ebbing tide, the H.O.T. (0.25m) at lowest water and the urgency to de-ballast tanks in order to prevent the vessel from sitting on the seabed. At this point, the Master insisted to just sail the vessel immediately without loading the balance of cargo. Due to shift change, sailing could only be booked after 18h30. Pilot could not be mobilised until 19h00. Sailing the vessel any later would have been deemed unsafe owing to the progressively reducing UKC. Given the futility of de-ballasting at this stage without the assistance of cargo to compensate for the draft, the vessel was compelled to touch the bottom. The plan was to completely de-ballast the forward tanks and compensate with the cargo at the fore part of the vessel until the vessel arrived at an even keel draft of 13.00m and then stop all cargo operations until the lowest tide at 22h00 to resume operations at 22h30.

Balances at 22h00: 23 / 137/ 47

Cargo operations resumed at 22h30. Master and Chief Officer were appraised of the compelling situation to de-ballast the forward tanks via our principals based in Geneva (as the vessel refused to take instructions from the local agency). The cut off time for sailing was mutually agreed to be 06h30, 7 March, regardless of the status of cargo loaded. Progress in operations were being closely monitored. At midnight, in view of the very slow progress in operations, it was decided to only load all the units for Port Louis and short ship 40 x 20' units for Xingang. Last unit was loaded at 05h00, 7 March

Vessel secured for sailing; pilot on board at 06h30, unberthed at 07h00.

When it became clear that DCT wouldn't be able to load all the planned units, a conscious decision was made to lessen the repercussions that usually goes with the short shipments. It was hence decided to place all the Port Louis cargo on board, as most of this cargo is commodity based and better paying; fortunately, all the cargo for Port Louis was placed on board. The cargo for Xingang, loaded out of South Africa is predominantly minerals and hence was targeted to be short shipped as the vessel had to cut and run due to tidal sailing compulsions. When any planned cargo is short shipped, the consequences are quite far-reaching. In this instance, the cargo short-shipped was part of three bills; 20, 23, and 1 respectively + 257 x 40' empty units were short shipped as per attached N76 details issued by DCT (appendix 4.2.2). What does this essentially mean? Even though the units forming a part of the above-mentioned bills would be discharged at Xingang, the cargo cannot be released owing to receipt of incomplete bills. This in essence means that the cargo will not be able to leave the terminal until the short-shipped units are reconciled, which, in the best-case scenario will arrive in a week's time, on the next weekly service. Until such time, all the units that were originally discharged will incur additional storage cost. There could be a *Letter of Credit* involved, which may further complicate matters for the shipper.

The summarised sequence of events demonstrates the colossal delays incurred and despite the delays, DCT couldn't load all the planned cargo. The SWH (*Ship Working Hour*) achieved by the terminal (DCT), was a meagre, 23 MPH (*moves per hour*). Despite making allowance for the slow working, vessel lost at least 24 additional hours, due to tidal restrictions.

Even with the availability of spare capacity in relation to the draft aligned to the tidal window, all the planned cargo could not be shipped due to extremely poor productivity. The problems on this ship were triggered with the middle gantry breakdown that was loading forward of the CF causing the vessel to trim by stern. This compelled the intake of ballast to compensate for the inability to load and maintain an even keel draft. Thereafter, the reluctance of the ship's mates to de-ballast the forward tanks further exacerbated the issues at hand. All these problems that were encountered were related to the limited depth alongside the berth. It is increasingly difficult to convince and manage the crew on the ships having tidal constraints, especially when the focus is to maximise the liftings. This task becomes further unmanageable if the productivity is erratic which jeopardises the plans set in place. In addition, circumventing the TNPA regulations does not provide a buffer to absorb the poor performances by TPT.

On the MSC Bettina, the complications related to tidal implications, kicked in after 22h00 on 5 March. The balance on the heaviest hook, at this stage, was 224. Working out the averages prior to this time, from the commencement of operations until 22h00 on 5 March, the Gross Crane Hour (GCH), worked out to 15 moves per hour, excluding all the delays logged due to adverse wind, equipment breakdowns, etc.

Total number of moves performed: 1285 (from commencement of operations until 5 March, 22h00)

Total gantry hours: 84.5

$GCH = 1285/84.5 = 15.2$ MPH

Working on a GCH of 15 for the remnant of the operations, it was perceived that the operation would take $224/15 = 15$ hours

Therefore, the ETC was 6 March 13h00, with ETS 6 March 14h00.

The vessel however sailed on 7 March, 07h00; in addition, 44 x full units + 257 x 40' empty units were short-shipped.

Let's project a hypothetical situation with a productivity rate of 20 mph per gantry, four (4) gantries in operation, SWH 80 mph and study what could possibly be achieved given the similar tidal conditions to optimise load.

Officially the draft at 22h00 on 6 March, could not exceed 12.75m (H.O.T. 0.25m) having due regards to the recommended UKC 0.30m.

$CD + H.O.T. - UKC = 12.80 + 0.25 - 0.30 = 12.75m$

Considering the high water at 05h00, 7 March, H.O.T. 1.96m, the permissible sailing would be = $CD + H.O.T. - UKC = 12.80 + 1.73 - 0.60 = 13.93m$

With a SWH of 80mph, the expected tonnage is 2400 tons per hour

A prudently planned sailing tonnage will be arrived at, prior the vessel's berthing after having due consideration to the ETS and the final available tidal window. The vessels' optimisation of sailing draft is best achieved at the last available tidal window, whereby the vessel loads to a point of no return, having to sail, regardless. In optimising cargo, in terms of lifting maximum tonnage, it is best to carefully sequence the full containers and heavier units at the tail end of the operations, wherever practically possible. The quantum of units (number of containers) that can be loaded during the final leg of operations, with the deployed resources remains more or less the same as the time for sailing is pretty much pre-determined, as the vessel phases into this concluding stage of operation. This being the case, once the vessel arrives into the final phase, given the fixed number of units that can be loaded in the fixed period of time, rather the heavier units be retained for final loading wherever possible. The weight of the containers varies, the trend is that a certain port will

predominantly load lighter units, for example, Port Louis, and there are other ports that predominantly load heavy units, e.g., Tianjin Xingang. As the total number of units planned for loading remains the same, a better optimisation can be achieved if the heavier units are loaded last as far as practically possible.

To further clarify, if all the heavier are loaded at the beginning, the vessel will enter the final phase of loading with a greater balance and more number of units to load; alternately, if the vessel leaves the heavier units to be loaded last, the number of units to be loaded will be relatively lesser. This of course, is not always achievable, and a compromise needs to be drawn, depending on the various parameters.

In the hypothetical scenario, let's take the case of loading, 1. heavy units (30 tons each), and 2. light units (14 tons each).

At an SWH of 80mph and 7 hours available for loading, we could load the following:

Loading heavy units, each unit weighing approximately 30 tons,

$80 \text{ mph} \times 7 \text{ hours} \times 30 \text{ tons} = 16800 \text{ tons}$

With a TPC of 155, sinkage = 108cms

Sailing Draft = 13.83m

Loading light units, each unit weighing approximately 14 tons,

$80 \text{ mph} \times 7 \text{ hours} \times 14 \text{ tons} = 7840 \text{ tons}$

With a TPC of 155, sinkage = 50cms

Sailing Draft = 13.25m

However, in the latter case, the vessel would have sailed 8960 tons lighter if the light units were planned to be loaded at the final stages of vessel operation. A cut and run scenario without optimising the vessel on tonnage. The quantity of 8960 tons equates to approximately 300 units of 30 tons each or 640 units of 14 tons each.

What needs to be clearly understood is that the vessel must achieve the maximum permissible draft at the lowest water aligned to the low water prior to embarking on the final leg of loading.

Depending on the tide, whether spring or neap, the load figure could vary significantly, so could the tidal window, as well as the required rate of load.

Between 6 March 22h00 and 7 March 05h00, $2400 \text{ tons/hour} \times 7 \text{ hours} = 16800 \text{ tons}$ can be loaded.

Increase in draft = $\text{Cargo loaded} / \text{TPC} = 16800 / 155 = 1.08\text{m}$

Sailing draft is $12.75\text{m} + 1.08\text{m} = 13.83\text{m}$

Sailing at 06h00, the UKC = $\text{CD} + \text{H.O.T.} - (\text{Draft at LW} + \text{Increase in draft}) = 12.80 + 1.73 - (12.75 + 1.08) = 0.70\text{m}$

The recommended UKC as per TNPA recommendations is 0.60m

In essence, the vessel could have loaded to 13.83m as against the 13.20m in the illustrated actual scenario.

Practical scenario

Stop cargo operation at a draft of 13.00m with an UKC of 0.05m. Resume operations at 22h00, 6 March and load to the highest tide, H.O.T. 1.98m at 04h00, 7 March.

Between 22h00 and 04h00, in the available six hours a quantity of $6 \times 2400 = 14400 \text{ tons}$ may be loaded

Sinkage = $14400 / 155 = 93\text{cms} = 0.93\text{m}$

Draft at the stop of cargo operations + sinkage = $\text{Sailing draft} = 13.00\text{m} + 0.93\text{m} = 13.93\text{m}$

$\text{CD} + \text{H.O.T.} - \text{UKC for sailing} = 12.8 + 1.96 - 0.60 = 14.16\text{m}$

Vessel could have essentially loaded to 14.16 m, but the resources in all likelihood would be limited.

With five (5) gantries, the scenario would have been better.

SWH = 100 mph

Consider six (6) hours for loading between 6 March 22h00 and 7 March 04h00, ETS 05h00.

SWH x available duration x weight per unit = 100 mph x 6h x 30 tons = 18000 tons.

Sinkage = 18000/ 155 (TPC) = 116cms = 1.16m

Departure draft = Draft at stoppage of operations + sinkage = 13.00 + 1.16 = 14.16m

At ETS, 05h00, maximum permissible draft = CD + H.O.T. – UKC for sailing = 12.80 + 1.96 – 0.60 = 14.16m

Hence the sailing draft (14.16m) is within the permissible limits of 14.16m

Inadequate equipment/gantries at all berths to handle large container vessels:

Owing to the sheer size of the vessel, especially the beam, 51m /20 rows across, the vessel could only be worked/berth at NP 203/204. By virtue of this alone the vessel incurred a berthing delay of 3.5 days

Tidal constraints:

Due to the tidal constraints, the vessel lost an additional day

Productivity and equipment breakdown:

The SWH achieved on this vessel was 23 MPH collectively across all the gantries deployed, including all the delays, significant delays were logged owing to equipment breakdown and a few hours lost due to tidal constraints.

The total number of moves performed were 1545. At a SWH of 60 MPH (with three gantries), the vessel should have taken 26 hours for operations. Total stay at the berth shouldn't have exceeded 30 hours. In actual fact, vessel registered a stay of 68 hours at the berth.

In this case study the more significant losses projected are due to the inability to load the additional cargo as per the hypothetical situations presented. A minimum of 500 container units could have been added, equivalent to freight earnings of approximately USD 500 000 at the conservative rate of USD 1000 per unit.

The potential loss in earnings for Transnet would amount to approximately ZAR 1.5 million inclusive of THC and cargo dues

Case Study 3 - MSC Altair

Voyage number: F031R // Durban

Length: 366m

Beam: 48m

Capacity: 13123 TEU

Summer Displacement: 192078 tons

Summer DWT 148342 tons

Summer draft 16.0m

Arrived: 18 August 2020 05h00

CTOC window: 16 August 18h00 to 18 August 18h00

Berthed: 18 August 14h24 at NP 203

Arrival Draft: 8.50m / 10.10m

Sailing Draft 13.30m EK (Even Keel)

Sailed: 22 August 08h20

Stand-by due to draft restriction: 21 August 22h00 to 22 August 01h00

Shift: 21/08 06h00 – 14h00

Balance to load at 0600: Forward 253 / Middle 330 / Aft 255

Loaded: Forward 132 / Middle 131 / Aft 27

Draft at 0600: F 11.60m A 12.80m

Balances at 14h00: Forward 193 / Middle 199 / Aft 156

Aft gantry stood by due to draft restrictions from 06h00 to 12h30 for a period of 6h 30mins

There may be a difference in the “balance to load” and the “loaded” magnitudes for the reasons explained below. As the cargo operations progress, there could be changes instituted to the plans and effectively the balances. Usually, if there is an uneven split in the work queue, this is rectified and balanced out, if it is practically possible. There could be times, where the shipping lines could add units to the lean hook, usually empty units in order to even out the work queue and maximise the load. The terminal could sometimes be waiting for rail units that had been planned, but for varying reasons, did not arrive, or the units did not get shunted in time. The terminal could be waiting for DG cargo (Dangerous Goods as per the IMDG Code), direct deliveries, whereby the trucks possibly get delayed due to congestion/traffic and therefore a decision could be taken, either to drop stow and continue, or wait for the units to arrive to get loaded. Similarly, dangerous cargo that cannot be landed and supposed to be discharged direct on to the assigned transport could induce delays, especially, if these units are supposed to be handled during daylight hours only. During the course of cargo operations, if the delays are excessive, the shipping lines could take a decision to omit a complete port and hence abandon load for this particular port, in order to mitigate delays; such a decision will trigger substantial changes. There are times where the shipping lines decide, to only load the reefer cargo, cut the dry, in order to ensure cargo commitments are met, owing to the shelf life and sensitivity of certain cargoes. There may be a situation, whereby instructions are given to short-ship empty or full units to expedite sailing to meet commitments or could be imposed due to the vessel being tidal.

Changes to the work queue is a continuously evolving process, depending on the priorities and what is critical to the shipping lines at the time.

Shift: 21/08 14h00 – 22h00

Balance to load: Forward 193 / Middle 199 / Aft 156

Loaded: Forward 141 / Middle 128 / Aft 96
Balances at 22h00: Forward 52 / Middle 31/ Aft 100

Shift: 21/08 22h00 – 22/08 06h00
Draft at 2200: F 13.05m A 12.85m

All gantries stood by due to draft restrictions from 21 August 22h00 to 22 August 01h00 for a period of 3h awaiting the rising tide.

At 00h01 on 22 August, the H.O.T. was 0.22m
Depth at this tide: CD + H.O.T. = 12.8 + 0.22m = 13.02m
UKC = Depth – Draft = 13.02 – 13.05 = **-0.03m** (vessel apparently laying on the seabed at the fore part of the ship)

Resumed operations at 01h00 on 22 August
Balances at 01h00: Forward 52 / Middle 31/ Aft 100
Completed operations at 05h30
Pilot on board: 06h45 on 22 August,
Draft on completion: 13.30m EK
Depth at this tide: CD + H.O.T. = 12.8 + 1.80m = 14.60m
UKC = Depth – Draft = 14.60 – 13.30 = 1.30m

Let's take the case of adhering to TNPA recommended UKC at berth of 0.30m
At 00h01, 22/08, the H.O.T. was 0.22m. Cargo operations would be required to be stopped at 12.72m and resumed at 00h01, 22/08; operations could continue until 05h30 (shift change).
Cargo operations actually stopped at a draft of F 13.05m and A 12.85m, Mean draft = 12.95m
Difference in drafts, between the actual and TNPA recommended = 12.95m – 12.72m = 0.23m
At TPC of 140 tons at this draft, additional 16cms sinkage is equivalent to,
= Sinkage x TPC = 23cms x 140tons/cm = 3220 tons
Considering each unit averages 20 tons, 3220 tons is equivalent to 3220/20 = 161 units.
With a gantry split between three (116/3 = 54 units per gantry) and considering the present average productivity of 15mph for this vessel, it would take an additional 3.6 hours (54 units/15mph), deferring the vessel's sailing by a similar amount of time.
New sailing time hence would have been hypothetically deferred to 11h00 (considering time lost for shift change and sailing formalities), whereby the H.O.T. is 0.23m, leaving the vessel with an UKC of **negative 0.27m** (CD + H.O.T. – Vessel's Draft = 12.8 + 0.23 – 13.30 = **-0.27m**)
This certainly implies that the vessel would have had to short ship the cargo (161 units) should the TNPA stipulated UKC be maintained at the berth.

General comments:

This was one of the straightforward tidal vessels without many complications. It is worth taking a note that the tides experienced were spring tides with the lowest water being 0.22m on 22 August 00h01 and highest being 2.14m on the 21 August 18h00, and 2.00m on 22 August 06h00.
Prior to sailing, the range of tide was 1.78m.

Let's consider various hypothetical scenarios to optimise load:

On 22 August 06h00, the H.O.T. was 2.0m.

The UKC required for sailing as stipulated by TNPA is 0.60m.

On this basis, the maximum permissible draft is CD + H.O.T. – UKC = 12.80 + 2.00 – 0.60 = 14.20m
If cargo operations were to be interrupted/stopped at 12.90m, leaving an UKC of 0.12m at the lowest tide, there was a possibility to load the vessel to a draft of 14.20m, that is, a sinkage of 130cms in a period of 5 hours, sparing an hour for sailing formalities.

Given the TPC (*Tons Per Centimetre*) of the MSC Altair, being 145 tons/cm, approximately 18850 MT of cargo can be handled in the window from the lowest water to the sailing time.
In order to handle 18850MT, let's consider various models to accomplish the load.

TPC at this draft is 145

Load = TPC x Sinkage = 145 x 130 = 18850 tons

Let's check the possibility of loading this tonnage with 3 gantries and 4 gantries, respectively.

The span available is 5 hours, leaving an hour for sailing formalities.

Let's consider a productivity of 20 moves per hour, per gantry

Weight of each unit container 25 tons on an average (considering the exports on this trade are heavy units, predominantly minerals, paper products)

Scenario 1: With 3 gantries,

3 gantries x 5 hours x 20 mph x 25tons = 7500tons

Scenario 2: With 4 gantries,

4 gantries x 5 hours x 20 mph x 25tons = 10000tons

Now going back to Scenario 1

With 3 gantries,

At 06h00, the H.O.T. is 2.00m, the maximum permissible draft is 14.2m

3 gantries x 5 hours x 20 mph x 25tons = 7500tons

The sinkage achieved in this case is 52cms with a sailing draft of 13.40m

At 07h00, the H.O.T. is 1.83m, the maximum permissible draft is 14.03m

Adding another hour to operations

3 gantries x 6 hours x 20 mph x 25tons = 9000tons

Sinkage 9000/145 = 62cms, sailing draft = 13.52m with an UKC of 1.11m

Extending another hour

At 08h00, the H.O.T. is 1.46m, the maximum permissible draft is 13.66m

3 gantries x 7 hours x 20 mph x 25tons = 10500tons

Sinkage 10500/145 = 72cms, sailing draft = 13.62m with an UKC of 0.64m.

0.60m is the UKC stipulated by TNPA. In this scenario, the UKC is 0.64m, within the stipulated limits.

As can be inferred from the above cases of scenario 1, by sailing at 08h00, the cargo load will be optimised.

Scenario 2

With 4 gantries,

At 06h00, the H.O.T. is 2.00m, the maximum permissible draft is 14.2m

4 gantries x 5 hours x 20 mph x 25tons = 10000tons

The sinkage achieved in this case is 69cms with a sailing draft of 13.59m and UKC = 1.21m

At 07h00, the H.O.T. is 1.83m, the maximum permissible draft is 14.03m

4 gantries x 6 hours x 20 mph x 25tons = 12000tons

The sinkage achieved in this case is 83cms with a sailing draft of 13.73m and UKC = 0.90m

At 08h00, the H.O.T. is 1.46m, the maximum permissible draft is 13.66m

The draft achieved at 07h00, i.e., 13.73m has surpassed the maximum permissible of 13.66m at 08h00.

Therefore, the ideal sailing time in scenario2, with the load optimised, would be 07h00 with a draft of 13.73m and UKC of 0.90m

Going back to the hypothetical situation and devise means to increase the load, or achieve a sinkage of 130cms, being the difference between the draft at the lowest water and the draft at the highest water.

Load required = Sinkage x TPC = 130 x 145 = 18850tons

The loading must be completed in 5 hours (in this instance from MN to 05h00), sparing an hour for departure formalities, sailing at 06h00

In order to achieve this load or get closer to achieving the target of 18850tons, let's consider a deployment of 5 gantries and a productivity of 25 move per hour.

5 gantries x 5 hours x 25 mph x 25tons = 15625tons

By deferring the sailing by an hour, the H.O.T. at 07h00 is 1.83m, and required sailing draft is 14.03

Loadable cargo = Sinkage x TPC = 113cms x 145 tons/cm = 16385 tons

By working an extra hour, the cargo that is expected to be loaded is,

5 gantries x 6 hours x 25 mph x 25tons = 18750tons

Since the above figure (18750 tons) surpasses the loadable cargo of 16385 tons at 07h00, the loading will have to be restricted to 16385 tons, sailing the vessel at a draft of 14.03m and the TNPA stipulated UKC of 0.60m at 07h00

Take note cargo operations will complete loading at 05h15 and the vessel could sail at 06h15 whereby the H.O.T = 1.95 and UKC = 0.72m

Inference

The more significant losses in this case study are related to the inability to load the additional cargo as per the hypothetical cases presented. In exploring the various possibilities, it has become evident that a significant number of container units could be added, despite the tidal / depth constraints. At least, an extra 500 units equivalent to freight earnings of approximately USD 500 000 at the conservative rate of USD 1000 per unit is a fair number.

The potential loss in earnings for Transnet would amount to approximately ZAR 1.5 million inclusive of THC and cargo dues

Case Study 4 - MSC Livorno

Voyage number: FY032R // Durban

Length: 366m

Beam: 51m

Capacity: 13988 TEUs

Summer displacement: 211314 tons

Summer DWT 165517 tons

Summer draft 16m

Arrived: 23 August 2020, 18h42

Berthed: 30 August 20h24 at NP 204

Arrival Draft: 8.80m / 10.40m

Sailing Draft: 13.20m EK

Planned sailing draft: 13.30m EK

Sailed: 06 September 21h00

Stand-by due to draft restriction: 6 September, 07h30 – 15h30

Vessel is a straight loader

Position on 5 September 18h00

Balances: 86 / 210 / Nil

Vessel warped 5 bollards forward from 18h00 – 21h00, 5 September

Vessel stood by for adverse wind from 22h00 – 01h00, 6 September

Lost 6 hours of operational time

Position on 6 September 06h00

Balances: Nil/ 98 / Nil

07h30 – 15h30: Vessel stood by due to draft restrictions; drafts reading 13.10m EK

H.O.T. at lowest water 0.32m at 12h00

Master reported, vessel touched bottom close to low water, as per appended email.

Quote

From: Master of MSC Livorno <master.cliv@offenship.de>

Sent: Sunday, 06 September 2020 12:08 PM

Subject: MC MSC Livorno - Durban - Urgent ! - Vessel touched Ground at Berth No. 204

Fm: Master MSC Livorno

Dear Sirs

Urgent !

As agreed, cargo operations at berth no. 204 was stopped on 6 Sept at draft 13.10 m for waiting rising tide to resume.

Vessel touched ground at berth no. 204 close to low water.

- Please confirm the maximum permitted draft and depth at berth no. 204.
- Please consider to off load containers.
- Please confirm if the shifting to another berth would be possible.
- Please advise if it is possible to arrange divers for investigation of the ship's hull.

Please confirm if departure from Durban is still planned for today
06.09./18:00 LT

Best regards
Capt. Frank Fredrichs
Master MV MSC LIVORNO
Unquote

The MSC Livorno is a vessel chartered by MSC. The *Charter Part Agreement* doesn't explicitly make allowance for such an operation, which then makes it mandatory for the Master to request for an under-water survey if the vessel touches bottom as per the Classification Society's requirement. Besides, if the Master is not conversant with the seabed, a bit of apprehension is expected.

Operations were ordered to resume at 12h30. However, the Master put a hold on operations until further investigations were satisfactorily carried out. All tanks were sounded to investigate for any breaches. Cargo operations were resumed at 15h30.

Master requested to offload containers and arrange for divers for hull inspection. At the time of reporting, the tide was at its lowest water. By the time the conversation progressed the tide was rising and there was no point in discharging containers as per request from the Master. Besides, the instruction to discharge containers cannot just be issued verbally, so to be actioned. It has to go through a process involving exchange in an EDI format and could take up to 2 hours, before any instruction is actioned. These are the practical difficulties experienced and hence it becomes impossible to reverse any loading activity as a matter of urgency.

Hull inspection / divers could not be organised / mobilised as it was a Sunday. Besides, the vessel could not stay on the berth in lieu of insufficient water, having had to sail prior the following receding tide.

Master issued Letter of Protest to Mediterranean Shipping Company, as a matter of procedure. Under water inspection of the hull was organised at Port Louis. No damages were reported, as expected.

Position on 6 September 18h00

Balances: Nil/ 45 / Nil

Balance units short-shipped

Master insisted to book pilot and sail vessel. Sailing draft 13.20m

Pilot boarded at 21h00

This vessel was a disaster of sorts!

She arrived on 23 August 2020, berthed on 30 August, sailed on 6 September.

The vessel spent 14 days in Durban!

The vessel experienced berthing delays (7 days) due to port congestion, compounded by delays at the berth (+7days) due to slow working, equipment breakdown, etc., further exacerbated by adverse weather. With a total load of 2575, and a starting split with 4 gantries, eventually going down to 3 gantries, the loading operations should have been completed in 2 days times.

Owing to the sheer size of the vessel with a beam width of 51m/20 rows across, the vessel could only be afforded a berth at the north quay. This limitation has also contributed to an extent to the berthing delays.

The *Charter Hire* for this vessel is approximately USD 55 000 per day.

14 days x USD 55 000 = USD 770 000 was the cost incurred on only charter hire, besides all other associated costs, whereas the cost towards charter hire should have been USD 110 000 (considering two days for operations)

Two weeks of delay in Durban, meant, an additional vessel had to be injected into service from the Far Eastern ports in order to cater for exports from these ports for that particular week, the MSC Livorno was scheduled to be in Far East. As a result, the MSC Livorno had to be taken off the Africa

Express service and deployed on another. In the interim, another vessel was hired to inject into the Africa Express service. The congestion in South African ports and its far-reaching impact is little conceived by TRANSNET. There wasn't enough usable tonnage available at the time, primarily due to the fact that a substantial tonnage has been booked out for the installation of the *Exhaust Gas Cleaning System* (EGCS), also called the scrubber. Following the MSC Livorno debacle with regards to the delays incurred in South Africa, a decision was taken to bypass the South African ports completely with the Africa Express service.

More on this, will be discussed in detail under the relevant topic in Chapter Three.

Inference

The MSC Livorno finds its place in the case studies due to two reasons.

Extraordinary delays incurred, mainly due to berth congestion and working inefficiencies at DCT, as a consequence of which, vessel spent a total of 14 days in the port of Durban, which triggered the decision to completely withdraw the service. There were recurring delays on the vessels deployed on this service; these delays became unsustainable to justify the call to South Africa, the MSC Livorno being the last vessel.

Although, the delays are not entirely attributable to the tidal constraints, the factor did have its fair share in delaying the vessel. To this effect, there is a link to the performance; if the terminal had to perform at a consistent rate of even 15 moves per hour per gantry (which is relatively less), the vessel would not have encountered problems of touching the bottom, as she could have been better managed with more leverage of control over the advancing draft. Towards the tail end of the cargo operations as per the details provided, the cargo operations were interrupted when it became evident to the Master that the vessel touched bottom. Further, some of the cargo was even short shipped, even though it was deemed safe to load without any issues on the rising tide. This is the problem that is usually encountered with chartered vessels. The MSC Livorno is a vessel chartered by MSC. The *Charter Part Agreement* doesn't explicitly allow for such an operation (NAABSA) which then makes it mandatory for the Master to request for an under-water survey if the vessel touches bottom as per the Classification Society's rules. Besides, if the Master is not conversant with the seabed, a bit of apprehension is expected. If TNPA had not laid regulations for the minimum under keel clearance required whilst the vessel is at berth, the vessels' owners would perceive it is safe to carry out the NAABSA operation.

As mentioned, in dealing with the chartered vessels, the loadable space provided by the vessels is comparatively lesser. Most of the chartered vessels, besides following the TNPA stipulations, also include a margin of safety for any unforeseen adversities. As a result, there is a substantial loss in freight earning, equivalent to 200 to 300 container units in the least, primarily depending on the size of the vessels, tides and anticipated rate of load or discharge. Considering a basic freight earning of approximately USD 1000 per container, the losses in potential freight earning are between USD 200 000 and USD 300 000 per vessel.

As for Transnet, the loss in potential earnings by way of THC and cargo dues amount to approximately ZAR 750 000 to ZAR 1 million. These losses in potential earnings are registered on every vessel that is tidal. With particular attention on the deployment of additional resources / equipment and a focussed drive on productivity, at least towards the commencement of operations for vessels berthing with deeper drafts necessitating a tidal window, and towards the final phase of operations for tidal sailings, the cargo liftings can be substantially increased.

Case Study 5 - MSC Rachele

Voyage number: ZF037A // Durban

Length: 334m
Beam: 43m
Capacity: 8238 TEU
Summer Displacement: 141022 tons
Summer DWT: 107154MT
Summer Draft: 15.0m

Arrived: 20 October 05h30
Berthed: 22 October 09h48 at NP 202
Arrival Draft: 13.30m EK

MSC Rachele was expected to berth on arrival in Durban.
In anticipation of berthing on arrival, vessel sailed out of Coega with a draft of 13.30m. The tidal window to berth and lighten the vessel within the prescribed duration was calculated and deemed to be sufficient.

Following were the assumptions taken into consideration in taking the decision to limit the load on the MSC Rachele up to a maximum draft of 13.30m ex Coega.

20 October 05h30: Vessel arrived Durban
06h30 (after shift change): Expected pilot boarding time
08h00: Estimated time of berthing; H.O.T. 1.37m, UKC 0.87m
09h00: Estimated time of completing unlash and commencing cargo operations
10h00: Expected discharge 1200 tons (average container weight for units stowed on deck taken as 20 tons. Deploying 3 gantries at the rate of 60 SWH, expected discharge = 20 tons x 60mph = 1200 tons).
Rise = Weight discharged/TPC = 1200/120 = 10cms
Draft at 10h00 = 13.20m
H.O.T. at 10h00: 0.55m
UKC = CD + HOT – Draft = 12.8 + 0.55 – 13.20 = 0.15m

11h00:
Expected draft = 13.20 – 0.10 (hourly rise) = 13.10m
H.O.T. at 11h00: 0.30m
UKC = CD + HOT – Draft = 12.8 + 0.30 – 13.10 = **0.00m**

As highlighted the calculations does indicate that the vessel will have touched the bottom. If the TNPA's recommendations were to be strictly adhered to, the vessel should have been planned for arrival into Durban with a draft of 0.30m lesser, i.e., 13.0m instead of 13.30m. In most instances, whereby the vessels are planned at the maximum permissible draft in relation to the available depth of water and having due consideration to the cargo operations (be it discharging or loading) in order to align with the stipulated recommendations of TNPA to maintain the UKC of 0.30m at the berth at all times, this remains to be an impossible task as the productivity at which these calculations are executed, are not always achieved, resulting in the vessels sitting on the bottom, regardless. Although, this is not official, these incidents of briefly laying aground are taking place.

12h00:
Expected draft = 13.10 – 0.10 (hourly rise) = 13.00m

H.O.T. at 12h00: 0.27m
UKC = CD + HOT – Draft = 12.8 + 0.27 – 13.00 = 0.07m

13h00:
Expected draft = 13.00 – 0.10 (hourly rise) = 12.90m
H.O.T. at 13h00: 0.46m
UKC = CD + HOT – Draft = 12.8 + 0.46 – 12.90 = 0.36m

Going forth, the UKC will increase as the vessel continues to discharge on a rising tide.

If there was an indication of the vessel berthing on the 22 October, the vessel could have further optimised loading to a draft of 13.60m in Coega as per the following assumption.

22 October 16h30: Pilot boarding time
18h00: Vessel alongside; H.O.T. 1.43m; UKC 0.63m
19h00: Commence cargo operations
20h00:
Expected draft = 13.60 – 0.10 (hourly rise after discharging cargo) = 13.50m
H.O.T. at 20h00: 1.47m
UKC = CD + HOT – Draft = 12.8 + 1.47 – 13.50 = 0.67m

21h00:
Expected draft = 13.50 – 0.10 (hourly rise) = 13.40m
H.O.T. at 22h00: 1.35m
UKC = CD + HOT – Draft = 12.8 + 1.35 – 13.40 = 0.75m

22h00:
Expected draft = 13.40 – 0.10 (hourly rise) = 13.30m
H.O.T. at 22h00: 1.18m
UKC = CD + HOT – Draft = 12.8 + 1.18 – 13.30 = 0.68m

23h00:
Expected draft = 13.30 – 0.10 (hourly rise) = 13.20m
H.O.T. at 23h00: 0.98m
UKC = CD + HOT – Draft = 12.8 + 0.98 – 13.20 = 0.58m

24h00:
Expected draft = 13.20 – 0.10 (hourly rise) = 13.10m
H.O.T. at 24h00: 0.80m
UKC = CD + HOT – Draft = 12.8 + 0.80 – 13.10 = 0.50m

General comments:

The vessel called Coega first as against the normal rotation of Durban – Coega, due to the draft being in excess of the permissible draft to enter the port of Durban.

Out of Coega, the load value had to be determined by establishing the berthing date/time at Durban, in order to align the cargo intake to the available tidal window. Whilst planning the cargo ex Coega, the berthing projections of Durban showed the vessel to berth on the 20th Oct, am tide, and therefore the cargo was accordingly booked for loading considering the worst-case scenario. Durban arrival draft was planned at 13.30m.

However, the vessel berthed on the 22 October; the tidal variances on this day afforded a draft of 13.60m into Durban as demonstrated above. Vessel could have accommodated an additional 3600 tons at a TPC of 120 tons/cm, should the berth plan of Durban reflect the same at the time. The berth plans across South African ports are generated taking into consideration the optimum productivity, rather than the averages of actual performances. One of the prime reasons of the projections on the berth plan going erratic is the inconsistency in the performances over the different shifts, different days. This makes it potentially difficult to forecast berthing and sailing of vessels, even into the near future. In this instance, the delay in berthing was completely contributable to the working inefficiencies at the port of Durban.

The associated cost in this case is the lost freight for approximately 180 units / 3600 tons (considering an average of 20 tons per unit). If there was an early accurate indication of the estimated time of berthing at Durban, at the time of sailing Coega (one day sea passage), the sailing draft from Coega could have been accordingly adjusted / increased to arrive Durban with a draft of 13.60m instead of 13.30m. Other losses are charter hire, and daily running costs that are less significant in the larger scheme of expenditures.

Loss in potential earnings for Transnet is the THC + Cargo Dues, in this case amounting to approximately ZAR 500 000

Lost freight, taking into consideration USD 1000 per unit = $180 \times 1000 = \text{USD } 180\,000$

Berthing delays of two days incurred an additional charter hire at the rate of USD 45 000 per day, amounting to USD 90 000.

Other relevant indirect costs remain valid to recover the time lost.

Case Study 6 - MSC Sasha

Voyage number: NZ030A

Length: 300m

Beam: 48m

Capacity: 9411 TEU

Summer Displacement: 144874 tons

Summer DWT: 111274 tons

Summer Draft: 14.50m

Vessel sailed from Las Palmas direct to Coega. The original rotation was Las Palmas – Cape Town – Coega – Durban. Due to delays, vessel was instructed to bypass Cape town to call Coega with ETA 24 August 2020 18h00. Further, due to berthing congestion and anticipated weather delays in Coega, the option of bypassing Coega too, and proceeding straight to Durban, was explored. This was to cater to / discharge the extremely urgently required production line stopper units for BMW. Vessel was drawing 13.60m even keel. The intention at this stage was to discharge only the BMW units, lighten the ship to render her non-tidal, move to anchorage and carry out the entire planned operation at a later stage; in essence, the plan was to discharge approximately 300 units (BMW + additional units) in total in order to afford her a better tidal span at a later date.

Instructions were given to delay the berthing of the Hyundai Mercury (MSC chartered vessel), original ETB, 25th 14h00 in order to accommodate the MSC Sasha for the above-mentioned operation. Instructions to MSC Sasha to bypass Coega were issued, vessel reverted with an ETA 25/10, 19h30.

The highest tide for the day to be considered for berthing was supposed to be, 25 August 20h00, with H.O.T. 1.63m. The Harbour Master was sensitised to the urgent provision of Pilot on arrival.

Depth alongside the berth (at high water 20h00) = CD + H.O.T. = 12.8 + 1.63 = 14.43m

Expected UKC = Depth – Draft = 14.43 – 13.60 = 0.83m

The vessel encountered the strong Agulhas current setting against, and adverse weather conditions on the route to Durban, hence the vessel's ETA was deferred to 21h00, which implied vessel would be on the berth at approximately 22h00 or later, on a falling tide.

H.O.T. at 22h00 = 1.47m.

Depth = CD + H.O.T. = 12.8 + 1.47 = 14.27m

UKC = Depth – Draft = 14.27 – 13.60 = 0.67m

With this anticipated UKC of 0.67m, and due consideration of berthing on an ebbing tide, TNPA refused to berth the vessel as it was deemed unsafe. The tidal window was limited in this instance in relation to the draft of the vessel. This spelt out a complete disaster as the tide in the following days until the 29 August wouldn't be conducive to berthing the MSC Sasha at DCT. The vessel finally berthed in the early hours of 30 August at 01h00 on a rising tide, with highest tide being 1.60m at 02h00, after a little over four days. The vessel lost four days before a safe berthing window was available. The BMW plant in Rosslyn had to be shut for a brief period; in the interim the required parts were air freighted from Germany on a chartered flight.

The chartered flight used was a 747 DACH, ex Hamburg to South Africa.

Cost for a full charter hire USD 1.8 Million.

Loading capacity 520 cubic metre / 120 tons.

General comments

As much as TNPA has stipulated an UKC of 0.60m for berthing and sailing, it has been observed that there is complete reluctance in either berthing or sailing the vessels at this UKC, even though it is their own guidelines. However, their stance may be justified as there could be a likelihood of possible high spots, owing to silting during the tidal runs and movement of bottom particulates during bow thruster operation and propeller thrust. Besides, when the UKC is low to the extent of 0.60m, there are instances where the clearances may be further jeopardised by the tugs, more so, when the tugs pull athwartship.

Take the case of tugs pulling the vessel athwartship; at this instance there is a possibility that the vessel heels over.

Let's consider a vessel with a beam of 48m wide. For ease of reference, let's consider the vessel to be boxed shaped.

As the vessel heels over by 1 degree,

$\tan 1 \text{ degree} = \text{Opposite side} / \text{Adjacent side}$

Opposite side is the additional immersion of the immersed wedge due to tug's pull

Adjacent side is the measure of the half keel bottom (considering box shaped)

$\tan 1 \text{ degree} = \text{Opposite side} / \text{Adjacent side}$

$0.0175 = \text{Opposite side} / 24\text{m}$

Therefore, Opposite side = $0.0175 \times 24 = 0.42\text{m}$

The UKC at a 1deg heel is 0.18m, considering an UKC of 0.60m in the upright position

As the vessel heels over by 2 degrees,

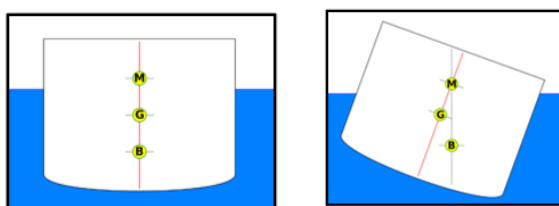
$\tan 2 \text{ degree} = \text{Opposite side} / \text{Adjacent side}$

$0.035 = \text{Opposite side} / 24$

Therefore, Opposite side = $0.035 \times 24 = 0.84\text{m}$

The UKC at a 2deg heel is **-0.24m**, i.e., the vessel will touch the bottom on the side she is being pulled, and the tug's pull will no longer be effective due to the drag friction of this manoeuvre.

Figure: Vessel in upright position (left) and vessel heeled over (right)



Source: MSC

The reasons for the reservations of carrying out the manoeuvre when the UKC is as low as 0.60m, stipulated as the least required UKC for berthing or sailing as per the TNPA recommendations, can be justified due to the above stated reasons.

Inference

- The vessel missed the planned tidal berthing window by an hour and half due to adverse weather experienced along the coast on the route to Durban. Consequently, the next available tidal window was only after four days. In this instance, the tidal window period was limited in relation to the draft of the vessel.
- Although, there was an opportunity to execute the manoeuvre, two hours later, TNPA declined to berth the vessel defying its own stipulated norms with regards UKC, despite deemed sufficient and within TNPA's official Standard Operating Procedures. The reluctance from the TNPA pilot may be justified to a certain extent as the tide was running out, but the implications were far-reaching, as follows:
 1. vessel lost four additional days waiting at Durban roads for the subsequent suitable berthing window;
 2. a section of the BMW plant at Rosslyn was shut down, as the automobile parts that were urgently required to keep the production line were carried on board the MSC Sasha, and the same could not be discharged in time, bearing in mind that the automobile industry works on minimum inventory and "just in time" principle. Parts for the plant had to be air-freighted from Germany on a chartered flight at a colossal cost.
- A general reference is made to the possibility of the UKC being jeopardised if the vessels heel over by one or two degrees when pulled by the tugs (no relevance in this particular instance cited).

Direct cost implications:

- Four days lost for berthing due to the vessel inadvertently missing the tidal window by an hour and half. Charter hire for four days at the rate of USD 45 000 per day = 4 days x USD 45 000 = USD 180 000
- BMW parts flown in from Germany at a colossal cost of USD 1.8 million

There are huge additional indirect costs incurred for recovery of the time lost, etc., which remains in place as discussed.

Case Study 7 - MSC Phoenix

Voyage number: NZ039A/ZF044R // Durban

Length: 300m

Beam: 40m

Capacity: 6586 TEU

Summer Displacement: 108898 tons

Summer DWT: 80270 tons

Summer Draft: 14.0m

Arrived: 31 October 2020, 23h00

Berthed: 1 November 2020, 02h30

Arrival draft: F 13.00m / A 13.20m

Initial reported arrival draft: F 11.90m / A 13.50m.

Altered the draft by taking ballast in the forward tanks in order to berth earlier and have a greater span for discharging / lightening, having due regards to the H.O.T. at low water, being 0.25m, at 10h00, 01/11 which essentially translates into a total depth of 13.05m.

01/11 04h20: First lift. Commenced operations with two (2) gangs deployed aft and mid-section as the aft draft was greater.

01/11 06h00: Resumed operations with three (3) gantries.

01/11 10h00: Drafts reading 12.75m EK with an UKC of 0.30m as stipulated by TNPA

UKC = Depth – Draft

Depth = CD + H.O.T. = 12.8 + 0.25 = 13.05m

UKC = Depth – Draft = 13.05m – 12.75 = 0.30m

Discharge total: 2545

Load total: 2586

30/10: Load file sent to the vessel as per the bookings.

Vessel reverted with a departure draft of 13.80m EK

Cargo planned for short-shipment from the load file: 100 x FCL + 200 x 40' empty units

Vessel reverted with a departure draft of 13.45m EK

Position at 05/11, 06h00

Balance to load: 115 / 196 / 109 / 103

Position at 05/11, 12h00

Balances: 69 / 101 / 45 (three gantry split) at the lowest water

H.O.T. at lowest water = 0.51 m at 12h00

Depth = CD + H.O.T. = 12.80 + 0.51 = 13.31m

Draft at 12h00 = 13.25m

UKC at 12h00 = Depth – Draft = 13.31 – 13.25 = 0.06m

05/11 18h00: Completed cargo operations

Draft = 13.45 m

Pilot booked for 05/11 18h30

Pilot on board 05/11 19h00

Vessel unberthed 05/11 19h25

UKC = Depth – Draft = (12.8 + 1.50) – 13.45 = 0.85m

General comments

Analysis with regards to cargo short-shipped 100 FCL + 200 empty units as per the introductory note.

Draft at 05/11 12h00: 13.25m at the lowest H.O.T. 0.51m

Difference between the drafts with the full booking list and revised

$$= 13.80\text{m} - 13.45\text{m} = 0.35\text{m} = 35\text{cms}$$

TPC = 100tons

Therefore, difference in tonnage = $35 \times 100 = 3500\text{tons}$

Removing the empty units $200 \times 40'$ with approximate weight of 4tons per unit

$$= 200 \times 4 = 800\text{tons}$$

Therefore, full cargo short-shipped = $3500\text{tons} - 800\text{tons} = 2700\text{tons}$

Could this 2700 tons of full cargo be accommodated?

With TPC = 100 tons/cm

Sinkage = $2700/100 = 27\text{cms}$

Actual sailing draft + Sinkage = $13.45\text{m} + 0.27\text{m} = 13.72\text{m}$

Could we have sailed at 05/11 18h30 with all the full cargo on board?

H.O.T. at 18h30 = 1.67m

Depth = CD + H.O.T. = $12.8 + 1.67 = 14.47\text{m}$

UKC = Depth – Draft = $14.47 - 13.72 = 0.75\text{m}$

If the vessel had to maintain a four (4) gantry split post 12h00 and maintain a modest 15 moves per hour per gantry, from 05/11 12h00 to 18h00, the vessel could have loaded all the full cargo booked and sailed with a draft of 13.72m and UKC 0.75m. Alternately, if the vessel had to work with three (3) gantries and performed 20 moves per hour, the vessel would have completed cargo operations by 17h00 and loaded the additional 100 full units.

In this case study all the planned cargo could have been loaded if the achieved productivity during the final window of loading, after the lowest tide, was either, 15 moves per hour with four gantries deployed, or 20 moves per hour with three gantries deployed. Both the targets are fairly effortlessly achievable with better planning. After this concluding sweep of loading, the vessel is obliged to sail on the tide.

The losses in potential earning for Transnet (comprising of THC for TPT and cargo dues for TNPA), with regards to the cargo short-shipped amounts to approximately ZAR 800 000

The potential freight earning lost by shipping line, calculated at a freight of USD 1000 per unit = $\text{USD } 1000 \times 100 \text{ units} = \text{USD } 100\,000$

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