Is Durban's Proposed Port Expansion Really Necessary from an Economics Perspective?

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ABSTRACT:

As vessels and seaports, - conduits for international trade growth, serving over 90% of world commerce, ascend to ever greater significance in a cost-conscious world reeling from the aftermath of the 2008 global financial crisis, the concepts of port efficiency and productivity matter more and more, especially in configuring optimal port designs. This paper attempts to illuminate this in considering the extent to which Durban's International Airport (DIA) and other port expansion/modernisation projects under consideration in ports throughout the world from Santos to Maputo, Bagamoyo, Singapore and Los Angeles, are really necessary. The alternative approach is to prioritise enhancing existing efficiency as a more feasible substitute. It seeks to outline the consequences of Durban's proposed port development for the current and DIA dugout port site as a prototype to determining the extent to which a proposed port expansion is really necessary, economically feasible or desirable from a key port user perspective. It derives from a UKZN Master's Dissertation comparing Durban to the Ports of Mombasa, Melbourne, Rio de Janeiro and Singapore. It will do so through outlining a timeline of port developments including future plans, a projected demand-supply, cost benefit analysis, through identifying the potential port user requirements, constraints to existing efficiency and concerns. The economic, environmental, traffic and transport and other general consequences of the proposed port development along with possible recommendations and solutions will also be outlined.

1: INTRODUCTION AND BACKGROUND

The South African maritime city of Durban with over 1.3 million people, situated on the East Indian Ocean Coast of Africa, is not just another port! UNCTAD 2013 estimates that over 90% of world trade is seaborne. As the main SADC conduit of trade, Durban's port accounts for over 70% of containerised trade passing through South Africa's ports. With an average of over 4000 vessels calling per year, and a total of 2.69 million, 20 foot TEU units of container traffic growing at 1.2% in 2013 and reefer cargo at 4.2% (Transnet January 2014), it is the most significant port in the Southern Hemisphere and in Africa in terms of marine-related economic activity. For example, Durban's port in 2013 with an average of over 6800 containers per day, handled total port traffic of 87,711,170 tons of cargo (44,829,622 for general) (Transnet January 2014), worth over R100 billion per year in terms of direct expenditure in the local maritime economy and value related activities (Booyens 2013). This port therefore comprises a significant part of not just Durban but the South African economy. Any inefficiency or under-performance level of Durban port that causes it to remain expensive and anti-competitive, has significant implications for the future of South Africa, regional Southern Africa and global trade, but primarily for the local port community affected by any development.

The future continued relevance and commercial value of Durban as a seaport is increasingly threatened by continued inefficiencies, failing to satisfy port user requirements and concerns in the 21st century including high annual Durban Container Terminal handling charges for a Supermax vessel of $250,000 compared to international competitor averages of $150,332, (Port Regulatory Authority November 2014) and how expensive Durban's inefficient port is at $275,000 for a Panamax vessel's average annual port costs, compared to a world average of $62,415 for rivals. Therefore research into lowering potential costs/improving port performance is necessary to assist the port authority and users interested in maximising Durban's potential benefits. Furthermore, investigating the feasibility of Durban's prospective port rehabilitation is even more significant, given the ever-increasing threat of African rivals all pursuing significant port expansion projects, plus Southern Hemisphere competitors i.e. Rio de Janeiro, Melbourne and Sydney. These threaten trade diversion from Durban through significantly projected container port demand and capacity growth forecast by the relevant port authorities in Table One, in planning for Bagamoyo, Beira, Dar-es-Salaam, Maputo, Mombasa, Port Louis and Walvis Bay. Besides, Durban needs to modernise in order to remain competitive as a port, satisfying all further user requirements.

Chart Area

1: Rival Southern African Port Competitors (TEU's)

Port	2013 Demand	2033* Demand	2013 Capacity	2033 Capacity
Bagamoyo	Insignificant	1,600,000	Insignificant	2,000,000
Beira	180,000	524,000	400,000	600,000
Dar es Salaam	775,000	1,250,000	800,000,	1,400,000
Durban	3,600,000	12,600,000	4,000,000	13,600,000
Maputo	170,000	370,000	150,000	400,000
Mombasa	899,000	1,700,000	950,000	2,100,000
Port Louis	315,567	1,250,000	900,000	1,350,000
Walvis Bay	337,000	863,000	355,000	1,050,000

* Estimates. Source: This Study

Durban's future as the most significant of African ports, is challenged further by the ascendency of Post-Panamax size vessels (over 350 metres long, with up to 12000 containers and a 170,000 deadweight ton carrying capacity), with the potential for ever greater economies of scale, efficiency and productivity but also increased externality costs for users and seaports able to permit their entry. Its existing port capacity denies their potential macroeconomic benefits, especially from significant forecasted international trade growth and possible container demand exceeding12 million TEUs by 2044 (Transnet January 2014). Geophysically, Durban's present harbour cannot expand, currently encircled by the city and the Indian Ocean. Therefore, unless it improves efficiency and productivity or expands, the port will face maximum capacity/throughput, suffering constraints to future growth by 2019 at current growth levels.

Therefore, increasingly aware of the potential value of modernised seaports and related infrastructure to the future of the city, provincial and national economy and the implications should it fail to be modernised for optimal peak port performance in alignment with other leading global ports, the South African government, Transnet Port Authority and local Durban Municipality (eThekwini) are working to ensure the future of Durban as a port city of significance. Transnet has committed to investing a total of R250 billion up to 2050, to convert the former Durban International Airport and even potentially the Bayhead Basin railway marshalling yard sites into further dugout port extensions to reach an annual 20 million TEUs of cargo handling capacity. Until 2019, R33 billion will be invested in enhancing existing port container throughput capacity to its maximum potential of handling 4.8 million TEUs at most, as another constraint requiring a physical port expansion.

While these may potentially resolve current problems of port-related capacity constraints and create a potential 64,000 construction linked and 28,000 operational jobs or more (Gigaba 2013), the DIA site

alone is projected to cost one hundred billion (exceeding ten billion dollars) over the next twenty five years to develop. This excludes other costs including fifteen billion rand to replace the Single Buoy Mooring (SBM), a single vulnerable strategic node, through which an estimated 75% of all South African crude oil imports passes (Cooper September 2012). Local community stakeholders have raised concerns over the social, environmental, economic, technical and traffic externalities plus other (especially time and opportunity) costs involved. Port users also remain uncertain over methods of financing this port. This paper's prime focus is therefore: to what extent this harbour expansion really is necessary and to what extent would it be better to focus on enhancing existing efficiency?

1.2 Problem Statement:

As noted above, the macroeconomic potential and value of efficient global seaports is imperative to key port users, as productive catalysts of development and economic activity that facilitate international trade. However, as for the example of twenty first century Durban, many of these ports have become increasingly constrained in terms of potential capacity and efficiency (especially in the Developing World), leading to the universally advocated method of port expansion, regardless of expense or other costs. The most pertinent question however, which first appeared to the researcher as a University of Kent undergraduate, when learning of Transnet plans for R250 billion invested in modernising Durban Harbour for the 21st century is this: Is Durban's harbour expansion – or any other – really necessary? Or could we enhance port efficiency – like other world and African Harbours? What are the constraints and costs in doing so?

Furthermore, is it not better to consider optimising port performance of existing facilities before enhancing port capacity? In doing so, these avoid the costs of underutilising existing port infrastructure and services – especially from a developing country perspective, as many commissioned port projects from New York to Ngqura fail to utilise their full potential. Considering the 2008 recession aftermath creating uncertainty over the global future of shipping and seaports (Dyer September 2013), various concerns/constraints identified in this dissertation and possible rival competitor port developments for Walvis Bay, Mombasa and others restricting growth, are projected Durban port trade volumes and the number of vessels/potential throughput sufficient to justify a substantial investment in additional port capacity? Given that Transnet has just commissioned the expensive but underutilised port of Ngqura in the Eastern Cape, is it possible to ensure a more productive, cost-efficient port configuration is designed – to provide sufficient overall port capacity, consistent with projected and actual demand for port infrastructure, services and related marine economic activities?

In reviewing literature, this study found that most ports incur these problems because in preparation, construction and execution, generally the state or municipality are involved or a parastatal (autonomously governed, self-funding state enterprise) does so on its behalf, While these parties may consult each other, on average those most directly able and qualified to offer potential insight into improving ports, as key port users and the local community are often ignored or underutilised (despite their dependency upon the port development). This paper considers direct participation and empirical investigation to determine the requirements of stakeholders in creating and operating ports. This study attempts to provide greater awareness of all aspects and consequences concerned in a port development, collating as much updated and pertinent information, wherever practically possible. It seeks to provide greater elucidation into potential costs and benefits, so that key port users may establish for themselves the feasibility of this and subsequent port developments. It aims at greater awareness of the challenges, issues, constraints and concerns facing the future of Durban as a port city. It aspires to make recommendations to address their concerns, wherever practical.

1.3 Motivation and Significance: Why Is This Paper Necessary?

In many current research and actual port expansion projects€, the design and function of ports merely focuses on being optimal interfaces between land and sea or as catalysts for economic development in alignment with government policies seeking to maximise efficiency and productivity without specifying how or standardising comprehensive port performance indicators. In particular, this paper seeks to assess this research approach of active port stakeholder management in enhancing port potential, by employing the specific example of Durban South Africa as a case study. As a harbour, Durban is immensely profitable but inefficient by world standards, defying conventional economic theory. Why? How can it become more efficient? In contrast to many previous research attempts and other projects, sufficient information exists to answer each key research question proposed in this dissertation. For Developing World countries facing financial, environmental and other opportunity costs of finite resources, this paper has further advantages: working towards ensuring the most efficacious utilisation of ports rather than in superfluous and expensive investments with other under/overcapacity costs.

This paper's potential does not limit its relevance to the specific exemplar of Durban's port expansion but it aims to contribute towards a hypothetical, prototype means of assessment to assist current and future participants in designing and implementing more efficacious port designs. This therefore could improve profits, and other potential benefits across all future ports in addition to stimulating multiplier effects of economic growth and development from greater Durban/other port competitiveness, while minimising

related user costs. It is further motivated from a Sub Saharan Africa, BRICS' and developing world case study viewpoint to provide greater intuition into specific Developing World challenges and considerations, trade and investment opportunities and key stakeholder requirements by African port communities. Previous research studies and technical port development feasibility reports are mostly First World orientated, neglecting both information and potential prospects of any African port development. Finally, this paper is motivated in seeking to overcome certain previous research limitations, which often focus and restrict themselves merely to possible benefits but seldom reflects costs of port expansion and efficiency. Many port users and academics often complain of the problems – they seldom think of the solutions to these port challenges and constraints. However, even without the macroeconomic significance of seaports to the global economy (still recuperating from the 2008 financial crisis), this study determining Durban harbour's invaluable role by interview, research and calculation for anyone affected directly and indirectly by any port development or interested in the future of a seaport, a maritime economy, shipping, a city and a country, is worth pursuing.

2: Durban Port DIA and Dugout Basin Historic, Current and Future Port Development Plans

2.1 Timeline Horizon:

The timeline of selected historical port events set out below, highlights the history and envisioned future of Durban port's development.

- 2002: TNPA revised Tariff Structure and Methodology – replacing ad valorem based cargo tariffs with user pays equity, efficiency and cost recovery principles.
- 2007: Phase 1 Pier 1 Durban Harbour Entrance Channel Dredging and Widening, plus enhancing the southern breakwater, creating a new north groyne, and improving navigational aids. Port modernisation will increase the maximum container vessel port user capacity from 4000 20 foot TEUs to 9000 and increase the maximum Point Terminal Car Capacity from 30,000 to 100,000.
- 2007-2012: Durban Municipality's Back of Port Development Plan research study is undertaken. Clairwood, Mobeni East and West districts are rezoned for logistics. Merewent expands its light industry/office park zone.
- February 2012. Durban Container Terminal Berths 203-205 expands port capacity to 2.7 million TEUs.

(Adapted from Iyer Design Studio 2012/ Muller, Smith, Sessions et al. March 2009)

Port Modernisation Phases:

Phase I: 2010-2020. Current Port of Durban Efficiency Upgrade.

- March 2011: South African Cabinet approval of Durban Harbour's Expansion granted.
- 2012: Start of Transnet Freight Rail's Investment Implementation Plan to 2050 from Cato Ridge (complete by 2025) via the Natal Corridor Line with R8.5 billion spent on improving Wentworth, Kings' Rest/Bayhead railway network, Clairwood and the DIA site rail links.
- April 2012-2019: Transnet's R300 billion Capital Investment Programme in road, rail, utilities and upgrading existing port functions including dredging City Terminal deepwater quays.
- July 2012: Modernising Durban Container Terminal and Pier 1 to handle Containers up to a total 2.9 million TEUs reaches completion. R72 million is spent on 2 gantry cranes.
- December 2012: R1.8 billion Transfer from Airport Company South Africa of old Durban International Airport site to Transnet.
- April 2013-April 2014: TNPA Port Pricing Strategy, Tariff Structure, Methodology and Port Expansion Pricing Proposal finalised – ignores financing port upgrades until DIA is officially South Africa's tenth port.

- 2013-2017: Current Port Berth Deepening and Pier 1 Phase 2 modernisation period including acquiring and converting Salisbury Island naval base and Maydon Wharf Container Terminal and installing an electronic pilot messaging system.

- **Phase II: 2020-2040 old DIA site Harbour Expansion** March 2014: DIA site Port Regulatory Authority Final Approval deadline.
- September 2015: DIA site Environmental Impact Assessment (EIA) and Feasibility Study finalised.
- 2016: Port concessioning and construction tenders awarded.
- March 2016-2020: First four berth terminal, breakwaters and channel dredging at DIA site scheduled to commence construction.
- 2020-2040: Remaining DIA site expansion phase preparations including planning and land use conversion, stakeholder consultation and EIA studies, construction, terminal, transport, infrastructure and services configuration and interlinkages to the local and national economy.

2.2 Study Location: Port Layout and Facilities of the Existing Durban Harbour

Chart I: Southern African Ports (Transnet July 2013.)

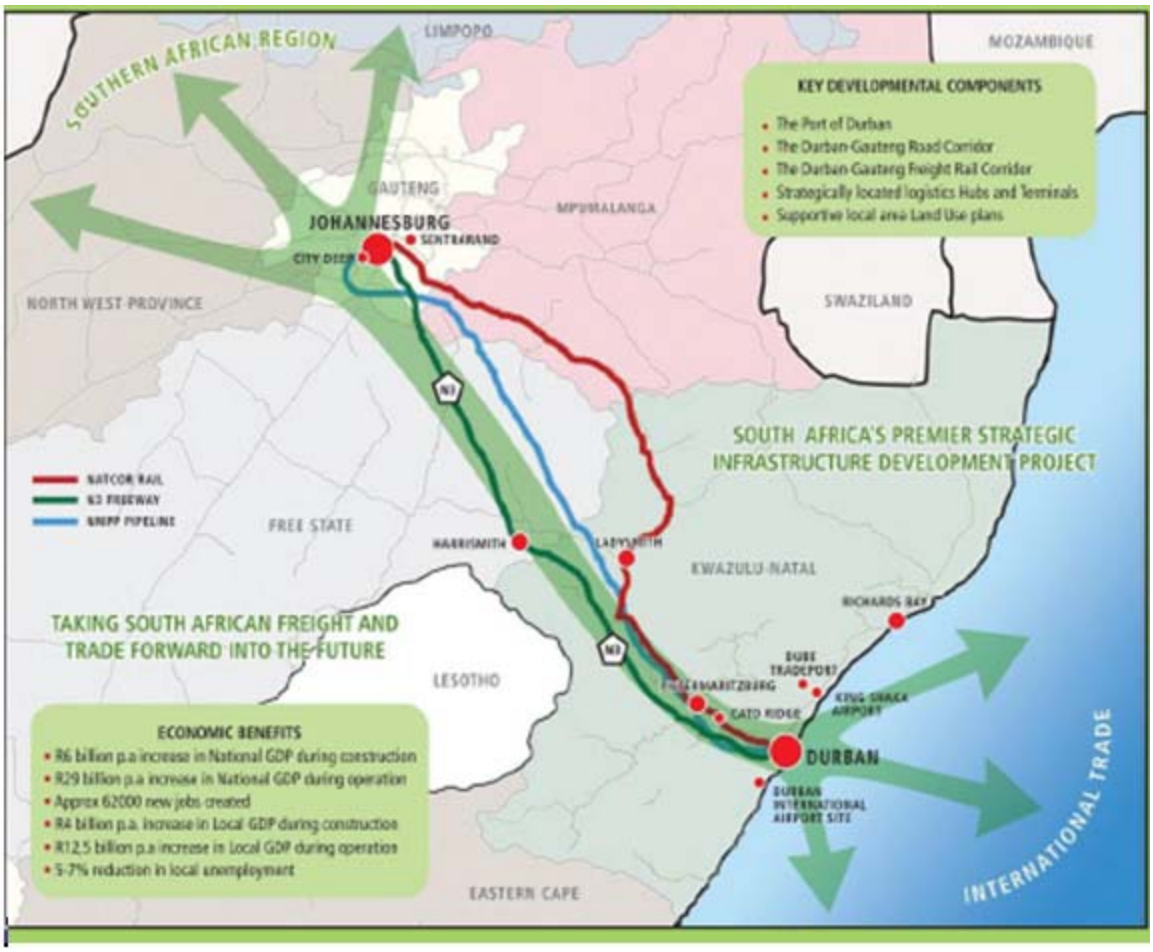


Chart II: Gauteng- Durban Freight Corridor Map: (Transnet July 2013)

The study will be conducted at Durban's current Harbour (Chart I/IV) and the proposed additional dugout harbour basins located at the former Durban International Airport site and Bayhead Basin (old railway marshalling yards) in eThekwini Municipality, KwaZulu-Natal South Africa, completing the Gauteng-Durban Freight Corridor (Chart II). Chart III below provides an overview of Durban's current and DIA harbour basins plus affected urban areas.

Chart III: Overview of Both Sites (Iyer Design Studio May 2012).

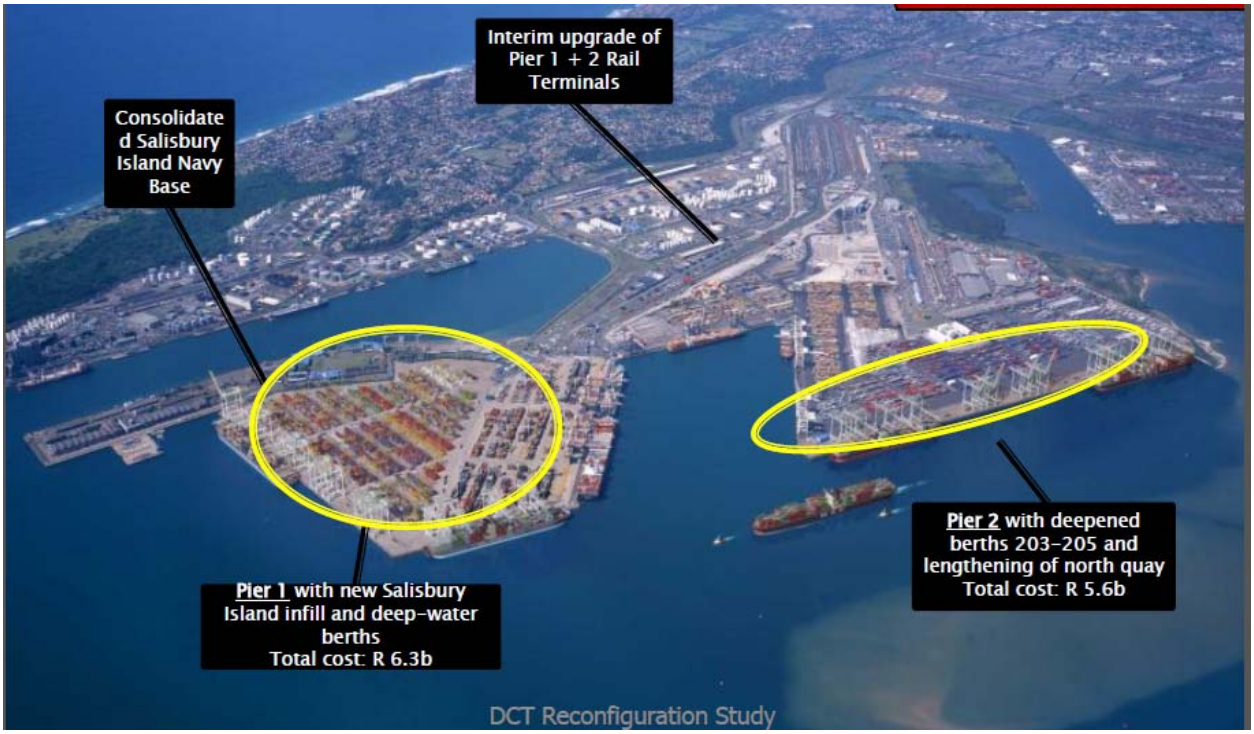


Chart IV: Durban Current Port Layout (Transnet July 2013).

To determine the extent to which Durban's Harbour can become more productive and efficient and to aid in configuring the optimal African/Developing World Port Design, this subsection considers the existing capacity of Durban Harbour. Chart IV shows the present port layout and existing port developments to illustrate that R6.3 billion for improving the efficiency of Pier 1 and R5.6 billion for improving Pier 2 is far more commercially sustainable in seeking cost-recovery from prospective port users than a projected R75-100 billion to develop the DIA dugout port site. Geographically and economically it is essential to consider where it is situated, what the current port layout is and what facilities/services and functions are provided. These questions determine the extent to which they should be modernised (to avoid underutilisation or overusage externality costs for stakeholders). This helps to answer whether existing port performance and capacity can be improved as a preferable policy alternative to an economic expansion. By summarising facilities and functions, port designers can use these to maximise port benefits and satisfy requirements throughout an existing and future harbour by answering: What Do Stakeholders Desire in a Port? What are the constraints to improving existing port capacity?

Geographically, Durban's port is situated at the nexus of Southern African trade – through seaward connections with the Indian Ocean (Chart 1) and landward, road and rail connections of the Gauteng Freight Corridor. Its transport modernisation process is expected to provide significant further

macroeconomic benefits pinpointed in Chart 2 (Transnet July 2013), interconnecting the two most economically significant South African regions of Natal and Gauteng. Transport infrastructure includes the 2010 constructed, North Coast based, King Shaka International Airport, the Durban-Gauteng railway line through the Valley of a Thousand Hills and N3 highway to the west with a North-South coastal N2 highway in addition to lesser roads. These links further substantiate the potential of efficient, interlinked ports to contribute to trade growth and economic development. Durban Harbour itself has ancillary maritime related commercial enterprises.

Durban Harbour's existing port layout extending over 21 kilometres in perimeter and encompassing 1854 hectares of port related activity, further substantiates the need for a physical DIA site dugout port. Despite R2.85 billion spent on widening the existing harbour channel (Mott 2010), it faces natural parameter limits to further expansion (geophysical and environmental), (Charts III and IV). The 335 metre north and 700 metre south breakwaters and tides serve as further physical barriers to the feasibility of a port extension within the existing Durban port location. As Charts III/IV illustrate, Durban's port cannot extend into the east Indian Ocean, the south facing Bluff Admiralty headland, the north and west city (apart from the Bayhead underutilised railway site, protected mangroves and angling/yacht clubs of the Amazinyama river and Silt Canal) and a natural sandbar in the port itself, necessary to preserve the estuarine system and prevent flooding (SDCEA 2014). The new port developments are considered necessary by certain users for fully laden Post-Panamax vessels to access Durban and to resolve inadequate existing, working berth water depth. These limitations further justify the need for the DIA/Bayhead proposed port sites to accommodate ever larger (i.e. Post-Panamax Dimension vessels), given essential sandbanks (Iyer Design Studio 2012) impairing a more cost effective berth dredging alternative.

With a pilot, port caller dimensions are limited to the 19 metre deep and 225 metre wide dredged outer channel into the 16 metre deep harbour basin where they are assisted by tugs to one of 6 Transnet owned, commercial piers and 58 common berths/3 car berths. All vessels have to report to Customs for clearance and to pay port/cargo dues (where applicable) at the Port Authority, both are located at T Jetty (Chart IV Transnet July 2013). Durban's current port targets strategic port callers providing a cruise ship passenger terminal (N shed, T Jetty) and fresh pumped water for vessels. Bunkering is offered by dedicated barges to vessels throughout the port, reaching over 2 million tons per year. Yachts, ferries and leisure vessels berth at Wilson's Wharf yachting and tourism marina. Other services include port functions listed in Table 2 below e.g. stevedoring, storage terminals and cargo handling.

TABLE 2: SUMMARY OF A PORT'S PHYSICAL ASSETS AND FACILITIES				
Marine Infrastructure	**Marine Services**	**Cargo Services**	**Cargo Infrastructure**	**Cargo Superstructure**
Port Approaches	Pilotage	Stevedoring	Terminals	Cranes
Port Limits, Breakwaters	Mooring	Port Security	Warehousing	Terminal operator vehicles
Fairways	Tugs and towing	Road	Other storage facilities	Stacking equipment
Turning Basins	Salvaging	Rail	Customs transhipment sheds	Mounted Gantries
Water Depth	Drydocks/Repairs	Value added activities – packing etc	Bonded warehouses	Container scanning
Channels	Waste Disposal	Warehousing	Conference facilities	Straddle carriers
Navigational Aids	Synchrolifts	Tracking	Offices	Lifts
Gravity Retaining Wall/Pavement	Water/electricity, communication	Inspection	Cruise Facilities	Reach stackers
Berths	Bunkerage	Freight Forwarding	Reefer points for containerised cargo	Information systems –NAVIS
Quay Walls	Firefighting	Financing	Cargo repair/ surveying facilities	Communications e.g. radios
Docks	Vessel Tracking	Insurance	Backup generators	Truck Appointment System
Port Authority/Customs	Sewerage/waste disposal, gas	Prioritised customs processing	Hazardous cargo Storage zones	Electronic data submission system

This paper maintains that enhancing existing port efficiency by reducing existing total port facility constraints (Table 5) identified in 3.7, (including the specifically neglected private Table 4 facility constraints), have significantly lower economic, social, technical and environmental externality costs than a physical port expansion for Durban. Although Durban port has modernised with greater usage of information technology – from mutual information cooperation between Transnet and SARS etc, COSMOS to NAVIS operating system (except Pier 2), automated screening systems, higher definition cameras and RFID scanning, constraints remain. For example, equipment summarised in Tables 3-5, requires investment in sufficient quality and quantities, via automated processes, adding/upgrading equipment, improving labour, management and layout etc in alignment with stakeholder identified requirements (3.8) to cost efficaciously optimise additional growth in cargo throughput, vessels and subsequent demand for port functions. This further reduces the extent of a physical port expansion that pro-port expansion advocates actually need to resolve current technical and congestion constraints, causing Durban's port to under-perform compared to international competitors. Investing in greater communication and information exchange capacity between port users and Transnet or Customs would further reduce congestion.

Table 3: Durban Port Equipment Summary.	
Durban Container Terminal 1 Summary	**Durban Container Terminal 2 Summary**
6 super-post-Panamax STS cranes, Navis N4 and Camco Autogate systems	7 Tandem Lift Cranes on DCT Berths N/Q 203-205 6 Liebherr 6 Noel 1 Impsa
2 Rail Mounted Gantries, 22 Rubber Tyre Gantry Cranes	113 Straddle Carriers
54 Haulers	53 Haulers
55 Trailers	53 Trailers
2 Reach Stackers	4 Reach stackers
2 Forklifts	7 Forklifts
2 EC Handlers	12 EC Handlers

TABLE 4: DURBAN PRIVATE PORT FACILITIES SUMMARY. This Study/ Transnet Port Terminals January 2014		
FACILITY	COMMODITY EXPORTED	QUANTITY (2013) (tonnes)
Agriport Terminal (Maydon Wharf)	Grain/Soda Ash	34500 Grain. 32000 Soda Ash
Bluff Bulk/ Coaling Terminal	Bulk Commodity (4 berths)	A total 250,000 ton capacity including 68000 tons of bulk maize, 8000 of andalusite and mono-calcium phosphates, 335000 of coal, 24000 of chrome ore, 4956 m^3 of vegetable oils (2013).
Rennies Bulk Terminals (Island View/Bluff)	Mineral/Bulk (4)	100,000 agricultural, 4000 mineral
Island View Complex	Liquid Bulk	4,900,000
Bidfreight Port Operations/ Grindrod Dry Bulk Terminals Maydon Wharf	Steel, chemicals, minerals, forestry	Unknown
Maydon Wharf Sugar Terminal/ Woodchip Terminal Pure Cane Molasses Terminal	Raw Sugar Woodchips Sugar Cane/Molasses	1,115,000 Unknown 46,000
Maydon Wharf (1 berth) T Jetty (3) Outspan International Citrus Terminal	Citrus fruit	175,000 pallets

Source: This Study/Transnet Port Terminals January 2014

Table 5: Total Durban Port Facilities. Source: This Study/Transnet Port Terminals 2014.				
Pier Name	Number of Berths (58)	Cargo Type	Cargo Capacity (TEUs)/year	Site Constraints
Pier 1	8	Container/General cargo	720,000	It contains 1113 ground slots and 90 reefer slots, 2 gantry cranes, a mobile crane with 100-ton lift, four reach stackers and 17 straddle carriers.
Pier 2	6	Container	2,300,000	14941 TEU slots, 1117 reefer charge points, 2128 metres of quays, 120 straddle carriers 19 quay cranes with 45-ton lifting capacity
Point and T Point Jetty	14 and 2 Cross Berth	Neo-bulk, Cruise Terminal	3.000,000 Tons	
Cato Creek Car Terminal	3 (Included in Point)	Cars	570,000 330,000 FBU's	8.5 hectares of area, 366 metre quay, 10.9 m quay depth
Island View	9	Dry Bulk 1 Liquid Bulk 8	5,850,000 Tons	420.000 metres of storage capacity
Bluff	4	Dry Bulk	2,000,000 Tons	743 metres of quay length, a belt loader, 2 grab unloaders,2 bucket loaders
Maydon Wharf	15	Dry Bulk	6000,0000 Tons	2809 metres of quay length
Bayhead:	Prince Edward	Fish wharf, Repairs	15000 TEUs	

	Graving Dock, 2 floating docks, a slipway and drydocks		Maximum capacity 30000 TEUs	

As the largest port in terms of maritime-related economic activity in both Sub-Saharan Africa and the Southern Hemisphere, with strong locational advantages to the economic hinterland of the African continent, South Africa and Indian to Atlantic Ocean trade routes, vessels passing through Durban Harbour trade a variety of cargo including citrus fruit, timber, sugar, steel, iron, vehicles, fertilisers, grains, oil, petroleum and containerised goods at high volumes. These include a total of 79,000,000 tons of cargo for 2013: 44,829,622 for general, 33.6 million tons for containerised, 2.75 million reefer and 9.6 million tons for dry bulk cargo (Transnet Port Terminals January 2014). As containerised trade alone contributed significantly to economic activity and development, it appears evident the necessity of Durban port, as without these volumes the city of Durban would not exist. This therefore further verifies the necessity of designing ports for all users to sufficiently maximise potential cargo, passenger and economic activity - efficiently, reliably, swiftly, accurately and cheaply from point of entry/vessel to final destination following Figure IV's conceptual design for a functioning port. This includes integrating the significant cargo volumes of landside areas (Table 6) and logistics zones.

Table 6: Volumes of Non-containerised Cargo Landside Area Moving through Durban Port (Iyer Design Studio 2012)			
Local Sub Area	**Cargo**	**Volumes Exported (Tons)**	**Volumes Imported (Tons)**
Congella	Citrus	110,000	
	Tyres	70,000	
Point	Citrus	200,000	
Maydon Wharf	Citrus	225,000	
	Fertiliser		600,000
	Molasses		225,000
	Soda Ash		200,000
	Pulp/Paper	840,000	
	Wood chips	450,000	
	Maize	47,250	
	Rice		416,000
	Wheat		617,000
	Steel	600,000	
Island View Storage	Maize	427,680	
	Wheat		183,000
	Liquid Bulk		3,390,708
Transnet PX Shed Precinct	Sugar (Illovo)	1,200,000	
Rossburgh	Sugar	600,000	
Clairwood	Citrus	11,000	
Mobeni	Citrus	11,000	
Prospecton	Motor Cars	140,000 (vehicles)	
	Citrus	207,900	

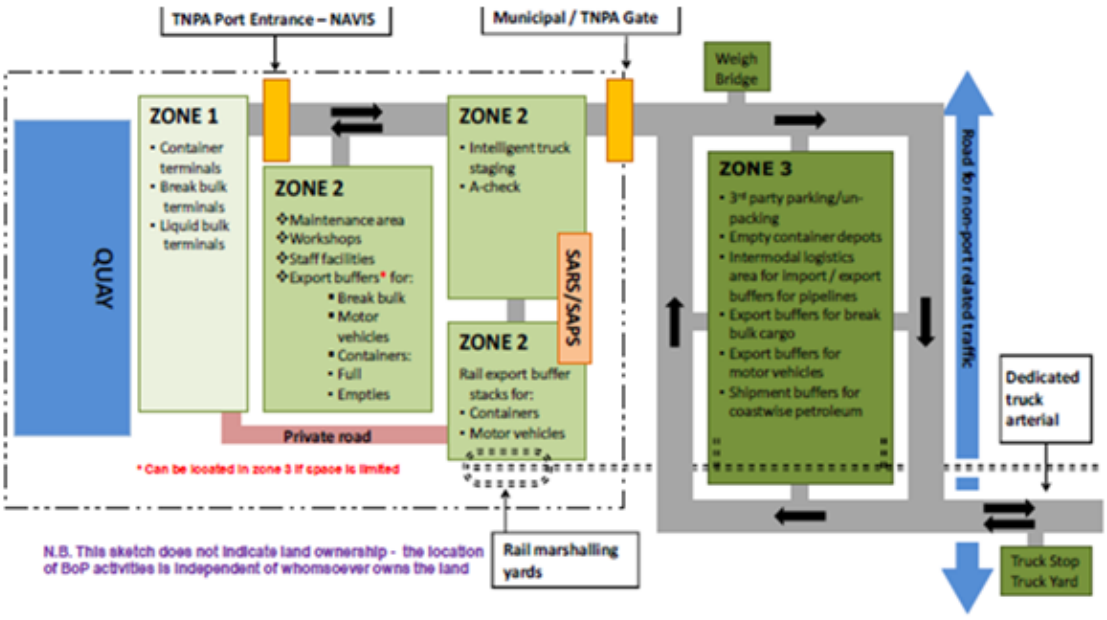


Figure IV: Conceptual Port/Back of Port Functions (Muller, Smith and Sessions March 2009.

2.3 The Projected Durban Port Expansion and Development Plan.

This section summarises the future projected port layout and facilities for both the proposed Durban International Airport site to be constructed 2016-2040 to potentially determine the extent of need for a possible, additional port. As with any development, key port users experience macroeconomic costs and benefits not just directly but also from the often ignored and under-measured opportunity costs of not constructing these extensions.

Image II: The Current DIA Site. Transnet (March 2014).

Image III: The Future Second Port (LeGuern 2013).

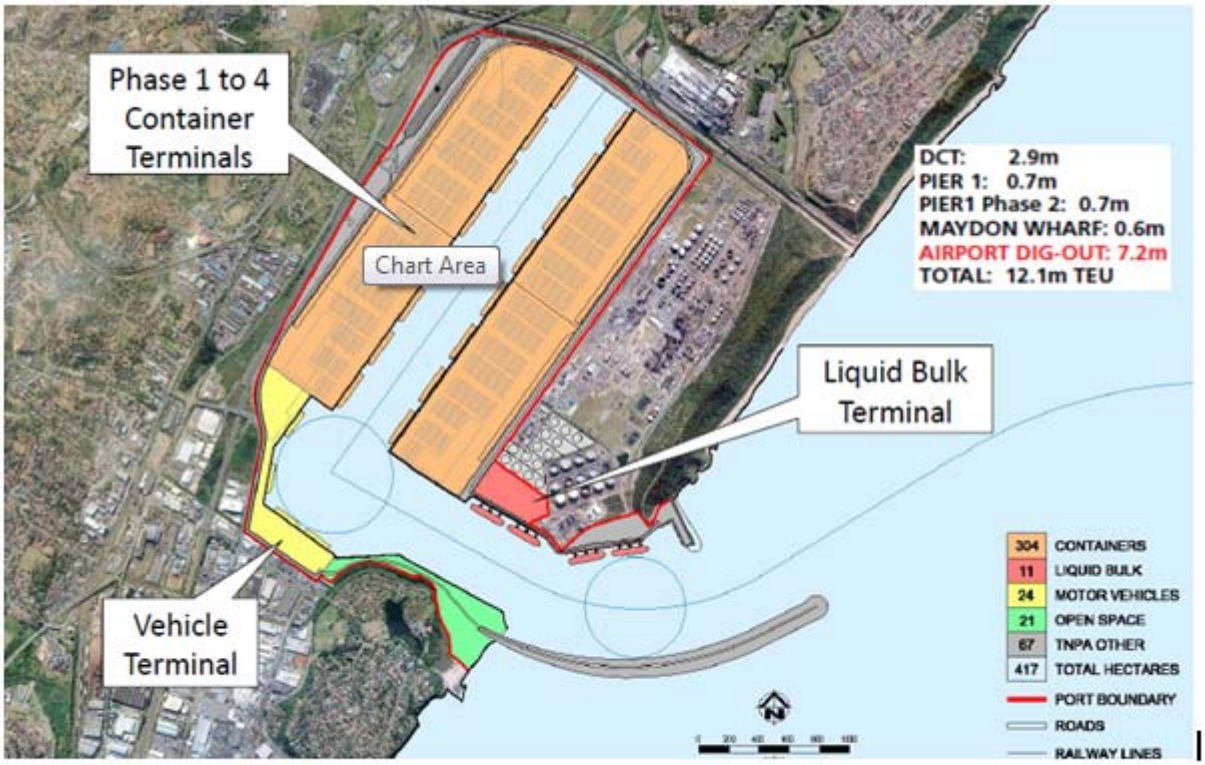


Chart V: Transnet July 2013.

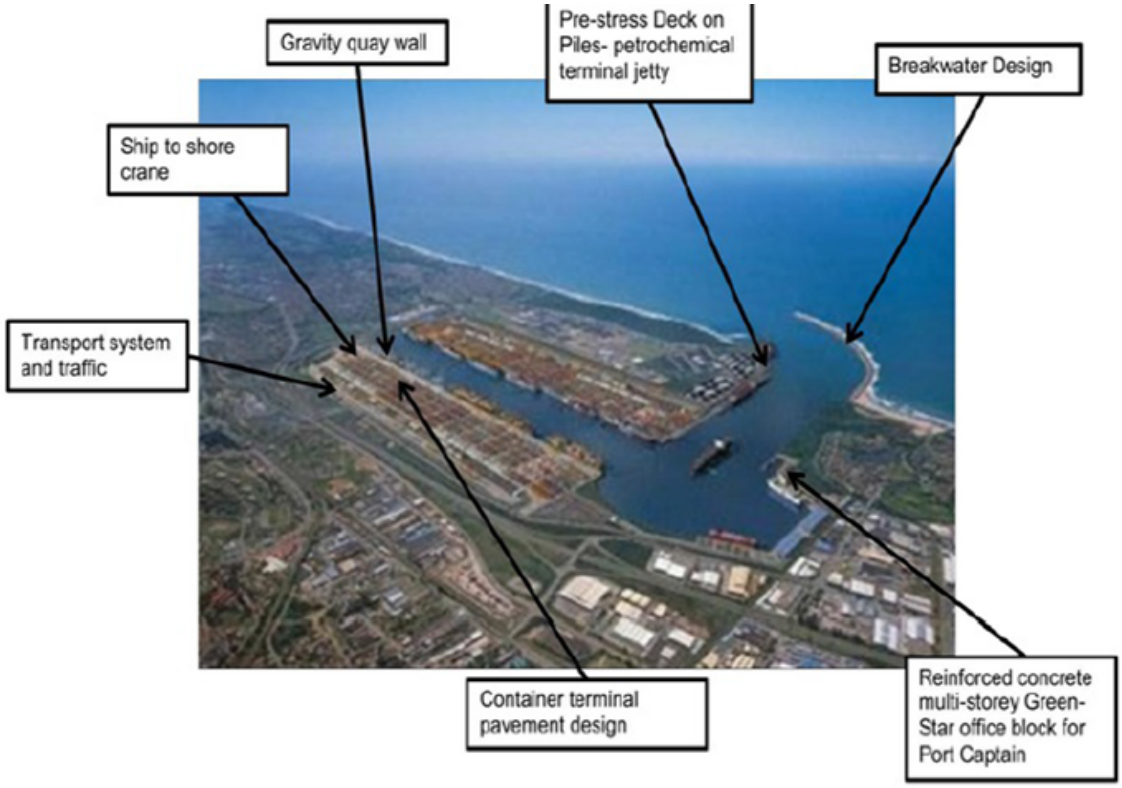


Figure IV: Proposed DIA Site Layout (EThekwini August 2012)

The DIA site designed to follow Chart V, Figure IV and Images II/III, costing R100 billion (excluding Transnet's R1.8 billion acquisition cost), over 25 years consists of…

- An approach channel with a water depth of 18.6 metres and a width of 360 metres
- 452 hectares of port related economic activity including storage warehouses/logistics (295 hectares for containers and 24 to transport) with a 9.2 million TEUs total cargo capacity.
- A 16-berth container terminal (Africa's largest, most modern) – 7.2 million extra TEUs of containerised cargo capacity.
- A 3-berth vehicle (reefer cargo) terminal.
- A 300 metre long, 4-berth liquid bulk terminal scheduled by 2050.
- Associated marine and cargo infrastructure and services to facilitate port functions.
- Road, rail, water, electricity, waste disposal and other infrastructure including a 450 MI per day desalinisation plant on site providing water for key port users.
- 1.2 kilometre breakwater and excavation of sand dune by DIA/Isipingo Beach.
- An eco-efficient designed Port Captain Control Office.
- An Administrative Craft Basin.
- In addition any port will require provision for its Table 2 identified functions and associated maritime economic, social, tourism and other key port user requirements.

(Transnet December 2012)

This DIA site has economic advantages for Africa in enabling 9000 TEU, 30 metre deep and 45.6 metres wide Post Panamax size vessels), 100,000 dwt (deadweight ton) liquid bulk and 300,000 dwt Very Large Crude (oil) Carriers to regularly use the proposed port.

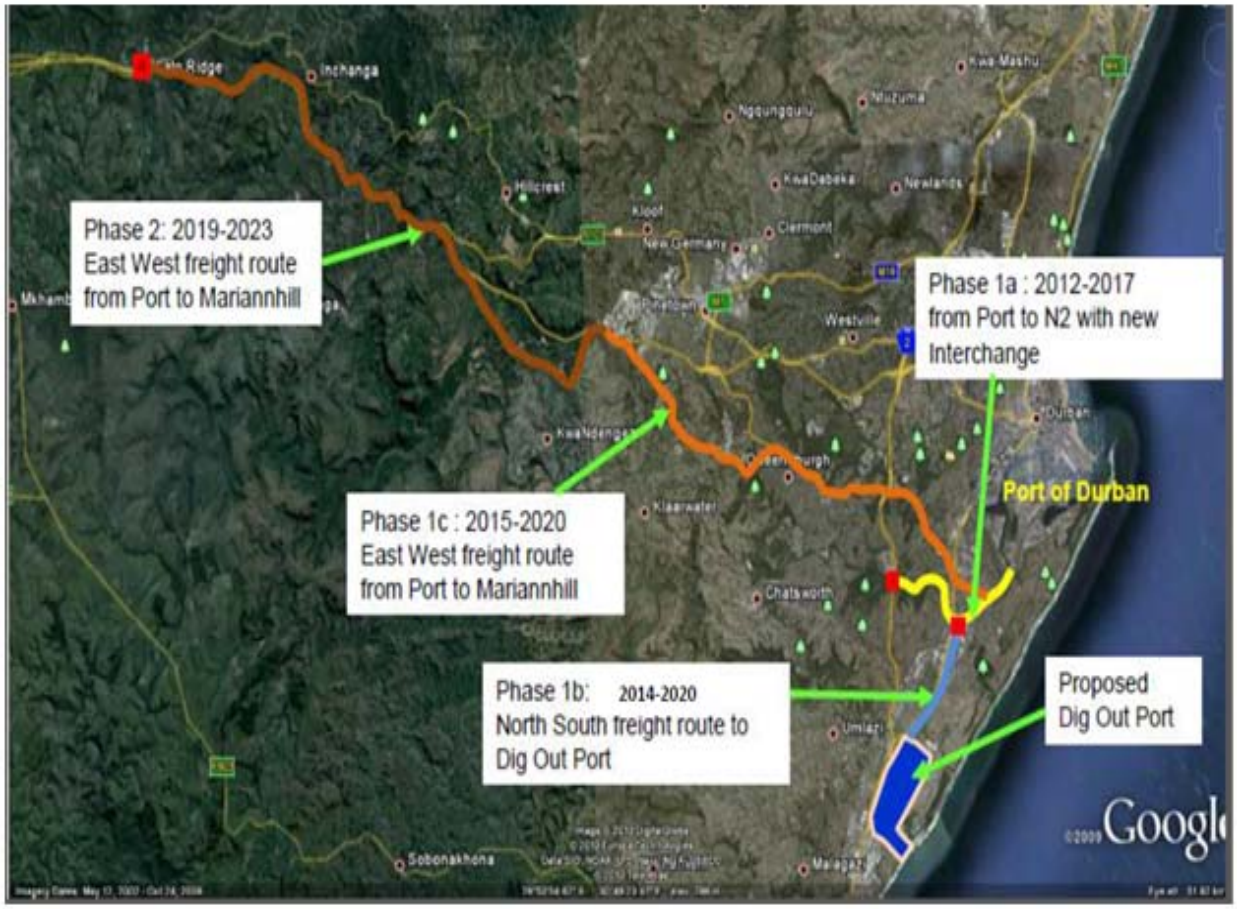


CHART VII: (Osman 2012.)

Associated Development linked to the DIA Site: (Table 6/eThekwini August 2012.)

- Bluff to Highway Link Road (via Clairwood, Austerville and Merebank).
- Sale of 92 Year Old Clairwood Racecourse for a Port Warehouse and Logistics Park.
- N2 uMhlatuzana River Valley Highway Extension: 2012-2017 (Chart VII).
- M4 Mobeni to Clairwood Truck freight road route: 2014-2020.
- N3 Highway Extension: Cato Ridge to Mooi River (2030), to Gauteng (2038)
- R8.33 billion Transnet Rail infrastructure modernisation (R1.2 billion rolling stock)
- R23.4 billion Transnet Durban-Johannesburg oil pipeline.
- Total SA private sector's R140 million modernisation of Island View Terminal and R90 million for Total's oil fuel depot.
- BP to modernise SAPREF oil refinery to Euro V standards (R2.5 billion).

- New wastewater treatment plant for Isipingo – NATCOS tank farm serves as a barrier to further port developments.
- Possible removal of chromium 6 hazardous waste landfill to Gauteng.

Table 6: Durban Port/Back of Port Transport Infrastructure Extensions Infrastructure Costs (Iyer Design Studio May 2012).

Project Number	**Project Name**	**Purpose**	**Priority/ Phasing**	**Budget** (Durban Municipality/ Transnet funded)
1	uMhlathuzana Arterial and Port access	Link between N2 and Durban Port	By 2015 Phase 1	R500 million
2	Link from uMhlathuzana to Sydney Road	Maydon Wharf access	By 2017 Phase 2	R410 million
3	Grimsby Road link and bridge	Link between Mobeni, M4 and Jacobs	By 2017 Phase 2	R694 million
4	North-South Arterial	Link between DIA/ Durban Port	By 2019 Phase 2	R1,800 million
5	DIA to Stanvac access	Improved refinery access and truck diversion to specialised routes	By 2019 Phase 3	R138 million
6	Quality Street Extensions to Mobeni and Bridge	Improved access between Mobeni and Jacobs/ across South Coast Road	By 2019 Phase 3	R145 million
7	Road Closures for trucks –Quality/ Duranta Streets	restrict truck movements to Tara Street	By 2019 Phase 3	R5 million

3: RESULTS TO DETERMINE DURBAN PORT'S FUTURE PROSPECTS

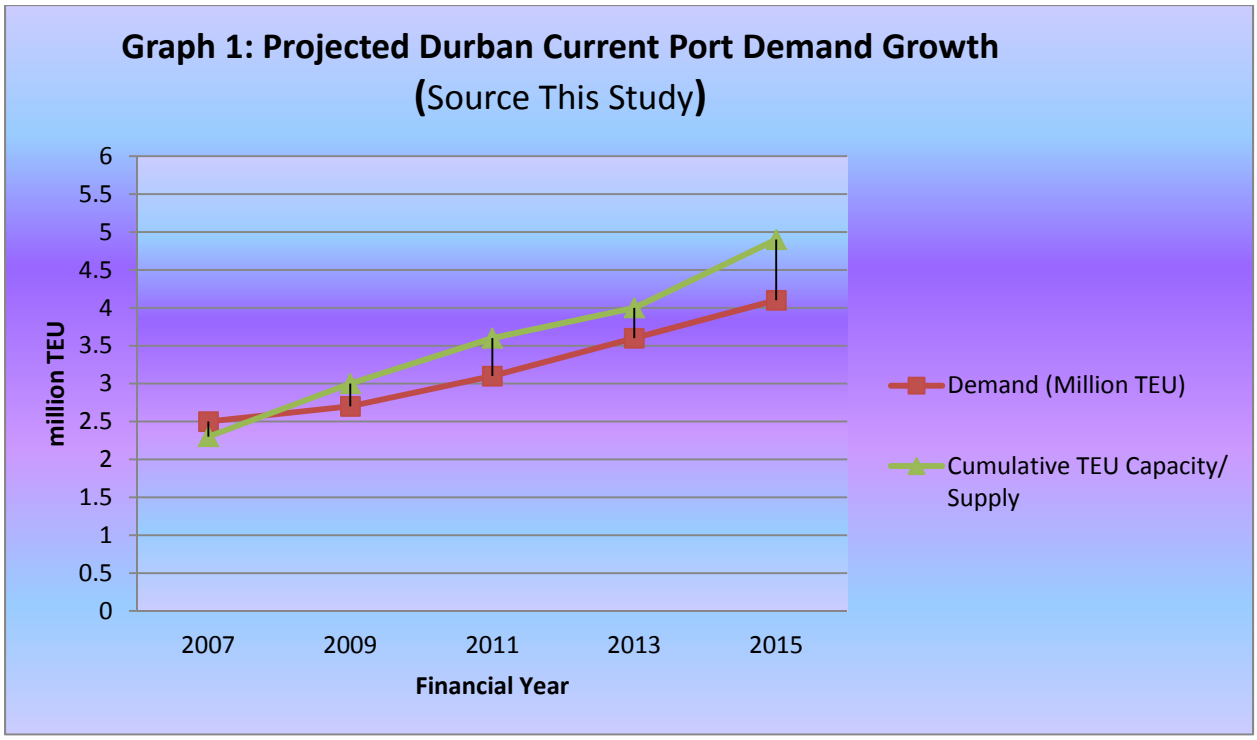
3.1 Projected Demand versus Supply for Enhancing Existing and Future Port Capacity.

This paper advocates that the first step to establishing whether any port improvement or construction of additional capacity is economically necessary and sufficient for a port design, is to determine whether or not sufficient demand exists for port functions, relative to projected port capacity/supply increases. This reduces under and overutilization, economic, social, transport, infrastructure and environmental costs. Table 8 and Graph 1 estimates (based on Transnet July 2013 port preparation estimates), from a commercial shipping perspective, that sufficient port user demand of 4.3 million TEUs by 2015 exists to prioritise enhancing existing port capacity up to Durban Port's current, natural, container capacity limits of 4.9 million TEUs through the above expansion project phases. These will avoid economic, port congestion and other opportunity costs of not increasing Durban's potential port capability for Post-Panamax Dimension vessels.

Table 8: Estimated Durban Current Port Demand Growth. Source: This Study.

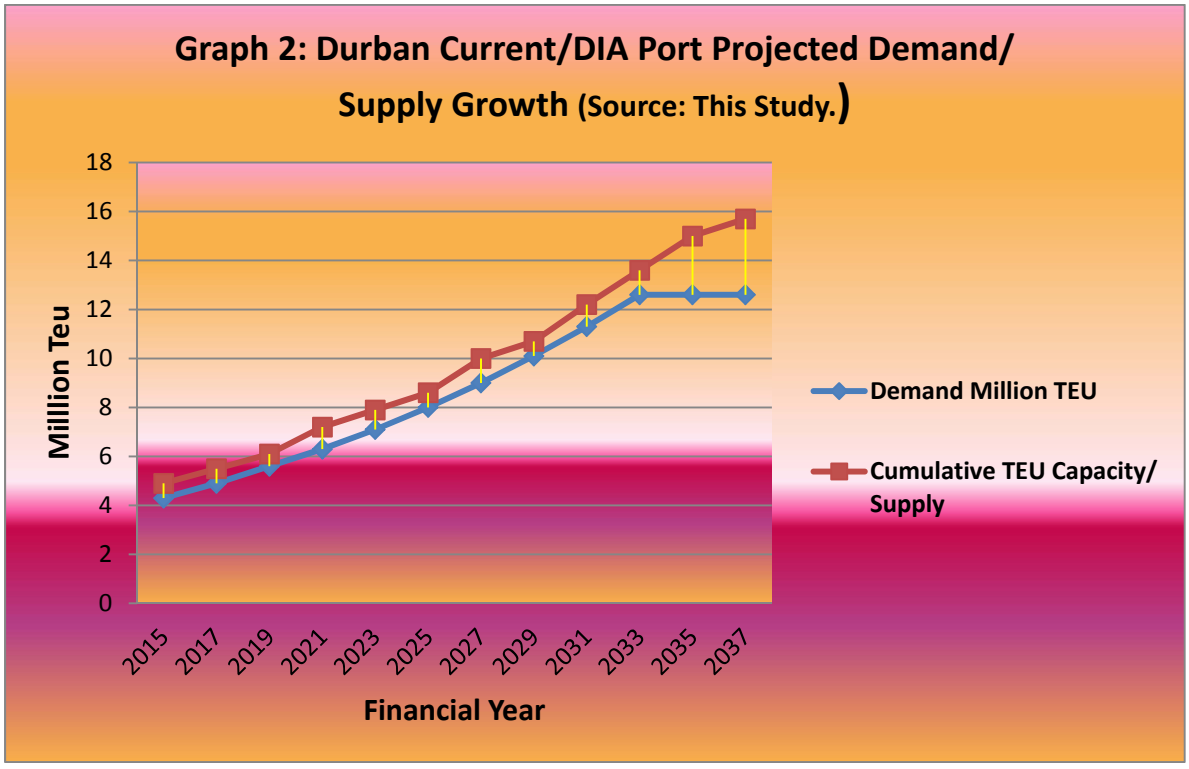
Financial Year	Annual D Growth %	Demand (million TEU)	Cumulative Million TEU Capacity	Expansion Project
2007	7.0	2.5	2.3	Pier 1 Phase 1
2009	2.0	2.7	3.0	DCT Phase 1
2011	7.0	3.1	3.6	DCT Phase 2
2013	8.2	3.6	4.0	Pier 1 Phase 2
2015*	6.7	4.3	4.9	Total Port Capacity enhancing existing efficiency.

*Estimated



In considering if the dugout DIA port expansion is necessary economically, it is – to the extent of a maximum projected demand growth of 12.6 million TEUs cargo throughput by 2033, against a cumulative port capacity (supply) of 13.6 million TEUs, (Table 9 and Graph 5), allowing for exogenous surges in port demand. Constraints to optimising existing port efficiency (3.8) limit current container capacity growth to 4.9 million TEUs. However, the externality costs of construction and operation; do not justify enlarging the DIA port to a total Durban container capacity of 15.7 million TEUs. As the type of vessel traffic growth cannot be predicted, differing berth types should all be constructed but Berths 1, 2, 3 and 4d are not economically necessary, being unprofitable. In addition, Transnet's yearly demand increase rate of 0.6 -1.3 million TEUs appears unrealistic, given the above projected excess port capacity over demand. It appears less plausible from procyclical economic and business cycle shocks combined with low immediate prospects for the global future of shipping and 4% predicted seaborne trade growth considering the economic consequences of the 2008 world recession.

Table 9: Durban Current/DIA Port Projected Demand/Supply Growth. (Source: This Study.)				
Financial Year	**Annual D Growth %**	**Demand (million TEU)**	**Cumulative TEU Capacity (Supply)**	**Expansion Project**
2015	6.7	4.3	4.9	DIA Berth 1a
2017	7.0	4.9	5.5	1b
2019	7.2	5.6	6.1	1c
2021	6.3	6.3	7.2	1d
2023	6.4	7.1	7.9	2a
2025	6.4	8.0	8.6	2b
2027	6.3	9.0	10.0	2d
2029	6.9	10.1	10.7	3a
2031	6.0	11.3	12.2	3b/c
2033	5.9	12.6	13.6	4a/b
2035	0	12.6	15.0	4c
2037	0	12.6	15.7	4d



As Table 1 targets show (sourced directly from each port authority's expansion plans), from a shipping perspective, demand and supply prospects are expected to stabilise and be considerably smaller than predicted growth estimates. These follow from increasing inter-port competitiveness in gross container

cargo volumes, from rival Southern African port modernisation competitors e.g. Walvis Bay, Maputo, Mombasa, Bagamoyo and Dar-es-Salaam (Table 1), all increasing capacity and causing trade diversion from Durban and other South African ports. This may further lower future Durban port demand and hence the requirement for these planned port facilities. However projected port demand is still sufficient to justify the proposed DIA dugout port expansion to 13.6 million TEUs, allowing reserve capacity for strategic, occasional callers.

Port improvements in layout, efficiency and capacity (including implementing recommendations proposed for Durban/endorsed by other ports) increasing port user benefits and lowering costs, may further raise demand for Durban as a seaport. This may further justify this port authority investment in Durban's second port to an extent, provided existing capacity is utilised as environmentally, technically and economically efficient as possible, lowering user costs. These may create further macroeconomic benefits of increased competition, trade, employment, revenue and expenditure, increasing total cargo handed, vessel numbers and gross vessel tonnage (Table 10) further from other SADC countries and trade creation for Durban's maritime, KwaZulu-Natal's provincial and South Africa's economy.

Table 10. Durban Port Traffic (KZN Treasury 2013)

Year	Total Cargo Handled (metric tonnes)	Total Number of Vessels	Gross Vessel Tonnage
2003	41,273,633	4,028	84,251,191
2004	40,026,277	3,707	79,970,878
2005	40,778,495	3,887	87,589,347
2006	43,861,241	4,161	95,085,938
2007	41,883,269	4,128	103,501,737
2008	41,578,997	4,229	106,505,793
2009	37,527,690	4,569	120,207,888
2010	41,645,861	4,317	124,192,321
2011	44,138,867	4,172	125,132,719
2012	42,977,232	3,935	121,373,327
2013	44,829,622	3,958	126,305,167

This may be commercially unsustainable, due to increasing inter-port competitiveness as other African seaports construct additional capacity, reducing demand for Durban's port functions (Graph 5 and Table 10). Demand is expected to reach a maximum of 12.6 million TEUs against a potential port overcapacity of 24 million TEUs by 2033 (Transnet December 2013), against 13.6 million with only the proposed DIA

dugout port. Any economic contribution of exports to employment, expenditure and the local maritime economy must be partially offset against losses from increases in import based consumption.

The DIA dugout port remains economically necessary however, for both projected containerised growth and 32 million tons of total general cargo imports/28 million tons of exports by 2040 (Graph 6 Transnet April 2013) to avoid port congestion and excessive other user costs. As vessels increase in size, gross registered tonnage increases (Table 10) implying that it would be more cost-efficacious to deepen existing berths rather than construct additional facilities for falling vessel numbers from 4569 to 3958 annually (2009-2013). Port functions and layouts could also be efficiently configured to projected demand and to minimise costs, satisfying stakeholder requirements.

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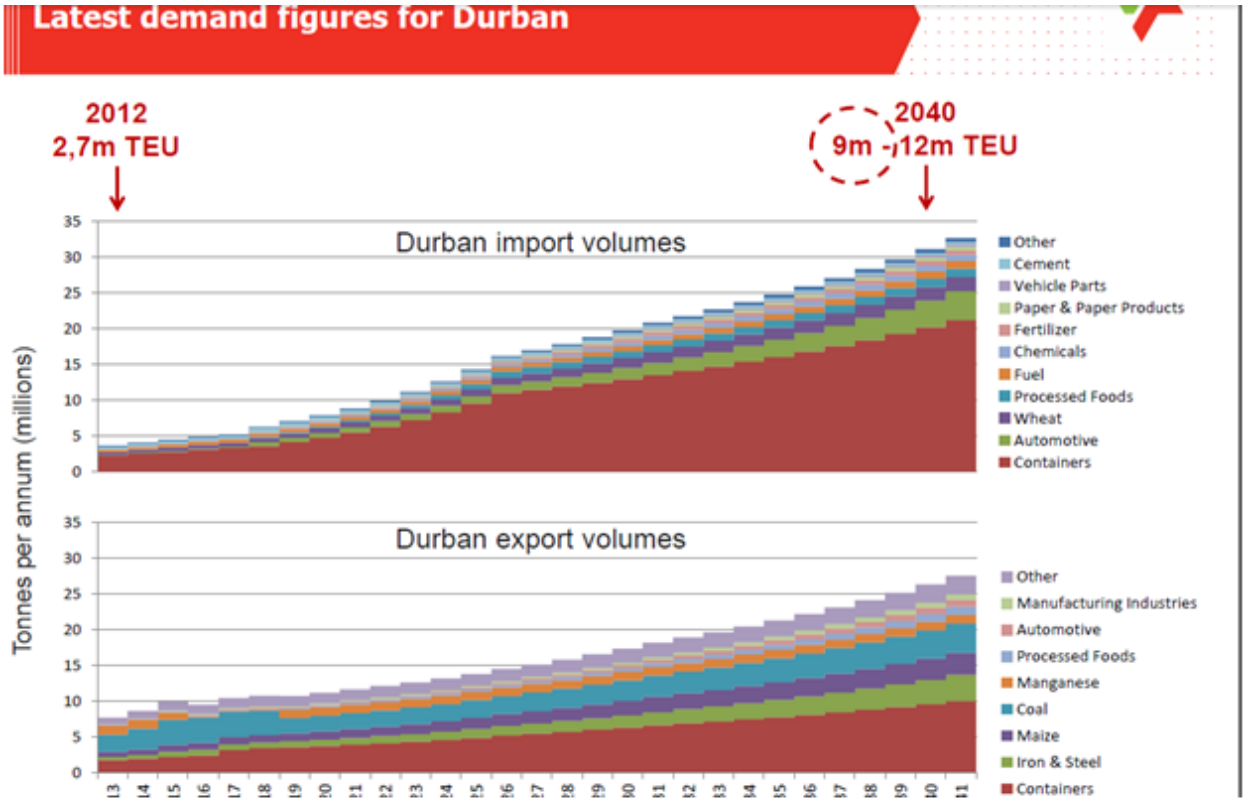


Graph 6: (Transnet December 2013).

3.2 A Projected Cost-Benefit Analysis of each Proposed Durban Port Development:

In considering the extent to which any port modernisation or expansion project such as the current Durban Harbour and proposed dugout DIA sites are worth pursuing: this subchapter attempts to aid interested, affected port stakeholders to evaluate this through identifying a partial cost-benefit analysis (further

developed in less quantifiable economic, environmental, traffic and transport consequences of Durban's Port Development. It provides this for which values can be approximated, located or calculated. Although port opponents have challenged the R250 billion as representing an opportunity cost of taxpayer's money, Transnet Port Authority, Rail Terminals and Pipeline are state enterprises without requiring any direct funding by taxpayers/government, self-financing: mainly through currently accumulated port due revenue, a floating bond, fiscal reserves and a China Development Bank loan for all Durban's port financing costs to 2050. The actual direct fiscal cost is unquantified but extends merely to that which Transnet is co-financing with the KwaZulu-Natal provincial and Durban city governments are investing in the Back of Port and associated infrastructure costs. Government financing of these aids the port/local community economically through increased additional commercial/Customs tax revenue and improved infrastructure – (especially necessary, given the private sector's reluctance to finance port improvements despite being self-advantageous for increased port performance and profits). However, state financing causes certain opportunity costs of alternative investments in social and economic development/community upliftment.

Durban Port and Associated Development Projected Costs

PORT PROJECT

- Total of R250 billion to 2050 for Durban Bay, and DIA Port Development.
- R3.36 billion on Durban's Harbour Entrance widening from 5000 to 9200 TEU vessels.
- Relocation of South African Air Force to King Shaka International Airport.
- Clairwood Racecourse and Housewives' Market social cost.
- Unknown cost of displacing present economic, social, environmental, tourism activity
- DIA site Logistics Park/additional traffic congestion and other externality costs

OIL

- R15 billion to replace single SAPREF oil refinery node.
- R23.4 billion Transnet Durban–Johannesburg oil pipeline.
- Opportunity cost of displacing petrochemical complex for Bayhead site/DIA fuel tanks.

TRANSPORT (Road, Rail)

- R43 billion total rail expenditure (R23 billion private sector/R20 billion Transnet funded) for Gauteng–Durban Freight Logistics Corridor, Cato Ridge inland rail terminal, Bayhead site refurbishment and DIA site railway link.
- Includes R8.33 billion modernisation of Transnet Rail infrastructure (R1.2 billion rolling stock).
- R3.674 billion on road infrastructure arterial construction costs (Table 13).

Total Durban Port and Associated Development Projected Benefits

- The priceless aesthetic, social/ community, tourist, recreation value of increasing the seaport capacity of Durban.
- The current port employs at least 50000 people in the shipping community and Transnet 53000 directly - 10% of city employment. (Maharaj April 2013).
- Durban Bay Port Modernisation and DIA site is expected to create a potential 64000 construction linked jobs or more adding a further R24 billion to the KZN economy and 28000 operational jobs (Gigaba 2013).
- The Current Port provides > R100 billion per year to the local Durban economy for 2.8 million TEU of current cargo capacity and 4000 vessels which currently annually spend over R6 billion) (Iyer Design Studio May 2012).
- The Durban–Gauteng Corridor is estimated to add R4 billion for local and R6 billion for national GDP per year from improved transport/port logistics capability.
- This Freight Corridor is estimated to add R29 billion for national and R12.5 billion for local GDP (Muller, Smith, Sessions et al. March 2009).
- Total SA private sector's R140 million modernisation of Island View Terminal, R90 million for Total's oil fuel depot and BP's upgrading of SAPREF oil refinery to Euro V standards (R2.5 billion) should lower pollution externality costs. The private sector will pay R91 million to clean up pollution contamination at the SAPREF refinery.
- The future port is expected to contribute R56 billion per year from port and cargo dues, customs dues, increases in employment, port related expenditure and value adding from the local economy in addition to taxes, improved efficiency and lower emissions by 2033 (reflecting a fivefold capacity increase to 12 million TEUs for projected demand and supply).
- From a cost perspective, Transnet would benefit through incorporating existing Airport workshops, parking, petroleum storage tanks, warehouses etc. wherever possible rather than the time, fiscal, noise and environmental costs of situating these elsewhere.

Phase 1: Enhancing Durban Bay Efficiency/Capacity Costs.

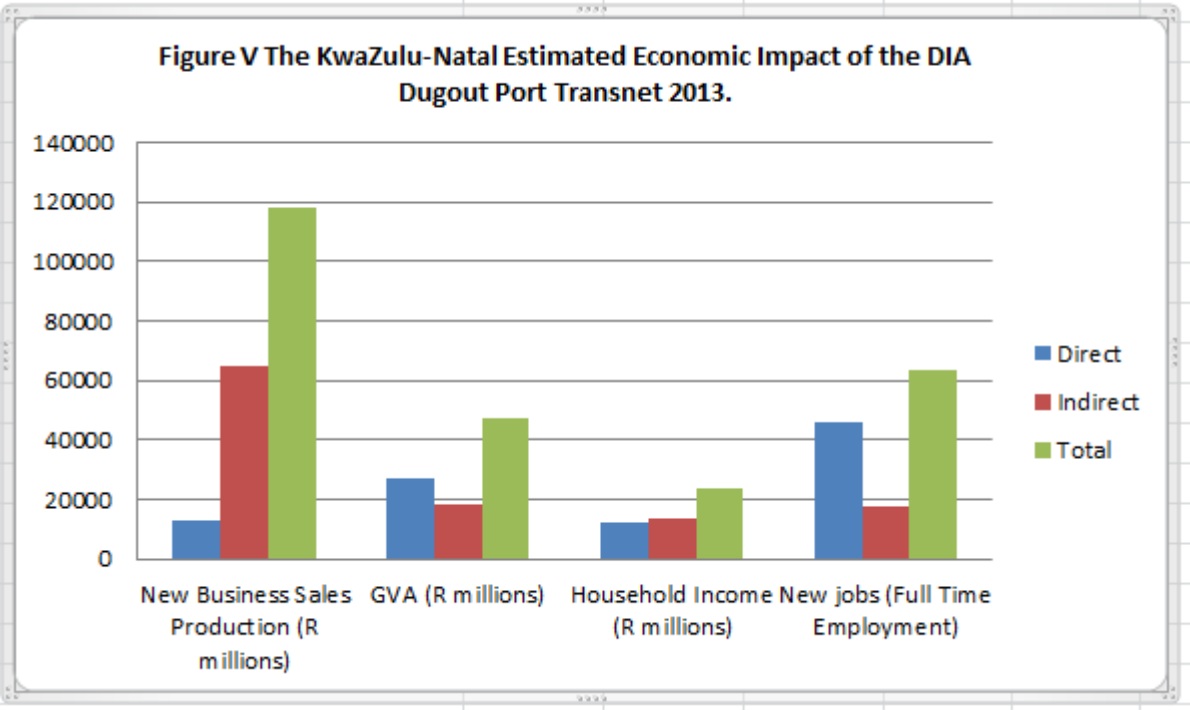
The financial cost of enhancing existing port efficiency equals R33 billion, allocated and financed by Transnet to improve port capacity to its maximum limit of handling 4.9 million TEUs. (Transnet Port Terminals November 2013).

- R6.3 billion of this improves Pier 1 with Salisbury Island deepwater berths and dredging
- R5.6 billion to Pier 2, new cranes and berths 203-205 widening.
- R44 million to upgrade Durban Container Terminal.
- R502 million for 7 assembled tandem-lift ship-to-shore cranes plus R89 million associated cargo infrastructure
- R894 million for DCT, Point and Maydon Wharf Cargo Handling Equipment upgrades.

Phase 2: The DIA Site (2.3)

The port costs for constructing the proposed DIA dugout port site include

- a R1.8 billion property acquisition cost.
- R5 billion in terminal equipment, R2 billion terminal infrastructure, R7 billion dredging etc.
- R75-100 billion in total construction costs until 2040.
- Acquisition cost of 31 additional site properties necessary to physically construct the port.
- Although Isipingo Beach and Clairwood will be retained, their tourism and community value are likely to be marginalised by the proposed port.
- A New 555 kilometre, 24 inch, R23.4 billion Gauteng-Durban Multi-Product Pipeline for petrol, diesel, jet fuel and start of Island View Terminal (complete 2013/2014) transporting 2.7 billion litres of fuel. However due to tender issues, prices have already inflated from original R15.5 billion costs.



Economically, the DIA site is justifiable to satisfy a predicted 12.6 million TEUs by 2033 from a commercial shipping viewpoint. As Figure XI shows from a provincial macroeconomic perspective, hypothetical economic port expansion advantages include a total projected 63,586 new jobs, a R23,802 million increase in household income and R117,871 million in new business sales forecast, (provided these targets are sustainable). As 1.1 clarified, improved DIA's proposed design efficiency could further increase Durban's cost competitiveness globally for 4000 or more vessels yearly e.g. lowering the total voyage port cost of $250,000 per Supermax vessel, while improved port efficiency could reduce some of the high annual Panamax vessel, terminal handling charges of $275,000 compared to a world average of $150,332.

3.3 Environmental Consequences of Durban's Port Development

Whether expanding or enhancing existing port efficiency and associated development/industry, certain adverse environmental consequences, exist in modifying Durban Bay's current ecosystem including the impact on sandbanks and mangroves but also through the future DIA site proposed port options (Chart VIII). This aims to further enhance the ecological and economic sustainability of current and future port developments such as Durban. Prioritising eco-efficient vessels and port facilities plus rail infrastructure over road freight (3.4) at the current and future ports could further reduce externality costs compared to more polluting alternatives. However, projected increases in port user demand (3.1) increasing the

expected number and size of port callers and associated ecological costs, will partially offset any reduced externality benefits from more eco-efficient vessel entrants.

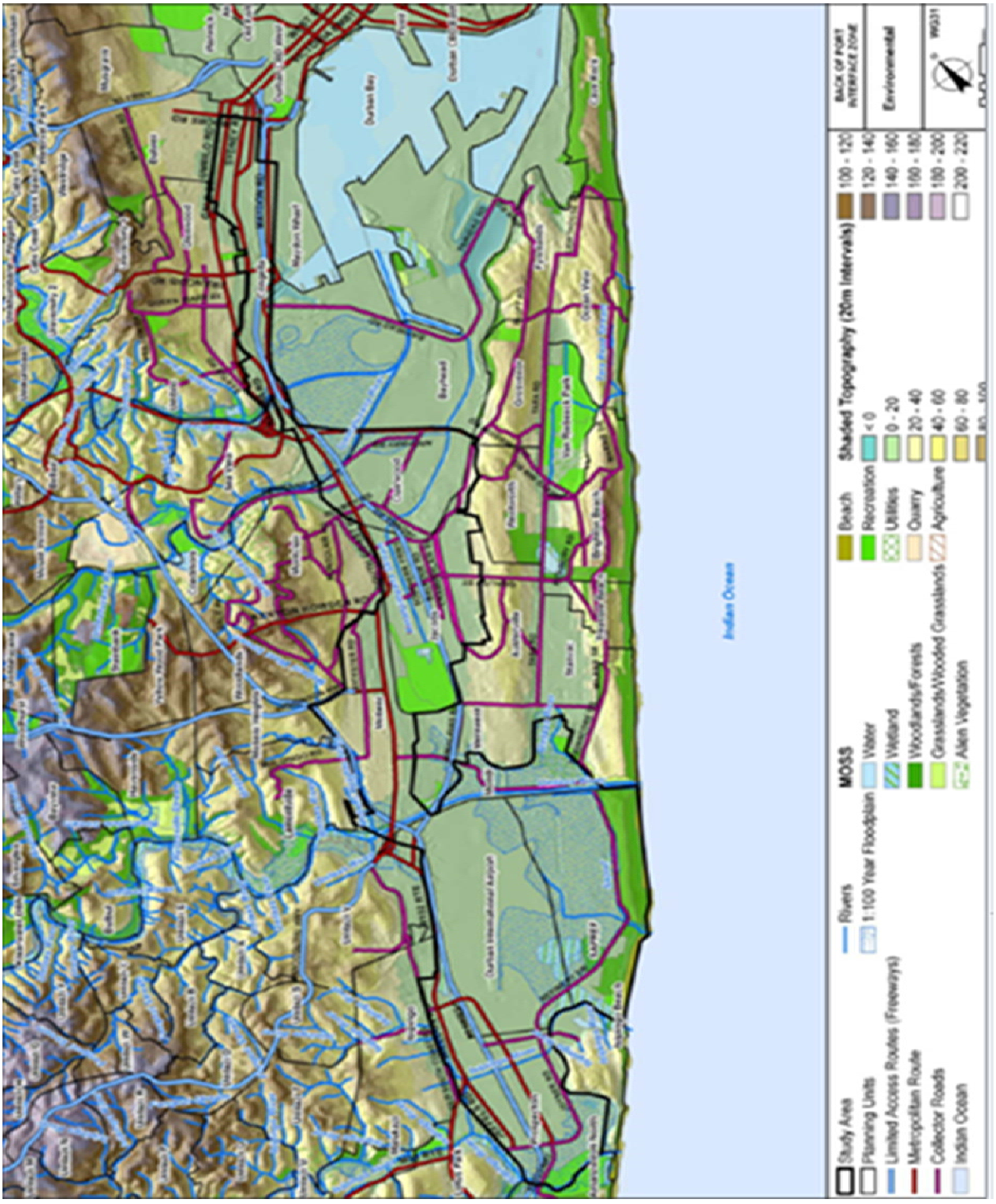


CHART VIII: Environmental Topography of Durban (Iyer Design Studio May 2012.)

Ecological Advantages of Durban's Port Development (3.3-3.5) include:

- Upgrading SAPREF/Island View oil refineries and Transnet's New Multi Product pipeline/A possible moving of the oil petrochemical complex and investments in energy efficient, pump stations, technology and infrastructure modernisation to reduce pollution leaks, road based fuel tanker numbers, emissions and transport costs.
- DIA port dredging may affect prevailing winds meteorologically, possibly assisting to disperse South Coast related stench externalities.

Ecological Disadvantages of the Proposed Port Include:

Air/Water/Soil Pollution

Table 11. River Impacts and Threats. Iyer Design Studio May 2012.	
River	**Impacts and Threats**
Umbilo	• Poor water quality from upstream catchment activities affecting the aquatic biota of the river. • Alien weeds in the irrigation zone
Umlaas	• Minimal (poor) integrity of the instream and riparian zones due to the concrete canal. • Poor water quality from upstream activities. • The canal acting as an effective barrier for those species dependent on getting to and from the sea/freshwater for various stages of their life cycle
Isipingo	• Treated and intermittent effluent discharge to the river. • Pollutant loads from upstream activities • Alien weed infestation of the riparian zone
Mbokodweni	• Raw sewerage pollution inputs • Alien aquatic weeds covering the water surface • Indiscriminate and uncontrolled solid waste disposal along the river banks and into the riparian zone. • Uncontrolled sand mining and lack of rehabilitation of historically mined areas. • Alien terrestrial weed invasion of the riparian zone, particularly in disturbed areas.

Wildlife/Biodiversity Conservation:

Durban's existing Harbour Bay including the Bayhead expansion, also serves as a carbon emission dispersal sink. It is one of only three South African estuarine habitats (the only KwaZulu Natal coastal protected ecosystem). Therefore at least 50% of affected grasslands and water sources have to be

conserved in the DIA/Back of Port sites for hydrographical, ecological, flooding and climate change mitigation reasons. As a Bonn Convention on the Conservation of Migratory Species of Wild Animals signatory, South Africa faces international as well as domestic legal obligations to preserve the 14% remaining tidal flats and 1500 hectares (19% total surrounding area) of natural vegetation (Happy Valley Swamp, Wentworth Bush, Isipingo Estuary, Bayhead Mangroves and Treasure Beach Grasslands). In addition, Transnet Port Authority and Durban Municipality would win community support and ensure ecological stability through wildlife/biodiversity conservation of the following threatened species. Their environmental/economic cost is unquantifiable but significant.

- 62 migratory avian species
- 132 total bird species
- 30 fish and sand prawn species.
- 9 mammals species
- 10 reptilian species
- 65 butterfly species
- 85 indigenous tree species (five protected under the National Forest Act)
- 17 exotic tree species
- 124 indigenous flowering plant species
- Endangered Fresh water turtle

Clairwood Racecourse partly sold to develop a Port Logistics Park/part municipal park threatens the following endangered species preserved by KZN Wildlife's C Plan.

- *Centrobolus anulatus* (Ringed millipede)
- *Doratogonus cristulatus* (millipede) on the Red Data List as a threatened species.
- *Kniphofia pauciflora* (miniature red hot poker) extinct on the Red Data List but exists there after being specifically reintroduced.

Given the biodiversity uniqueness and the opportunity cost of creating a species' extinction, it is also advised to conserve the world's last remaining 9 square kilometres sheltering the *Bradypodion melanocephalum* (Black-headed Dwarf chameleon, Spotted Shovel and Pickersgill's frogs. It is further essential to conserve the 15 hectares of mangrove swamp at Bayhead site (3% of the original), along with the last remaining Bay sandbank for Durban Bay environmental stability. A 2013 Environmental Impact Assessment rejecting increasing capacity for three Maydon Wharf berths, defended the sandbank as essential to the future prospects of Durban, serving as a habitat, through filtering bay water contributing

nutrients to biomass, and for tourism, education and scientific purposes. Legal noncompliance costs exist in ignoring international and national protection (i.e.1998 National Forestry Act (84) Section 12). For the DIA site the port authority could win further community support by retaining the existing 16 farmers, allowing sustainable fishing, tourism and recreational access to the new port and ensuring a buffer zone preserving Isipingo Beach, the grasslands, dunes and other areas not essential to the port expansion.

Climate Change

For the affected 650 acres of the proposed DIA site port and Back of Port suburbs, this port expansion has significant environmental implications, threatening the potential sustainability and survival of the port development process. Isipingo Beach faces dune erosion while the proposed breakwater needs to be configured to minimise the flooding impact of a projected 2-6 metre sea level and disturbed ocean currents rise from global warming/climate change (SDCEA September 2013) if the following are not considered in its optimal port design. Modifications to the natural shoreline via breakwaters etc have the potential to disrupt oceanic current, sediment flows, tides, winds and aquatic species unless specifically adapted (UKZN Department of Civil Engineering 2014). This paper proposes leaving a DIA site buffer wetland zone to protect the dugout port from flooding, increased wave action, storm damage and avoid erosion costs from vessels using the channel. As with the sandbank above, projected port demand increases do not validate potential berth additions and increased port access from its removal.

Transnet and other international port authorities in enacting the optimal 21st century port design need to consider effective ballast water disposal facilities and waste disposal from port activities/construction for all port development projects to minimise ecological degradation (Lam and Notteboom 2012). To minimise water and soil pollution Transnet, Durban and constructors need to solve threatened water sources (Table 11), avoid further contamination in its construction and planning for the 1.5 kilometre long, 20 metre deep channel between the Umlazi and Isipingo rivers from hydrocarbons etc. and in disposing 70 cubic metres of dredged soil, avoiding excess channel sediment. To reduce the social, heath, economic, environmental and opportunity costs of this port's expansion: vessels, industry and other port stakeholders need to reduce the following existing environmental hazards of effluent discharge and other pollution.

- Agricultural and Industrial pollution – pesticides, ammonia, lead, zinc and lithium etc.
- Air pollution from over 180 factories creates a high child leukaemia infection rate in Merewent, 24 times than the SA average and the world's highest asthma rate.

- 80% of Durban Beach's water tested in 2013 failed SA Quality Guidelines
- Oil/Petrochemical pollutant dumping from refineries (SAPREF to spend R91 million on clean-up) plus hydrogen fluoride/sulphide emissions.
- Isipingo estuary's world record high HCH (hexachlorocyclohexane)
- Preventing the Bayer factory leaked, Chrome pollution in Merebank, present under 34 houses.

Durban Municipality could heed the following environmental based recommendations

- Upgrading Merewent and other sewerage treatment facilities to prevent Bay ecosystem contamination.
- Adding storm bunds to preserve ecological catchment areas.
- Enforcing the Polluter Pays Principle – ensure industry clear contaminated land.
- Preserving natural river banks and canalization – securing river systems as a recreation zone.
- Upgrading state or enforcing private maintenance of DIA/other underground fuel tanks.
- Ensure trucks dispose of wastewater used for cleaning properly.

The following international port measures to minimise environmental, health and financial costs of port expansions on the local environment and port community (Table 12) which identifies solutions such as providing conservation zones for threatened species, waste reduction, eco-efficient design processes and other measures, specifically relevant for Durban. These seek to reduce adverse environmental consequences of a possible port development such as Durban including increased pollution, vessel emissions, climate change and other externality costs, to improve the quality of port life, environmental and community health, to improve the environmental sustainability of a port, to demonstrate that a proposed port such as Durban can be necessary if it leads to physical environmental improvements.

Table 12: Port Design Environmental Concern Solutions (Iyer Design Studio 2012).		
Port	Solution	Relevance
Belfast	Preservation and extension of open space networks for community use/ offset emissions	Integrate open space panning for port and Back-of-Port development
Bristol	Port electricity is provided since 2007 by 3 wind turbines at Avonmore Dock. Each produces 2 megawatts - 75% total of port needs, saving 15,000 tonnes of carbon emissions per year	Renewable energy would reduce emissions and ensure a reliable electricity source for Transnet and its port given unreliability of state electricity company Eskom
Bristol	Energy is used with optimum efficiency –low energy lightbulbs, photocells, self-contained wastewater and water recyclers at port, drainage and waterways are monitored. Redevelopment of decrepit brownfield over greenfield sites (conserved as carbon offsets) Materials from demolition work are partially recycled Only timber from renewable sources is used SUDS-Sustainable Drainage Systems are installed to improve water quality Over 70% of vessel and port generated waste is recycled. Employees are trained to recycle used motor oil, paper, print cartridges etc and favour environmental charities	To ensure emission and waste reduction plus renewable energy as mandatory – part of port lease for port facilities and Back-of-Port area To utilise existing DIA/port infrastructure and recycle where possible
Darwin	Port authority monitors effects of port on local ecosystem	Little or no monitoring takes place and is necessary to reduce externality effects of impact, understand environmental state

Rotterdam, Antwerp	For areas of ecological sensitivity, ecological loss has to be offset by greenfield sites established elsewhere At Delfland, a 23 hectare foredune was created as a flood/ climate change barrier 35 hectares of dunes/reserves were created to offset potential effects on existing reserves. A 25000 hectare sea bed marine ecosystem reserve at Maasvlakte II was created to offset losses to North Sea ecosystem.	Ecologically sensitive areas on proposed DIA and Bayhead site needing mangrove extension, sandbank, Clairwood racecourse/ grasslands etc
San Diego	San Diego port is working with its Zoo to establish home reserves/ breeding sites are conserved/ established for affected species	
Sydney	Sydney Ports Corporation have prepared a document on minimising waste use for employees, tenants, port users and businesses related to the port – part of lease/tender policy	
Sydney	As part of port expansion permission, Sydney Port had to establish an "enhancement" plan for the existing Penrhyn saltmarsh estuary ecosystem	Transnet need to for the Bayhead mangroves.

To favour more eco-efficient port users and marginal callers (i.e. repair, cruise vessels, hybrid powered vessels etc) and to finance the above proposals, the municipality/port authority could adopt the following tools, as set out in Table 13 below, commonly utilised by other port authorities. Providing these financial incentives to encourage more environmentally sustainable practises/vessels for ship traffic, cargo handling and stowage, intermodal connections, industrial activities and throughout designing and operating the port/ back of port development process, while imposing fines and penalising those inefficient/ higher polluters can further assist port authorities to improve the environmental quality of life and mitigate the corresponding environmental consequences of any proposed port development such as Durban, which consulted environmental activists and concerned community stakeholders including South

Durban Community Alliance, and others identified as a key stakeholder priority. This might persuade more port users to perceive the value of further port developments if the related social and environmental costs are discouraged through pricing incentive mechanisms.

	Tools used by port authority/ public regulator			
	Penalty pricing	Incentive pricing	Monitoring & measuring	Market access control & environmental standard regulation
Ships traffic	Surcharge to docking fees RTM Fines on marine oil spill ANT RTM SHA SIN	Ships meet Environmental Ship Index scores get discount on GT section ANT RTM Reduction of port dues SIN	Ship GHG emission ANT RTM SHA SIN Sustainability report ANT	- Sulphur fuel cap, GHG emission RTM ANT SHA SIN (IMO MARPOL VI) - Regulation on oil pollution casualties RTM ANT SHA (IMO INTERVENTION Convention 69) - Regulation/control on pollution damage to marine environment by vessels ANT (co-signed document by shippers, terminal operators and port authority) SHA (Regulations of China[1]) SIN (Regulations of Singapore[2])
Cargo handling and storage	-	-	Crane GHG emission ANT RTM SIN Vehicle GHG emission ANT RTM SIN Sustainability report ANT	- Cargo handling vehicles with Sulphur fuel limits ANT (Antwerp Port Authority) RTM (Municipality of Rotterdam[3]) - Terminal concession criterion on sustainability RTM (Port of Rotterdam Authority), ANT (future) - Regulated operation activities SHA (Regulations of China[1])
Intermodal connection	Fines for non-compliance with agreements on modal shift RTM	-	Monitoring and analysis of policy developments ANT Sustainability report ANT	Agreement on modal shift RTM (agreement between terminal operators and port authority)

Table 13: Ecological Pricing Solutions. (Lam and Notteboom 2012)

3.4: Transport and Traffic Consequences of Durban's Port Development

To evaluate if Durban's port expansion is really necessary, this paper summarises several linked road and rail, transport infrastructure improvements (Table 13 and Figure V), traffic consequences, constraints to enhancing existing rail efficiency and road externality costs. It provides potential solutions/ recommendations to constraints and concerns raised by affected port parties.

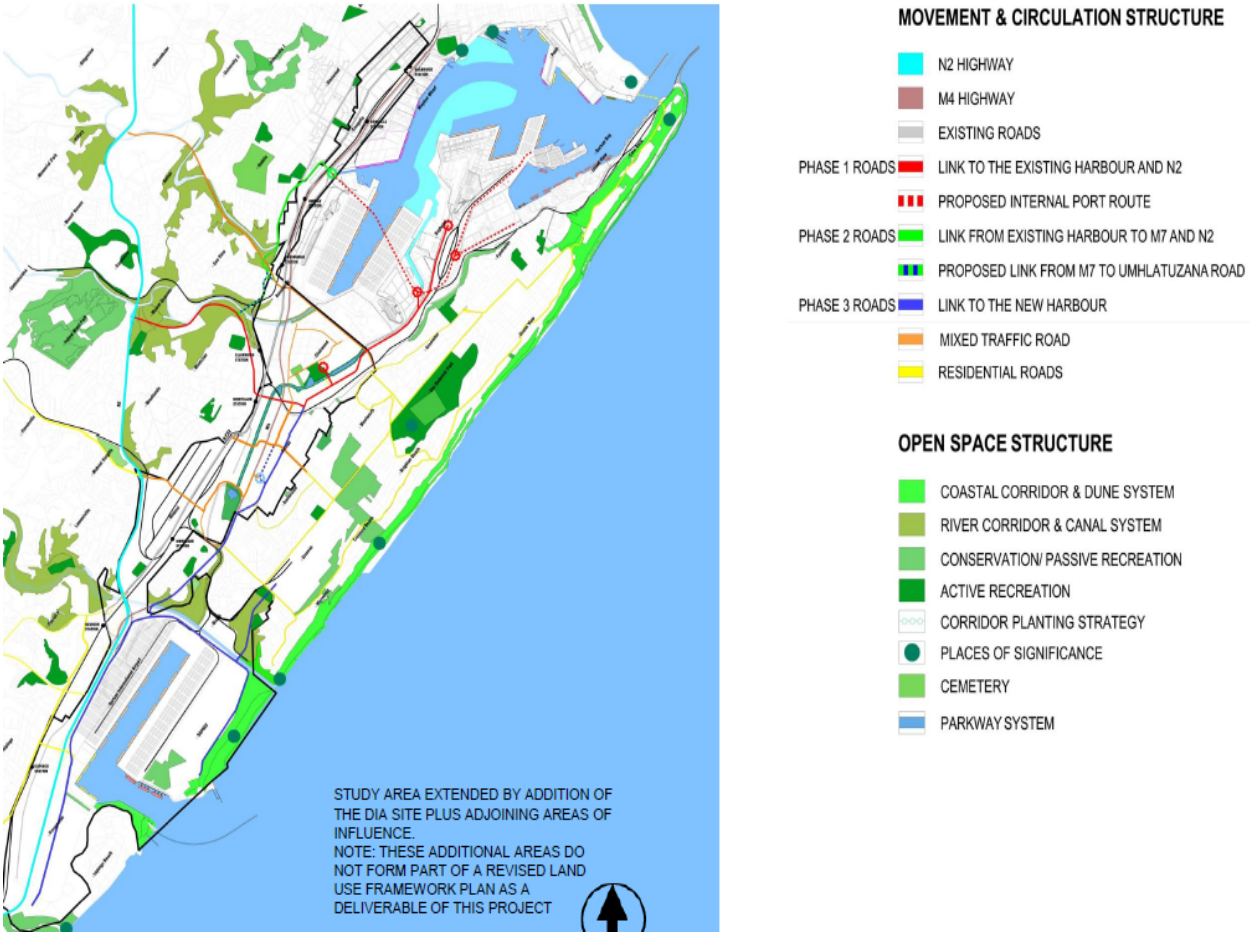


Figure V: Durban Transport Development Overview: (Muller, Smith, Sessions et al. 2009**.)**

Table 14: Projected Freight Transport Demand/Capacity Growth (This Study)		
Year	Transport Type	Total Freight Volumes (million tons per annum mtpa)
2011	Rail	220% growth (3.5% per year x 30 to give total)
2041		690
2011	Road	123% growth (2.7 % per year x 30 to give total)
2041		1237
2011	Total	762
2041		1927

In order to be feasible and sustainable, Durban's Port Developments would require the provision of sufficient transport capacity to provide for an over-optimistic projected expansion of cargo throughput/port demand from 9 million to 12 million TEU's. Based on Transnet's port consultant estimates (Graham Mueller) from a 123% road traffic growth, Table 14 demonstrates significant potential congestion, time, emissions and other economic cost disadvantages of this proposed port development. Despite a 220% increase in rail capacity, currently planned railway investment is only projected to satisfy 690 mtpa out of a total 1927 mtpa traffic growth (2011- 2041). Despite being less efficient with fewer potential economies of scale plus higher financial and externality costs, forthcoming road investments, are heavily overinvested and overprioritised by Durban Municipality and Transnet. Prioritising the following recommendations may assist in reducing these high costs, plus traffic and transport consequences, currently experienced by the port and local community as further constraints to potential growth.

As concerned key port users have frequently counselled, rail modernisation provides an environmentally and economically efficacious solution. Transnet's own 2013 Annual Report identifies this for 1000 tonnes of container traffic (Durban to Johannesburg) creating 19.68 tonnes of C02 emissions (41.33 tons lower than the equivalent by road), plus lower accidents, road maintenance and traffic congestion costs. Interviewing commerce produced average estimates of R2000 per day per truck in delay/opportunity costs of client dissatisfaction. This would further justify the extent to which it is better to modernise existing efficiency of Durban/other port's rail capacity before undertaking the financial and other opportunity costs of investing in proposed road extensions (Table 12). Transnet Freight Terminals have partially resolved this by the following DIA and existing Harbour Rail Modernisation Programme (Mott 2010/Transnet 2014) to further improve upon port user identified productivity measures summarised in Table 15, limiting further expanded rail utilisation opportunities. This further affirms that with lower user costs and greater economies of scale. it is preferable and possible to focus on enhancing existing efficiency to a degree, rather than automatically physically expanding a seaport.

Table 15. Transnet Freight Rail Productivity Measures. Transnet January 2014.					
Key performance area	Key performance indicator		Unit of measure	2013 Compact target	2013 Actual target
Service reliability	On time departure	General Freight Business (GFB)	Average deviation from scheduled times (minutes)	225	280
				160	206
		Export coal		60	73
		Export iron ore			
	On time arrivals	GFB		260	356
		Export coal		325	332
		Export iron ore		120	140
Locomotive utilisation	Gross ton/km/loco/ month	GFB	GTK/loco/ m (000)	5,500	4,973
		Export coal		24,700	24,998
		Export iron ore		44,000	47,500
Wagon utilisation index	Wagon turnaround	GFB	Days	9.2	11.3
	Wagon cycle time	Export coal	Hours	58	68.5
		Export iron ore		78	93.7

- R43 billion total rail expenditure (R23 billion private sector, R20 billion Transnet funded) for Gauteng-Durban Freight Logistics Corridor, Cato Ridge inland rail terminal, Bayhead site refurbishment and DIA site railway link.
- (This includes R1.2 billion for rolling stock upgrades).
- R 8.5 billion of this is scheduled for Durban Port Area expansion upgrades (from 180 to 234 million tons per year (2010-2015).
- R1 billion on 200 new locomotives (increase of a l5 year average life expectancy and 20% traction capacity for each)

Identified Rail Constraints

Apart from improving certain rail productivity measures (Table 15), identified rail constraints to existing port efficiency that could be resolved to optimise rail capacity include:

- Greater utilisation of the dormant Bayhead/Mobeni railway marshalling yards
- Expanding train numbers from 17 per day (the 1980's had over 30 without refurbishing rail infrastructure)
- Electrification not diesel.
- Improving shunting, yard handling and communication

- Increasing carriage numbers over a current maximum average of 50.
- Additional lines and rail overpasses for all cargo terminals in Durban (extending current rail capacity from an average 200,000 to 400,000 tons per year each.)
- Increasing speed, adding railway efficiency enhancing pricing incentives.
- A centralised container booking system.
- Electronic tagging for reliability and security.
- Expand port terminal stacking space provisions.
- Synchronisation with cargo and marine infrastructure and services, the port authority and Customs/Excise to reduce superfluous duplication of paperwork.

In addition, they could consolidate rail freight services with trucks at inland terminals, improving port access by improving cargo handling and terminal productivity and synchronising joint train-port payment, clearance and inspection processes to minimise port clearance time, congestion and delayed cargo user costs for each port area. Transnet and the private sector could utilise other key port user identified suggestions to improve rail efficiency and productivity. Both trucks and trains could avoid idle rail/road capacity by penalising inefficient users with congestion pricing charges and offering discount incentives to more productive port stakeholders. Transnet Freight Rail could offer thorough provision of a 24 hour daily, streamlined service to match terminal opening hours (rather than from 8am to 6 pm), reducing congestion and other costs on existing and future transport links. They could aim to address requirements of cost-efficiency, equity (user pays principle) optimal rail performance, punctuality, reliability, security, flexibility and competitiveness

Road Externality Costs and Solutions

Insufficient seaport demand exists to economically validate this port expansion to the extent proposed .Converting the Bayhead railway site to maximise rail capacity and throughput away from a 20:80 road-rail percentage share of cargo distribution to a technically feasible 73% by 2041 (Transnet July 2013), would have the following economic, road maintenance (from additional vehicle pressure), environmental (noise, vibration, vehicle emissions air, water and soil pollution), congestion, stress, health and social benefits of reducing road user costs of extensive traffic from a predicted port area hourly average of 600 in 2013 to 8300 by 2041 (Iyer Design Studio 2012). Further costs include traffic deaths (7000 in 2013) alone (SDCEA January 2014), especially for historic suburbs facing restricted vehicle access such as Clairwood, designed originally for residential purposes rather than the proposed logistics/commercial rezoning.

In recognition of these costs and certain geophysical limits to extending rail capacity for Durban's existing and future DIA/Bayhead sites, Durban municipality, Transnet and the state have proposed infrastructure extensions (Table 13), Maydon Wharf and Terminal truck staging areas, truck call in systems, a truck collection point for peak seasons and specialised freight routes as partial congestion/traffic reducing solutions. However existing suburbs indicate significant current traffic congestions, accidents and other problems especially for Jacobs, the residential Bluff and others, lowering residential property values. Potential for alleviating congestion has been suggested inland at Cato Ridge but remains a speculative possibility given Customs require clearance only through specified seaport points of entry, constraining cargo to Durban's port.

3.5: Economic Consequences of Durban's Port Development

Historically the economic consequences of Durban's current port, as the nexus of its marine based economy are self-evident. Without the port, neither the city nor the Natal provincial economy would exist. Its modernisation and extension are recognised as necessary to the future of Durban, with significant prospects through expanding opportunities consistent with Durban's 2012 Integrated Development Plan: ***"Improving our city's port and logistics infrastructure will ensure that we maximise the opportunities presented by the port's existence and other enterprises to partner us in increasing economic opportunities. The port and its environs is the greatest, most consistent and sustainable job-creation source at present."***

The port may also be considered by many affected parties as a preferable catalyst for economic development, to targeting reindustrialisation as an opportunity cost policy alternative of rejecting the port, with far lower externality costs. In providing the port capacity to manage imports/exports of the proposed Gauteng-Durban Freight Corridor, Durban's current and proposed DIA port developments complement the KZN Development Plan and the National Economy's secondmost strategically important infrastructure project after the Gauteng-Richard's Bay pipeline. It also has the further advantage of assisting South Africa's only port operator, constructor and landlord authority Transnet to potentially to lower port user/logistics costs. In considering the extent to which the port should prioritise enhancing current port capacity, (as with any port improvement and expansion project), economic consequences include assisting port users facing low market freight rates costs from the 2008 global recession, to recover commercially. From a shipping perspective, vessels will theoretically pay lower port dues, crew, fuel, food and maintenance costs (offset by higher port activity for authorities' revenue) from increased efficiency. The port community gain from an increasingly competitive Durban port capable of lower freight (lower import prices) from allowing larger, safer, more fuel and eco-efficient Marpol Convention

vessels port access and prioritising rail capacity over road. These produce economies of scale advantages creating lower transport, emissions, externality, time, fiscal and delay/opportunity costs per ton and lowering user costs from direct improvements in port potential performance and port functions (3.9). Examples include lower vessel/transport turnaround and port/customs clearance times.

Even through enhancing existing port capacity, Durban's current port is constrained to a maximum 4.8 million TEUs per year for containerised cargo. The proposed dugout port will enable additional growth and reduce port congestion costs along with evident potential economic benefits of increasing expenditure, trade and port revenue for the provincial and local Durban economy, national GDP growth and employment in alignment with South Africa's ASGI-SA (Accelerated and Shared Growth Initiative). Iyer Design Studio (May 2012) pointed out for the South African Citrus Growers' Association alone, that prior to Transnet renovating its cargo handling equipment, an average 12 hour delay cost over R105 million (out of R4 billion exports) per season. Delaying 20000 trucks adds significantly to port congestion, finance, opportunity and externality costs. DIA port site extension oppourtunities include macroeconomic regeneration through additional increases in employment and expenditure, further lowering poverty for South Durban Basin's community following the North Coast displacement of the airport to King Shaka and the currently nonutilised existing site. Economic advantages include those from the upgrading of port, transport and logistics infrastructure and services along with related employment, investment and expenditure aiding port users, the local maritime economy, tourism and community. There is no empirical evidence though that any affected zone –Durban Bay modernisation, the DIA dugout port, or the South Durban Basin will experience displacement of existing economic activity, provided that agrarian concerns are resolved in providing continuing occupation for the 16 farmers currently dependent. The municipality are proposing the rezoning of Clairwood to a logistics zone but this is being actively challenged by its residents preferring to preserve their historic home. However they and other South Durban Basin areas e.g. The Bluff and throughout the South Coast will experience higher property values from the port's existence and surrounding logistics hub to further benefit the local community as logistics provide greater economic value than residential suburbs/a non-functioning airport.

The current and DIA site extension phases have increased commercial potential to be internationally cost competitive in targeting additional strategic port callers, in providing additional ship repair yard facilities, (given enough marketing) as sufficient demand exists from the physical hazard of the Namibian-South African Coastline. In addition, locational advantages exist from proximity to the globally commercially strategic Cape route and insignificant African repair and general port competition in South Africa, Africa and the Southern Hemisphere. Repair opportunities exist for Durban with either shallow port access/poor

facilities or a lack of complementary skills in Walvis Bay, Mombasa, Diego Suarez, Lobito, Lagos and others. However, existing Bayhead repair yard port facilities need improving and investing in additional infrastructure for vessels with greater than 3000 containers/large dry bulk, while the private –public cargo handling and terminal storage interface need synchronisation to reduce user costs. As existing shipyards currently provide R300 million and over 900 jobs to the local economy (Osman 2012), this further justifies the extent to which Durban's port efficiency and expansion programme is necessary economically, with little related opportunity cost. Other economic opportunities exist in Table 16 below.

- From a tourism perspective, it is advised that Transnet (or any designated landlord/port authority) preserve the existing character of an existing city e.g. Wilson's Wharf, the Esplanade and recreation of Bayhead plus grasslands and dunes of Reunion's site to retain community support.
- It is recommended that the harbour railway offer passenger services for tourists and key port users, not constrained to freight.
- For the proposed dugout DIA port, additional employment and recreational opportunities (plus additional port authority revenue) could exist in adding commercial wharfs with restaurants and shops for vessel crews, local residents and tourists as in Melbourne, Rio and other ports. These services would be patronised if provided, as people derive enjoyment from physical proximity to a port.
- The cruise terminal and associated infrastructure could be modernised and extended to adjust for greater passenger/vessel flows for further prospective macroeconomic possibilities.
- Although the community oppose the proposed DIA port development in reducing the residential value of historic Clairwood/South Durban Basin, all existing places of heritage; worship and social recreation as well as residential property rights will be conserved by the city, protected under the Constitution and National legislation.

Table 16 Durban Port/ Corridor Opportunities. This Study	
Port	Physical port facility construction, financing and investment/ upgrading Table 2 identified infrastructure and services Environmental Impact Assessment, consultation and other port planning/ technical feasibility studies
Transport	Dual carriageway, toll road and other road infrastructure costs and concessions -Rail investment and expansion
Maritime	Repairs, Provisions, Equipment, maritime and cargo handling services (Table 2). Bunkerage, salvaging
Commercial	Banking and Financial services, other port and maritime economy jobs Inland freight distribution port, real estate
Tourism	Accommodation, restaurants, shops, port tours, yachting, clubs, heritage operation
Agricultural	Sustainable fishing, farming, aquaculture and processing
Industrial	Light and heavy marine related industry, beneficiation
Utilities	Water, electricity, sewerage and garbage disposal,

In conclusion, the addition of a second Durban port/current port modernisation may attract larger but more eco-efficient vessels, fewer in numbers with lower associated emissions costs per vessel visit than current users. Modernising the oil refineries further reduces associated pollutants discharged. Durban's port development further offers the most cost-efficacious chance given current port constraints to address adverse effects. Without Durban's proposed port and associated investments in public and port infrastructure, the pipeline, railway, refineries, terminal improvements financed by Transnet subsidiary and private capital and loans rather than taxpayers, these economic opportunities would be denied.

3.6 Standardised Stakeholder Requirements and Concerns Evaluation Criteria:

As Figure VI indicates, seaports are complicated with myriad purposes that need to be addressed simultaneously: both in modernising existing capacity and in physically enhancing future capacity. In planning the optimal seaport and in achieving these aims, this research argues designs should target the economic criteria of productive efficiency – maximising throughput/activity/capacity with the most cost-efficacious inputs, involving the fewest possible port resources. Designs need to focus on allocative efficiency – those port functions/facilities and services most demanded/required by stakeholders are those

produced. This aids in answering the extent to which Durban's proposed port expansion remains unnecessary compared to enhancing existing port performance.

Figure VI: Durban Port Roles/Services. Tempi 2006	
Municipal	Waste assimilation
	Disease management
Provincial/National roles	Landscape conservation/character
	Food production
	Recreation and leisure
	Provides regional ecological resilience
	One of only three estuarine bays in south Africa
	Nursery for fisheries
	Research and knowledge creation
	Bird refuge
International role	Education at all levels and research – especially the tertiary sector
	Tourism
	Environmental externalities
	Bird refuge for migrating species

This approach proposes that it is possible for a port in identifying concerns/constraints and implementing solutions, to establish a more economical, pragmatic, productive and efficient port configuration that avoids duplication of superfluous facilities and associated externality costs, for both current and future port development phases (Brooks, Schellinck and Pallis 2011). Direct port user consultation for Durban's proposed port development established stakeholder concerns (Table 17) that need to be resolved to minimise negative externality costs, while maximising seaport benefits for any port expansion or efficiency improving process.

TABLE 17: SUMMARY OF KEY DURBAN PORT STAKEHOLDER CONCERNS:	
CONCERN	**Examples**
Economic	Employment, expenditure, tax revenue, trade and other economic/social displaced activity costs of existing and alternative usage
Traffic and other congestion	Congestion/Other Costs of Road, Rail, Port Functions
Environmental	Air, Geology, Water and Soil pollution, waste disposal, vessel emissions effluent discharge, littering, biodiversity loss, wildlife conservation threat, climate change
Health	Noise, pollution and other health costs
Social	Crime, prostitution, drugs and vices increase, conserving religious and social facilities
Planning/Zoning	Lack of coordination and consultation among port users and integrating existing facilities
Agrarian	Existing usage by farmers threatened, closure of Clairwood Housewives Market
Tourism	Dining, shopping and port observation/scenic railway etc, preservation of heritage, Beach and port access
Recreation	Fishing, Water Sports, Beach access etc

TABLE 18: DURBAN PORT USER REQUREMENTS	
Expectations of a Port Authority/Customs	**Commercial/Community Port Expectations**
Provide sufficient information	Availability
To Consistently update information	Promptness/swiftness of services/infrastructure
Security	Allocative/Productive Efficiency
Cost Competitive	Functions are modernized as much as possible
Productive/Efficient – swift and accurate processing	Direct service/transport connections exist
Reliable/frequent functions of sufficient quality	Productive, trained labour responsive to needs
Satisfying unusual requests – altering schedules/ port pricing	Sufficient Capacity exists Efficient – utilises capacity/economies of scale
Sufficient quantity of functions exist	Commercially profitable
It satisfies marginal caller requirements	Equitable in satisfying the user pays principle
It avoids delays/strikes etc	Minimises negative externality/congestion costs

All consulted port users require that Durban and other leading seaport functions satisfy Table 18 summarised requirements, as their devised solutions to present constraints in existing and future port developments, when either improving existing port efficiency or physically expanding capacity through a proposed additional port. Endorsing these not only increases Durban's port capacity/activity but creates cost-efficacious, environmentally sustainable, reliable and productive ports that are internationally

competitive. Facilities need to be consistently upgraded wherever possible to enhance port potential, minimising port time externality, congestion and user costs, while maximising vessel numbers/throughput. Port users also require concerns to be resolved and the preservation of existing and future access/provision of certain port facilities to maximise benefits. They desire certainty that they will not lose any requirements in any port development –especially that the port will not lose efficiency or be adversely affected by any improvements/modifications. The DIA port expansion/current modernisation process will be economically valid if it commercially improves the prospects of Durban's maritime and municipal economy. It will prove itself where user and community benefits exceed displacement, opportunity and other costs and the degree to which stakeholder identified port requirements and concerns are addressed.

3.8: Identifying Potential Constraints to Optimising Existing/Future Port Potential

In establishing an efficient and economical port design for Durban and others, this section recognises that port expansion projects are often justifiable and necessary to some extent. By identifying and summarising various constraints to optimising existing port capacity, activity, productivity and efficiency to mitigate/resolve in future port extension phases, it attempts to further establish the extent to which a seaport such as Durban is capable of augmenting existing port performance. This aims to aid proposed investments in existing port functions/services, increase cargo throughput and improve port sustainability, productivity and competitiveness. These guidelines may assist in comparing international ports to each other, to determine the extent to which additional investments in physical port expansions, further equipment, infrastructure and layout are necessary. These provides some guidelines to mitigate increased port user costs (including externalities), the opportunity costs of underprovision or underutilisation of port facilities, loss of port revenue and significant loss of economic activity to Durban's international port competitors such as Walvis Bay, Maputo, Luanda, Dar-es-Salaam and Mombasa. Therefore, as with most port expansion projects, Durban's proposed dugout port extension will not be necessary to the extent proposed by Transnet for the DIA and site. Specific examples of solvable constraints include SARS's R300 million Customs Modernisation Programme and the 2013 SA Parliament passing of the Customs Control and Duty Bills, specifically designed to reduce customs compliance procedures, to facilitate trade while simultaneously ensuring the securitisation of the global commercial network, summarised in custom modernisation points below, lowering port user costs and significantly augmenting port activity through a higher vessel turnover

TABLE 19: CONSTRAINTS TO ENHANCING PORT EFFICIENCY AND PRODUCTIVITY	
EXOGENOUS CONSTRAINTS	ENDOGENOUS CONSTRAINTS
2008 World Financial Crisis	Customs and Excise
Political/Social Shocks	The Port Authority
Climatic Change/Natural Disasters	Port Pricing, Tariff Structure and Methodology
Influences affecting the Global Future of Shipping	Marine/Cargo Infrastructure and Services
Changes in vessels – types, technology and research	Land/Geophysical (environmental, relocation and opportunity costs for existing facilities the impact of tides, river currents and the ocean)
Technological Progress	Capital – Congestion, maintenance, operations
Financing Port Projects -Revenue limits, opportunity costs of port financing,	Labour – unions
Inter-port Competitiveness	Management administration – coordination, maintenance, operations
Legal	Technological
Crime – resolve with security	Planning/zoning
	Traffic congestion
	Transport (Road/Rail) access/provision
	Psychological – motivation and incentives
	Education and Training
	Social

Customs and Port Authorities have utilised these to lower clearance, inspection and documentation procedures, extend facilities and opening hours, while improving training, punctuality, professionalism, service frequency and quality (Goodger September 2013). For example, similar improvements listed in the modernisation points below, have minimised the Average Cargo Customs Declaration Time now comparable internationally at 48 hours. Maximising throughput with minimal resources is achievable for the dugout port but is conditional on establishing the same facility provision and layout in the DIA site, eliminating existing observed customs constraints to improve current efficiency, rather than focussing on expanding subsequent customs facilities. Increased use of automation, information technology, the Single Window Concept and Authorised Economic Operators would improve the performance of the road, rail, public and private terminal operators and the port authority Transnet, allowing increased throughput at marginal additional cost.

Planning constraints from consulting key port users, include

- not adjusting DIA site capacity to additional economic and port activity/traffic growth incurred during construction and allowing sufficient reserve capacity for port demand/function or supply fluctuations.

- Cargo and marine infrastructure and services along with storage and road/rail access do not currently prioritise the most efficient vessels or the most urgent key port users.
- Vessel cargo stowage, packaging and handling need configuring to optimise existing and future improvements in equipment, labour, operations, maintenance, transport and storage. Efficient utilisation lowers costs to port users and to authorities, reducing the need to invest in additional capacity, in alignment with projected demand and supply.
- Other constraints that stakeholders for Durban and other ports have identified include poor maintenance, insufficient staff, insufficiently regular maintenance practices, inventory supplies and inadequate equipment upgrading for existing civic and port infrastructure causing limits to port usage: including stormwater drains, electricity substations, water and oil pumps/pipelines etc. raising port user costs.

Aside from aforementioned constraints limited by port location and purpose creating insufficient capacity for modernisation and expansion prospects from other port users, planning constraints include synchronising existing port functions, facilities and services with future ones (including customs, the port authority along with integration with transport links and the surrounding maritime economy. They include the challenges of financing these port performance improvements whilst avoiding economically prohibitive port user costs. However, former constraints are being reduced. Durban has prioritised lowering operational efficiency often incurred in ports by Customs transit cargo warehouses used for long term storage, by penalising long customs clearance and cargo dwell times to increase port throughput. Transnet have modernised existing cranes, further reducing productivity constraints. The DIA site will provide for sufficient terminal storage capacity along with designing berths/storage facilities to specialise to vessel purposes, lowering costs.

In evaluating the below port activity and capacity indicators (Table 21) with high containerised berth occupancy rates along with projected demand and supply (3.2) indicating significant pot congestion, it is evident that Durban's current port lacks the capability of servicing the requirements of vessel callers and its maritime economy without either investing in efficiency or expansion especially investment in rail. Assessing recommended Durban seaport efficiency indicators (Tables 20/21) both against its own 2013 and comparable international targets, helps to illustrate the extent to which Durban's port is inefficient and underutilised for existing capacity.

Table 20: Durban Container Terminal Port Activity and Capacity Indicators			
Measure (Motivated 2.5 Defined 3.8)	**2011**	**2012**	**2013**
Average Annual Berth Occupancy Rate *	84%	87%*	85%*
Total Port Capacity/Supply (TEU's)	3,6,000,000	3.8,000,000	4,000,000
Total Port Traffic Demand (TEU's)	3,1000,000	3,3000,000	3,6000,000
Total Cargo Handled (metric tonnes)	44,138,867	42,977,232	44,829,622

Source: This Study (based on Transnet Port Terminals data).

* >70% indicates berth congestion.

Table 21: Port Efficiency and Productivity Indicators (This Study)					
Durban Measure (Motivated 2.5 Defined 3.8)	**2011**	**2012**	**2013 Target**	**2013 Actual**	**International Target**
Waiting Time for Berths: Hours	63	46	63	46	24 (Singapore)
Average Cargo Dwell/Clearing Time: Days	4.2	4	3.5	4	2
Average Customs Clearance Processing Time: Hours	80	80	72	82	24
Vessel Turnaround/Clearance Time: (Days)	4.2	4	3.5	4	2
Road/Rail Turnaround Time: Minutes	40	37	35	32 Pier 1 47 Pier 2	20
Total cost to port users per year. Panamax			NA (Not Applicable)	$250,000	$150,332
No of potential days lost to strikes	6	4	NA	7	NA
Gross crane moves per hour	23	26	30	23 (Pier 1) 28 Pier 2	70
TEU per stat working hour	40	45	53	40	120
No of containers handled per ship working hour.	84	86	100	136	200

Source: This Study.

An additional specific exogenous port constraint/underperformance indicator, affecting all ports includes adverse weather. Preventable endogenous constraints include:

- construction disruptions at Durban's berth expansion, labour strikes and terminal handling equipment failures creating business delay costs and violates charterparty cargo time restrictions. Terminal berthing delays cost 22.4 hours in 2013 against a projected 16 hour target (Transnet Port Terminals January 2014).
- Cargo handling operators lack sufficient morale/incentive, facing weak management planning foresight.

- Imports and exports are discharged at the same tower. Some are underutilised, while others experience congestion constraints.

Physically, while the number of vessels may be declining, the actual average Post-Panamax vessel size is increasing, creating physical constraints to existing Durban port infrastructure. Despite widening the harbour channel to 16.5 metres, current access limits vessels to a maximum daytime 243.8 metre length and 12.2m draft (Figure VII). The proposed DIA dugout port dredging costs include the challenges of disposing 70 million cubed metres of dredged material to disperse, 3.5 million tonnes of rock and 14.5 million of earth. Dredging the current port would not only create ecological and other costs of removing remaining sandbanks and ecosystem already under acute pressure and disturb the yachting, social, tourism and recreational amenity value of the current harbour, it might create significant loss of economic activity and further port congestion and other inefficiency costs from disrupted shipping during construction. Some of these indicators and constraints will be resolved through the proposed investments in road, rail and marine infrastructure, terminal handling equipment, upgraded pipelines and other development aspects outlined in 2.2/2.3. One potential DIA port advantage is that it offers the possibility to satisfy the requirements of port users for the twenty first century, including maximising potential site specific economies of scale, to integrate into the economic hinterland, existing and future infrastructure and utilising the most modern port/shipping technology available. For example, Durban's port will be able to process vessels with a cargo carrying capacity of greater than 3500 containers. In addition, the DIA site chosen has no geological constraints above bedrock. Two quarries also exist as a potential rock source within a 13 kilometre radius, reducing construction costs.

3.8: Possible Stakeholder Solutions to Improving Existing and Future Port Functions/ Layout.

Possible solutions that have been implemented and recommendations for improving existing and future port performance specifically for Durban will be outlined to enhance existing and future harbour efficiency. This reduces the need to undertake the more expensive solution of investing in significant and costly additional future site expansion equipment, capital, land, infrastructure, services, labour and technology. For example, does Transnet really need to purchase additional equipment sufficient to satisfy the requirements of the proposed DIA port up to its full 9,6 million TEU supply capacity, when in 2013 alone it managed to lower carbon dioxide (CO2) emissions costs by 2% (206,540) tons through improving road/rail transport? (Transnet January 2014).

Is the DIA site really the best way forward? Is it cost efficient? Is it practical? In order to justify building the scaled down dugout port this research study proposes –with fewer berths/container handling capacity,

these questions are essential. Stakeholders have already challenged its necessity, given the harbour entrance has already been widened (costing R2.85 billion) to allow access to Post-Panamax Sized vessels. Increasing the depths of existing berths, (provided it doesn't affect the natural mangroves/sandbank), is advocated as the more cost-efficacious solution, as the temporary opportunity cost of paralysing related economic activity and port revenue during construction is far less than investing in the new DIA/Bayhead alternative sites. Transnet has already implemented another possible solution to rectify constraints to a certain extent producing cargo infrastructure inefficiency through importing seven new STS (Ship-to-shore) cranes costing R302 million- the first in Africa with an 80 ton load capacity, able to lift 2 40 TEU or 4 20 TEU containers simultaneously (but this threatens vessel buoyancy).

They have also recently upgraded conveyer belts, forklifts and reach stackers. These all still need to recover costs to be profitable. Transnet and the private sector are resolving constraints in improving maritime/cargo services (training for pilots/operators etc) and management – through investing in education in Maritime Studies (specialising at the University of KwaZulu-Natal, Durban University of Technology and Transnet School of Ports.) Transnet are also creating a Pilot Port Operations Centre to further synchronise port control with the private sector and expand performance. Truck congestion constraints should further be lowered by an electronic Truck Appointment System at Durban Container Terminal's Pier 2, which could eventually be extended to Island View, the Point and other port facilities. These, increasing rail capacity and others should further improve efficiency, lowering congestion and environmental externality costs, in addition to helping to resolve existing constraints and port user concerns to a considerable extent, causing Durban's existing port underperformance.

Through consulting key port users this study recommends:

- Avoiding excess sediment dispersal/drilling through the Rapid Optical Screening Tool (ROST) method during DIA channel widening.
- Extending the Authorised Economic Operator Customs incentive scheme to transport providers/terminal operators allowing swifter clearance in exchange for adhering to voluntary, self-regulated guidelines – increasing port and terminal throughout.
- Provide reduced cargo/port dues for more efficient vessels and provision of maritime and cargo infrastructure and services, plus lower rents for equivalent terminal operators as incentives to invest in modernised equipment, technology, labour and management lowering port congestion – especially among the private sector. Compensate by penalising those with longer cargo/transport dwell/customs clearance times (Dyer November 2013).

- Containers with lower cargo dwell times could be stacked on top of those less slow
- A lower turnover rate of management to encourage greater port experience.
- Localizing procurement of parts– to further stimulate the economy wherever possible.
- Although container equipment has been modernised, the port's other cargo operators have faced marginalisation, it is advised to upgrade break-bulk, ro-ro, liquid bulk, fishing, shipyards and general cargo facilities.

4: CONCLUSIONS AND RECOMMENDATIONS.

4.1 Overview – Is Durban's Proposed Port Expansion Really Necessary?

In conclusion, most port authorities do not question the need for port expansion projects. Regardless of the potential impact on the community/city, they often perceive them to be the only solution for congestion, constraints to existing port activity or performance and other challenges facing ports and their dependent key users. This paper's and chapter's prime purpose was to test this for the specific example of Durban's current port modernisation and proposed DIA dugout port sites, as a prototype for future port expansion and rejuvenation developments, as a possible means of evaluating the extent to which Durban's proposed port expansion was really necessary or whether it is preferable and possible to improve existing port efficiency. This is imperative to ultimately determine the future of Durban's current and proposed port developments. 4.2 outlines further dissertation recommendations to potentially improve Durban and other seaports, to maximise port performance, benefits, throughput and lower user/community related externality costs, contributing further to an ultimate port preparation design model. 4.3 summarises certain dissertation research limitations and strengths, while 4.4 identifies potential ideas for future research. This discussion paper first introduced the city of Durban and its proposed port developments (Section One) along with potential problems of increasing Durban port inefficiency amid rival African and global port development expansions, the 2008 global recession aftermath and reduced prospects for seaborne trade/ the global future of shipping. Section Two involved outlining the current Port and DIA historic and projected dugout developments. Section Three aimed to specifically test Durban's proposed port expansion prospects through directly applying this research methodology, projecting potential port user demand against supply to consider whether the dugout port development was necessary to the extent proposed. This was further affirmed through a cost-benefit analysis (3.3) specifically for Durban's current Port modernisation process and the proposed Durban International Airport dugout port sites.

In ultimately determining whether Durban or any other port development is really necessary, this dissertation outlined potential environmental (3.4), economic (3.6), traffic and transport consequences (3.5) and solutions. To answer if a proposed port expansion is really necessary, this paper agrees to a considerable extent that it is not always possible to improve existing port efficiency to the degree necessary to remain competitive. There are often physical constraints (3.8) to magnifying current port performance. However, this research states that it is always more cost-efficacious to always improve existing port performance wherever possible, first by identifying a port's purpose and by summarising port user requirements in 3.7.

4.2 Recommendations

Those against the port development point to the significant environmental, traffic, financial, social, agrarian and other costs of Durban's projected DIA port site outlined in. 2.2/2.3. To minimise these externality costs it is recommended to prioritise efficiency wherever constraints and solutions have been outlined in this discussion paper and its originally sourced dissertation, through endorsing recommendations and solutions (3.9), that international ports facing similar problems have undertaken. These include to modernise all identified port functions, to ensure current and future port projects satisfy port user requirements as much as possible (including marginal cargoes and strategic callers), to address stakeholder responses and concerns, to implement key port user solutions, to prioritise rail over truck transport links, to synchronise, computerise and automate all port authority functions with other prime port users wherever possible, to maximise operational proficiency. Modernising currently underutilised rail infrastructure present at Bayhead (3.5) would significantly reduce many current port constraints to maximising cargo throughput including economic, environmental and social, congestion externality costs. From a tourism, environmental and community perspective, (3.4-3.6) it is essential to preserve Clairwood Racecourse/suburb, the remaining Bay sandbanks and mangroves, Esplanade, Wilson's Wharf, the Point luxury development and Bluff Admiralty Reserve to retain Durban's character. For the Durban DIA dugout port, it is necessary to undertake some physical expansion given projected increases in port users and vessels, as Durban's current port is constrained to a 4.5 million TEU maximum containerised cargo throughput, to maintain inter-port and cost competitiveness.

Consulting those favouring the proposed port expansion, there are definite implications to reduce poverty for the South Durban Basin. As 3.4 details, definite potential national, provincial and municipal macroeconomic benefits of employment, expenditure, reduced congestion and port delays, increased port efficiency, productivity, capacity and activity exist. It will enable post-Panamax Dimension vessels and

other strategic callers to access the port and be more efficaciously served through investments in new infrastructure and technology where existing infrastructure cannot be improved. Upgrading SAPREF and other oil refineries/pipelines further reduces present externality costs. However, given the need to cost-recover over $225 billion and rival African port expansions, this dissertation recommends not increasing berth capacity to the extent proposed, avoiding overcapacity. Chasomeris (2013) noted original DIA port estimates were R6.5 billion, they are now inflated to R75-R100 billion. This research advocates a more gradual development approach, adding expanded infrastructure/services where necessary in alignment with stakeholder requirements and concerns, retaining and extending grassland buffer zones/Isipingo beach.

It is also recommended to prioritise integrating the port community with the proposed back of port/port development (as in Singapore and Melbourne), to create a mutually sustainable future port for Durban. It is advised to specialise in Durban's comparative advantage of containerised cargo, reserving COEGA and Richard's Bay for bulk (as with Rio de Janeiro). This paper advises Mombasa's and Singapore's approach of targeting strategic callers for improved transhipment, cruise and bunkerage facilities and improving non-containerised cargo facilities (dry, liquid and neo-bulk – including fruit/automobiles currently ignored. In addition these, correcting certain research limitations (4.3) and choosing directions for future research (4.4), provide a start towards a more cost-efficacious, productive, profitable, community and environmentally sustainable solution to Durban's and other port challenges, rather than to merely automatically, physically undertake a preferred port expansion project.

4.3 Research Strengths and Limitations.

1.3 motivates why this dissertation is necessary. It is essential in presenting a coordinated source of pertinent port information for all users, as an overview of port developments and cost-benefit analysis to simplify and clarify Durban and other port modernisation/expansion processes to all. It aspires to provide a means of assessing their significance to determine a city and port's development prospects, interacting with all cooperative stakeholders rather than a sporadic participation process. This averts asymmetrical information, since currently many remain unfamiliar with the background, facts, implications, consequences, costs and benefits of a port process – despite it evidently affecting key port users/the local community, for Durban and other seaports. In addition, this paper's findings will hopefully further contribute to guidelines for improving port potential and performance as a technical feasibility study to commercial port users, state and parastatal port entities, magnifying potential port user welfare. It aims to aid in establishing a port capable of resolving twenty first century concerns and challenges from those

most qualified in the hypothetical research approach of port stakeholder consultation for Durban's current port and future DIA site (given the R225 billion allocated)and other ports.

This paper encountered several substantial research limits which may constrain the potential applicability of this study. Previous port modernisation and expansion case studies demonstrated inconsistent, unstandardized methodologies lacking homogenous standard assessment criteria of port performance, productivity, efficiency, activity and capacity, which led to calculating uncertainty – especially for prototype indicators for evaluating customs and labour productivity. This may impair comparing inter-port competitiveness in comparing differing port potential performance. Forecasts, indicators and port statistics may experience econometric reliability issues primarily from trying to derive individual Durban and other port specific information from general, cumulative total South Africa/national port statistics. Projecting port demand versus supply may have been biased – based on the most optimistic estimates of the port authority and was limited to one time period and suffering the problems of accurately forecasting future port demand/supply/costs and benefits. Several different scenarios would have presented a more accurate and equitable approach.

Most required information outlined and data in Section 1-3 was nonexistent, or inaccessible where present, or outdated 2011/2012 or earlier rather than 2013/2014, especially for the private sector. Most research/statistics/port improvements are specifically limited to containerised rather than other cargo types and average vessel sizes – i.e. port user costs. While civil society, academics, environmentalists, government, the port authority and affected community were often helpful to some extent, this paper noted that the proposed doctrine of active port consultation was considerably impaired in devising possible stakeholder solutions/perceptions due to the increasing reluctance of unions and the private commercial shipping sector of the Durban port community to consent to participate in this research. Despite the self-evident benefits of improving existing efficiency rather than paying continued port and cargo dues considered internationally expensive this research often experienced considerable communication, financial and other costs in seeking to gain access. Greater consultation would have increased the number of constraints, concerns and solutions/research quality. In addition, for Chapter Three's results, given word constraints, it was only possible to provide an extensive investigation of the extent to which one port's physical expansion was really necessary or whether it was preferable to improve existing port potential. Only Durban was physically examined to the extent required to provide some illumination into an optimal port design. It is recommended that future studies manage to consult all port participants – including foreign ports to evaluate potential similarities and divergences in research results.

4.4 Directions for Future Research

What is the potential impact of comparable port developments on Durban's proposed port expansion, especially on demand/supply? In addition research could be undertaken into the extent that port users experience that their requirements and concerns are being addressed, that they experience improved facilities or layout etc in this port development; or that they see a potential improvement in specific key performance indicators as a result of the development. Further questions still to be investigated are the economic and environmental sustainability of the port and how effectively it integrates with the back-of-port community. Investigations could include to what extent the projected costs, and hence financial implications; are accurate and affordable and to what extent are the projected benefits of the port developments achieved in the future? There still remains further potential for studies to consider ways to improve port performance for the private sector, for transhipment, strategic callers, dry bulk, wet bulk, automotive cargo (ro-ro facilities) cruise facilities and others. There is also scope for studies to consider additional measures of port performance and efficiency, and to consult other ports and users to see if the recommendations/ conclusions of this and other studies on proposed port expansions are really necessary. Future research that uses a similar methodology of engaging with port stakeholders could benefit by increasing the sample survey size beyond those engaged in designing seaports to include members of the local maritime economy, influenced by a port's future, such as those involved in providing supplies and bunkerage, marine and cargo infrastructure, equipment and services, storage, transport and ships' agency services.

It could also benefit by engaging more fully, beyond the maritime economy, with those in the wider community that are impacted by port developments. More comprehensive potential port demand and supply forecasts would also strengthen future research – affecting the need for proposed marine, cargo, transport infrastructure and services as economic circumstances and other exogenous/endogenous factors change. Individual studies could be used to determine the extent to which Durban port's development is really necessary – for example specifically concentrating on differences in vessel types/sizes and cargo sectors (dry, break and liquid bulk, container and general cargo). Most research studies including this one – are essentially static in their relevance – based on current demand and future projections and once off feasibility studies However continued cost-benefit, demand-supply analysis and port user consultation throughout the 2016-2040 DIA construction process might enable the most cost-efficacious utilisation and provision of port functions, minimising environmental, community and other opportunity cost consequences of a port development. Finally a fully comprehensive economic/other impact assessment

study conducted after construction and completion will truly answer the question: Was Durban's proposed Harbour Expansion Really Necessary?

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