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Democratic Socialist Republic of Sri Lanka: National Port Master Plan

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The Colombo Port Development Plan – Volume 2 (Part 1)

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Colombo Port Development Plan

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Index

Executive Summary

Port of Colombo and National Strategy

> Port of Colombo will be leader in the Indian Ocean, Middle East and East African hub ports, and is to become an efficient logistic hub to attract sustainable investment and trade, to facilitate the national import and export strategies and to become an international maritime centre.

As such four tier focus applies to Port of Colombo:

- Maintaining a World Class Transhipment Hub, serving the Middle East, East Africa, India, Pakistan and the Bay of Bengal;
- Becoming an efficient logistic hub for imports and newly developed exports;
- Becoming a sustainable Port.
- Becoming an international maritime centre.

Colombo Port is leader in the Indian Ocean as Transhipment Hub port and should stay competitive with other national and international transhipment ports. To achieve this, focus should be on operational excellence both on the marine services, cargo handling services, auxiliary functions and on interterminal traffic. The marine activities and handling activities are one of the core activities of SLPA. Port designs are adjusted and future capacity is planned for in order to stay ahead of demand. Innovations and new technologies will support this development.

The Port of Colombo should also become more efficient to facilitate the National Export Strategy on targeted exports sectors, as well as improving the logistics on import cargoes. As many trades are transported by containers, the container logistics chain is prime focus to become more efficient. This can be catered for through better infrastructure on port and hinterland connections as well as on administration and procedures. The latter can be achieved through a combination of digitalisation through a single maritime window as well as through trade facilitation and improved customs procedures. Further the development of cargo villages or Free Trade Zones (FTZ) connecting to the port should cater for demands on export manufacturers and foreign direct investment (FDI).

The above shows that the port sector needs to move fast on the innovation and efficiency improvements through investments to stay competitive both to support the transhipment Hub as well as the exports visionary. The port of Colombo will be a reliable partner in developing the nation and serving new clients.

Sustainability has become an important element in the global production chain. Global supply chains focus on partners which have a sustainability policy in place. Port of Colombo wants to align with modern practises of sustainability standards and green policies, innovation in the priority export sectors and integrate the logistics operation in the green supply chain.

Port of Colombo and the city are under massive development and together with the new Port City ideally situated to become an International Maritime Centre (IMC). The Port of Colombo is to become a well recognized as International Maritime Centre, a place in which efficient maritime services are provided and which various trade related services and maritime industries are vested. The strategy is to be developed over time. Development in three main “centres” have been identified such as trade, port and shipping industry and supporting industries. Examples of be be the establihment of corporate companies in the filed of shipping, classification societies, maintenance and repair and bunkering. Importantly is to increase the knowledge industry on training, research and development and concultancy. Several tasks are to be executed to create an international maritime centre:

- Profiling and branding Colombo Port
- Boosting Ease of Doing Business
- Creating a vibrant business and living environment
- Facilitate new business opportunities
- Provide incentives to attract business
- Partnership with other IMCs

Current Colombo Port Environment

Colombo is located on the West coast of Sri Lanka and is the country's principal city and port. The port handles containerized cargoes, liquid bulk (crude and refined oil), dry bulk (mostly grain and cement), general cargoes (mainly steel products and RoRo), and cruise passengers. Colombo is located near the main East-West shipping routes and has become a major port for gateway cargo and the transhipment of containers. The map below presents the main port facilities and their respective functions.

Figure 1-1 Colombo Port Facilities

	UCT	JCT	CICT	SAGT	PVQ	South Jetty	New North Pier	Colombo Dockyard	Slipway	JCT Feeder Berth	New Feeder Berth	Coastal Berths	Bandaranaike	Sydney/Melbourn	Passenger Berth	Water Supply	Canal Berth	ECT	Dolphin Tanker Berth	Cement Storage	Warehouses	Weighing &	Hospital	Fire Brigade	Training Centre	Tug & Pilot Station
Number on Map	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*	*20*	*Not Indicated on Map*					
Containers	■	■	■	■						■	■							■								
Ro-Ro	■																									
Dry Bulk					■															■						
Liquid Bulk						■													■							
Gen. Cargo					■		■						■													
Passengers															■											
Ship Repair								■	■																	
Navy												■														
Auxiliary														■		■	■				■	■	■	■	■	■

Port Operational Activities

Containers

The container trade comprises the largest cargo segment in the port of Colombo in terms of volumes, accounting for approximately 90% of tonnage handled in 2016. The table below presents the evolution of containerized cargo volumes over the last decade, split between gateway and transhipment containers. Total container throughput increased from 1.0 M TEU in 1995 to 5.7 M TEU in 2016 (CAGR: 8.43%). Transhipment volumes account for the majority of container throughput in the port, with a share of 75.9% in 2016. This share has increased gradually, from 66.8% in 1995.

TEU '000	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Gateway	803	813	752	932	1,047	1,020	1,032	1,127	1,218	1,300
Transhipment	2,469	2,785	2,633	3,096	3,124	3,065	3,208	3,700	3,888	4,355
Total	**3,272**	**3,599**	**3,385**	**4,028**	**4,171**	**4,085**	**4,240**	**4,827**	**5,106**	**5,655**

Dry Bulk

Dry bulk handling in the port of Colombo comprises the following activities:

- Bulk cement imports
- Bulk wheat, maize and corn imports
- Bulk and bagged fertiliser imports

Bulk cement imports account for the majority of the dry bulk volumes at the port of Colombo. The cement is bagged at the Tokyo cement factory and distributed further inland. Overall, the dry bulk volumes have remained relatively stable over the last decade.

('000 Tons)	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Bulk Cement Import	1,985	1,889	1,763	1,971	2,027	2,047	1,961	1,863	1,795	2,185
Bulk Wheat / Maize / Corn Imports	26	129	96	127	147	147	178	146	157	190
Fertiliser Bagged Imports	372	202	175	275	239	119	44	165	292	118
Fertiliser Bulk Imports	136	342	172	269	235	334	291	355	307	196
Total	**2,518**	**2,562**	**2,206**	**2,642**	**2,648**	**2,646**	**2,475**	**2,528**	**2,550**	**2,689**

Liquid Bulk

Sri Lanka is dependent on refined white oil imports for its national supply; these imports also include gasoline. From the table below, it can be noted that there has not been a substantial change in crude oil imports over the past decade; this is due to the fact that refining capacity has remained stable over this period.

Tons '1000	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Crude Imports	1,939	1,854	1,932	1,819	1,934	1,625	1,743	1,740	1,761	1,685
Refined Imports	2,064	2,025	1,945	2,224	2,431	3,111	2,253	2,483	2,330	2,778
Total	**4,003**	**3,879**	**3,877**	**4,043**	**4,365**	**4,736**	**3,996**	**4,223**	**4,091**	**4,463**

General Cargo

General cargo volumes comprise a multitude of commodities, but project cargo and bagged fertiliser – which was also presented in the dry bulk section - are the only categories with substantial volumes. Steel and iron imports are project cargo imports destined for the many construction projects in the city of Colombo; the steel and iron imports have increased substantially, due to the Port City development and Megapolis developments.

('000 Tons)	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Iron / Steel	-	-	-	-	-	-	232	356	623	672
Rice	7	7	-	6	-	-	-	-	65	-
Sugar	9	22	35	27	20	-	-	-	-	-
Fertiliser Bagged	372	202	175	275	239	119	44	165	292	118
Cement Bagged	-	-	-	-	-	-	-	-	1	2
Timber	-	-	-	-	-	-	1	-	-	-
Other	433	400	296	293	428	484	51	21	22	10
Total	**821**	**630**	**506**	**601**	**687**	**603**	**328**	**541**	**1,002**	**801**

RoRo

Through policy changes, the entire vehicle transhipment business has been moved to Hambantota, relieving Colombo port from the space constraints resulting from handling vehicles. The resulting reduction in transhipped vehicles in Colombo can be observed from the table below. The relocation of vehicle transhipment to Hambantota has also resulted in Colombo losing market share in the gateway vehicle trade.

Vehicles	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Gateway	30,047	21,875	6,732	45,779	90,824	38,886	6,651	21,296	71,738	31,888
Colombo Share of Gateway	*100%*	*100%*	*100%*	*100%*	*100%*	*86%*	*20%*	*36%*	*51%*	*50%*
Transhipment	10,065	2,154	4,973	2,455	993	183	466	-	13	778

Cruise

The table below provides an overview of cruise vessel arrivals in Colombo between 2007 and 2016. It can be observed that cruise vessel arrivals have remained relatively stable in this period, despite year-on-year fluctuations. As such, Colombo's growth is lagging in comparison to the overall cruise sector in Asia, which nearly doubled between 2013 and 2016. This lagging growth is mainly attributable to the underdeveloped cruise terminal in Colombo, prohibiting large vessels from berthing in the port and impeding efficient embarking and disembarking operations.

Cruise Vessels	CAGR (%)*	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Vessel Arrivals	6.7%	38	16	15	26	72	34	32	36	37	43

Supporting Processes & Activities

Logistics & Warehousing

Currently, SLPA handles all LCL cargo at the CFS warehouses within the port limits and at its warehouse at Peliyagoda (outside the port limit). Recently, the LCL cargo handling has been liberalised, meaning that private parties can perform these activities as well. There is no operational constraint for private parties to deliver the same service at an equal or lower price. Following this development, SLPA should decide if, and at which scale, it wants to continue its LCL handling activities in competition with private parties. Alternatively, SLPA could act as a landlord for warehouse tenants that operate the areas they are assigned to by SLPA.

The figure below shows the locations of current warehouse facilities operated by the SLPA.

Figure 1-2 Colombo Port Warehouses

Description	Type of Cargo	Capacity (m^2)
BQ1	General non-dangerous cargo	5,000
BQ2	Local cargo/Transhipment/Dangerous cargo	5,000
BQ3	General non-dangerous cargo	5,000
BQ4	Transhipment/MCC cargo	5,000
CFS I	General /Dangerous Cargo	7,000
CFS III	Bonded Cargo	1,300
CFS IV	General Cargo	2,388
CFS V	Bonded Cargo	2,397
CFS-Peliyagoda*	General Cargo	19,500
Total		**52,585**

*Not in figure

Connectivity

The Port of Colombo has one internal port road that runs along the entirety of the port. The port road has 9 gates, of which gate number 6 (indicated as location 1 in the map below) is the main gate for truck traffic. The map below further indicates several critical sections of the port road, which are elaborated on shortly in the table below.

From the port's exit gates, trucks can enter Colombo's city road network towards the A01 highway to the East, which subsequently connects to the E01 expressway towards the South and the E03 expressway to the North.

Figure 1-3 Colombo Internal Port Road

#	Location	Description
1	Main gate	The main gate currently has six gates. Most of the time 2 are used for exports, 3 for imports and one service lane.
2	Underpass of Aluthmawatha road	The under pass has four lanes in width. In order to have six lanes this bridge needs to be upgraded. Next to the underpass a high voltage cable is located. This has been incorporated into the road works for the PAEH.
3	Gate 3	This is the main gate for personnel and services towards the warehouses at BQ, the terminals of BQ and JCT as well as towards South Port (CICT/SAGT). The gate has the main function to connect the city with the port. Other gates also provided access such as gat 1 and gate 0, however the main gate 3 is best located access from the city.
4	Bridge at Admin building	The bridge in front of the admin building is providing a height obstacle as current allowance is 4.5m. Under the PAEH project the road is expected to be lowered by 0.5m and the bridge (after demolishing) will be erected newly with 0.3m creating and new underpass height of at least 5.2m
5	Ramp up and ramp down	The bare land near gate 1 and gate 0 (“The triangle land”) will be used in future for locating the ramp down and ramp up for the Evaluated Highway. By careful planning the section of land will also has a reservation for a railway track which can be erected once rail cargo is lifted into the country.
6	Connection to PVQ and guide pier	The road connection to PVQ is currently in poor conditions. The road needs rehabilitation.
7	Road access to/from Flourmill	The road at the back of the flour mill at PVQ is in a deteriorated state and needs to be rehabilitated to ensure trucks with flour can pass safely at the northern side and not across the quay, which is today’s practise.

Customs

Customs in Sri Lanka have adopted the ASYCUDA system, which is promoted by UNCTAD, in the period between 1992 and 1994. Today, the version "ASYCUDA World" is implemented, which is the latest version for customs applications worldwide and has the ability to connect through Electronic Data Interchange (EDI). Shipping agents send their E-declaration to customs in advance of the goods arriving in the ports of Sri Lanka. About 90-95% of all containers is declared through this principle. The clearance of container is done by customs after payment of duties. The payment is either done through E-payment, or manually at the customs counter desk.

Despite the ability to clear cargo electronically, the majority of containers is inspected, for which the containers are sent to designated areas outside of the port. Such a process is typically observed in countries that have not yet implemented E-clearance and proper risk management processes. The consignments are allocated to one of the following three categories: Green, Amber, and Red. Consignments that are allocated to the amber or red category are subjected to examination, whereas the green category consignments are released without examination. Based on the risk profile, the containers follow the following procedure:

1. Red Line: inspection at Gray Line I and II (about 1%) - The inspection in the Red Line concerns boxes with a high risk profile. Clearance is provided whilst they are at the terminal but containers are directed to Grayline I and Grayline II at the time of clearance. The areas of Grayline I and II have limited capacity for about 20% of the daily inspected containers. Currently around 1% follow this route.
2. Amber Line: directed towards inspection area Rank (about 92%) - The customs send cleared containers to inspection area Rank. About 1,000 containers are inspected daily at the inspection sides Rank, the site often receives more than 1000 per day based on the 92% share in daily traffic. Indicating that RANK site is insufficient to handle the traffic efficiently.
3. Green Line: are released from examination and go directly to consignees (7%) - The Green Line is provided to consignees with a low risk profile. Today about 47 Importers have been selected for the Green Line consisting of about 120 containers per day or 7%.

Navy

The Navy has a presence in all major ports due to its function as coast guard, as well as for matters of national security. The Sri Lankan Naval fleet consists of a dedicated fleet comprising missile ships, combat ships, offshore patrol ships, support ships and inshore patrol crafts. They have ordered larger vessels that are too large to berth at the current naval facilities in Colombo port.

Auxiliary Functions

The table below provides an overview of the current auxiliary services provided in the Port of Colombo.

Auxiliary function	Colombo	Current Operations
Tugs & Pilotage	x	SLPA
Linesman & Mooring	x	SLPA / 3rd Party
Bunkering	x	3rd Party
Water Supply	x	SLPA
Weighing and Scanning Facilities	x	3rd Party
Warehousing and CFS	x	SLPA

Auxiliary function	Colombo	Current Operations
Maintenance workshops	x	SLPA
Logistic Zones & Dry Ports	x	3rd Party
Ship Repair Yards	x	3rd Party
Container Maintenance and Repair	x	3rd Party
Ship Registration & Classification	x	SLPA
Training Centre	x	SLPA
Licensing	x	SLPA
Ship Chandlery	x	3rd Party
Fire Department	x	SLPA
Medical Services	x	SLPA
Financial Services	x	3rd Party
Seamen club	x	3rd Party

Current Issues and Bottlenecks

Subsequently, the table below summarizes the key issues in the port, which have been identified through (i) desk research, (ii) stakeholder meetings, and (iii) site investigations.

Category	Issue
Container Activities	
Infrastructure	CD -9.0m water depth is insufficient for large container vessels and therefore less suited for handling containers
Equipment	Investment in 2 mobile harbour cranes (newbuilt or second hand)
Equipment	Three gantry cranes need to be upgraded and moved towards JCT terminal
Operations	Terminal is underutilised for container vessels and often used for RoRo cargo Terminal can be used for general cargo more often
Logistics	Gate (with two in-lanes and two out-lanes) is sufficient
Logistics	UCT has space available for warehousing when it is converted to General cargo berth
Infrastructure	Quay extension with 120 metres (currently, the planning phase is in progress)
Equipment	Installation of 3 gantry cranes from UCT at JCT berths I-II
Equipment	Technical and financial assessment on the feeder cranes at JCT I-II
Equipment	Scrap/amortisation of old tractors and trailers
Equipment	Over a period of time, the RTG equipment fleet need to be upgraded when additional investment for new RTGs and/or replacement of RTGs is required
Operations	Truck flow direction should be changed back into a one-directional flow
Logistics	Expansion of the gate complex for import/export containers
Systems	Upgrade of the Terminal Operating System (TOS) to N4 version
PVQ Activities	
Infrastructure	Quay wall PVQ is deteriorated
Infrastructure	CD -9.0m water depth is insufficient for large bulk carriers
Infrastructure	Ceylon Grain Elevators quay warehouse is deteriorated (abandoned)
Equipment	Grain operations carried out with 2 suction cranes with substandard performance (240t/hr)
Equipment	PVQ operations carried out with an inefficient belt system to a newly developed warehouse (240 t/hr)
Berth	Berth occupancy is too high, causing delays.
Cement	
Infrastructure	CD -11.0m water depth is insufficient for large bulk carriers
Infrastructure	200m quay is insufficient for large bulk carriers
Equipment	Discharge rate is substandard
Berth	Berth occupancy is too high causing delays.
Fertilisers	

Category	Issue
Equipment	Mobile equipment lacks efficiency
Liquid Bulk	
Infrastructure	Maximum vessel LOA is insufficient to accommodate large liquid bulk vessels at Dolphin jetty
Infrastructure	Pipelines to refinery are outdated
Infrastructure	A connection between Kollonnawa tank farm and Muthurajawela tank farm should be created in future
Infrastructure	Sapugaskanda oil refinery outdated; needs to be revamped or demolished and newly built at more suitable location
Infrastructure	A LNG handling capacity for the envisioned Kerawalapitya power plant should be planned for
Infrastructure	In case dolphin jetty is removed due to north port development new refined product jetties should be catered for
Warehousing Logistics	
Logistics	Inefficient use of gate infrastructure, due to substantial amount of manual handlings and lack of automation.
Logistics	The complete logistic chain need to adapt a 24-hour operational scheme to better distribute truck arrivals
Infrastructure	Transit sheds are used as warehouses, but are not adequately equipped to handle the MCC and LCL cargoes. Additionally, layout / spacing of the transit sheds is not suited for the current operations.
Operations	Operations are carried out through manual documentation.
Equipment	Equipment is outdated and in poor state.
Systems	There is a lack of an efficient automated warehousing system.
Environment	
Organisation	The organisation has no department which coordinates, monitors and controls environmental issues
Emission Measurements	SLPA has no emission measurement system installed, hence the actual emissions cannot be measured
Health and Safety	Occupational Health & Workers safety is very important but, safety guidelines are not adequately implemented, monitored and enforced. At the terminals no specific hats, jackets and shoes are being used. Several terminals can be regarded as unsafe as movement of personnel and heavy traffic often coincide.
Port equipment	The majority of SLPA equipment is diesel based. Hence the emissions from the organisation is subject to improvement.
IT systems on revenue stream	
General	Manual processes and paper based approvals cause high administration and time consumption

Category	Issue
TOS	The TOS of JCT (Navis Sparcs 3.10 and Navis Express) are outdated and do not support modern yard utilisation, real time yard planning and web based applications, GPS and modern gate applications
TOS	TOS system to provide a dashboard management system with relevant management information (productivity and performances)
TOS	Ability to upload files and amend records within the permitted timeframe
TOS	System should be able for to bill activities directly on handlings and storage and share the invoice lines with the finance system.
TOS	Babplie files often have errors leading to communication, corrections by shipping agents
TOS/ harbourmaster	Berth planning system to be shared between container terminals and harbourmaster and linked to scheduling system of vessels on calendar planning
Gate automation	JCT has no gate automation, once TOS system is updated OCR gate systems become feasible (OCR and automated truck driver passes).
Damage control	Equipment Interchange Reports (EIR) are made manually. These reports lack photo's. Accident reports and claim handling is subject to become more efficient through OCR scanning.
Harbour master	Tug and pilotage recording and invoicing is subject to manual registration.
Harbour master	Ship registry, berth planning, mooring and de-mooring is not integrated with invoice recording. A Harbour Information Management System (HaMIS) is required integrating the ship registry file with actual ship history call records. The ship registry file is to be linked with the international ship file from IHS/Fairplay or Clarksons.
Harbour master	HaMis system is lacking and planning on tugs and pilots including statistical data should be provided from HaMis to a management web based dashboard. Turnaround times to be integrated into the dashboard with information provided by the TOS systems (productivity & performances)
Warehouse	The warehouse LCL system is a manual driven process, no automation available (no barcodes scanning, no receipt alerts, no damage control systems, no track and trace)
Single window	There is no single data window for port users. Approvals in the information chain are based on manual procedures and stamped documents. Communications on the process is based many circular round via phones and even by fax. System should share specific and allowed data between terminal operators and management information systems
Single window	Publications on procedures, rules and practices
Legal	Contract management system with alerts should be linked with TOS to respond effectively on disputes
Payment control	Systems to be linked with unrestricted Payment Gateway and Pay online and submit digital receipts.
IT systems on costs stream	
CRM	A Customer Relation Management system is lacking.
Manual document management	The manual document management system should be digitalised to avoid business based on hard copies.

Category	Issue
Shift planning & rostering	Shift planning and rostering is done on a manual basis whilst services have to offered 24/7 optimisation is required in this respect.
WIFI networks	WIFI networks are lacking at various locations
Cable internet	Cable internet is often not reliable causing file transfer to fail
Customs	
IT	Asycuda World is able to handle E-declaration and uses HS classification codes for all commodities
IT	They apply a Single Administrative Document (SAD) comparable to many developed countries
IT	Asycuda World is able to handle electronic payments, yet the business is often still cash based
IT	Too limited consignees and shippers use the ability to do electronic declarations.
IT	Electronic clearance is not yet integrated in a Customs single window despite using the SAD
Gatepass	The Gatepas procedure is a manually intensive procedure which also involves wharf clerks to run around the trucks at main gate (safety issue). The original gatepass, the sealing and the issue of a new gatepass in all is rather a time consuming procedure.
Gate efficiency	The Main gate handles about 1 container each two to three minutes.
Logistics	High traffic queues of over 5 km are present at several days in the week. Next to manual procedures at the Main gate also the congestion in the city and in front of the inspections yards is causing this queue. Often the queue in front of the inspection area is all the way, from South Port to Grayline II.
Logistics	Inspection areas are scattered over several sites, often not easy accessible due to traffic. The scattered locations cause sub-optimal use of resources and planning. The customs is not able to control the truck flow as consignees themselves plan the truck move to the inspection areas.
Green line	A few shippers and consignees have been appointed to the green line which allows the container to pass directly without standard checks. Unfortunately, only a small part of the full container loads get the green line label, resulting in many inspections still today.
Inspection	The total capacity on inspection is limited to about 1,000 containers per day.
Scanning	Customs likes to implement 100% scanning (today about 70%). Scanning would increase the daily capacity of inspecting containers which is today limited to about 1,000 Containers per day. Today the scanning at the port is limited by only two mobile scanning trucks
Detention	Customs has own detention areas near the inspection sites. Also in the port there are warehouses with goods under detention. The issue is here that these goods are not moved our frequently. Sometimes as auction are planned. The storage space in the port occupied by is Customs is for them free of charge. This space is however very valuable for the port and should be cleared if possible.

Future Demand and Development

Port Operational Activities

The table below summarizes Colombo's estimated Base Case future demand for each of the port's major commodity groups. Inter alia, the following key drivers have been considered for the forecast:

- **Containers**
  - Gateway - Total Sri Lankan gateway container demand is estimated to reach 3.2 M TEU by 2050, driven by population growth and increasing economic welfare.
  - Transhipment - In the Base Case, it is assumed that Hambantota does not develop any transhipment capabilities and handling is limited to gateway cargo in that port. In total, Sri Lankan transhipment container throughput is estimated to reach 12.7 M TEU by 2050. The drops in the period 2020 and 2024 are related to assumed growth in direct trades and increased competition from other transhipment hubs.
- **Dry Bulk**
  - Fertilizers - The import of fertilisers is expected to almost entirely diminish, as Sri Lanka is expected to further develop fertiliser production.
  - Cement - Cement is expected to keep increasing in the short term, due to ongoing and planned large-scale construction projects; after the construction boom, volumes are estimated to decrease to an equilibrium value.
  - Wheat, Maize, and Corn - Wheat, maize, and corn volumes are expected to increase on a national scale; however, as an efficient corridor is established between Colombo and Trincomalee, it is expected that Trincomalee will be able to (partially) serve the Western hinterland. Hence, Colombo's volumes are expected to grow at a slower pace.
- **Liquid Bulk**
  - Crude Oil - As the Sapugaskanda refinery is to be revamped or replaced, it is expected that refining capacity will remain equal to the current capacity. As such, crude oil imports at the Port of Colombo will remain relatively stable, in order to keep serving the refinery.
  - Refined Oil - Colombo will remain the primary port for refined oil imports. However, due to an expected 100,000 bbl/day refinery in Hambantota, which is to developed by 2025, the total market for refined oil imports is expected to decline substantially in the long term.
  - LNG – LNG is expected to be an important commodity for meeting the nation's energy demand. In 2019, the first imports of LNG are expected to take place to serve the envisioned Kerawalapitya LNG power plant (2 x 300 MW).
- **General Cargo** - General cargo imports are expected to spike in the period leading up to 2025, due to the large-scale Megapolis and Port City developments.
- **RoRo** - National imports of vehicles are expected to increase, but Colombo's share remains relatively stable, as it is assumed that Hambantota absorbs the majority of additional demand. This is under the assumption that these operations can continue in Hambantota; as new terminals are being developed at Hambantota, the space that is currently used for RoRo transhipment may decrease.

Colombo cargo forecast is presented in next table.

Commodity	Demand 2016	Demand 2020	Demand 2025	Demand 2030	Demand 2050	Difference 2016 - 2050	CAGR
Containers ('000 TEU)							
Gateway	1,300	1,643	2,153	2,498	3,289	1,989	2.77%
Transhipment	4,355	5,775	5,873	6,433	12,671	7,990	3.19%
Total	5,655	7,418	8,026	8,931	15,960	9,979	3,10%
Dry Bulk ('000 Tons)							
Wheat / Maize / Corn	2,179	2,866	2,871	2,560	2,334	156	0.48%
Cement / Clinker / Gypsum	190	211	257	302	342	152	1.37%
Fertilizer	314	160	-	-	-	(314)	-100.00%
Total	2,683	3,237	3,128	2,861	2,676	(6)	-0.01%
Liquid Bulk ('000 Tons)							
Crude Oil	1,685	2,512	2,512	2,512	2,512	826	1.18%
Refined Oil	2,778	3,010	3,193	845	2,264	(514)	-3.44%
LNG	-	343	781	995	1,994	1,994	
Total	4,463	5,864	6,485	4,352	6,769	2,306	1.23%
General Cargo ('000 Tons)							
Non-containerised General Cargo	855	949	1,046	734	509	(346)	-1.51%
RoRo ('000 Vehicles)							
Domestic	32	109	131	145	236	204	6.06%
Transhipment	1	-	-	-	-	-	-100.00%
Total	33	109	131	145	236	203	5.98%

Taking into consideration the forecasted demand and planned short-term capacity increases/decreases, the table below summarizes the capacity requirements for each of the commodity groups.

Commodity	Capacity Development Requirement
Containers	**2025** – By 2025, 883m of additional quay is required. **2030** – By 2030, 1,735m of additional quay is required, including the 883m that is required by 2025. **2050 –** By 2050, 8,075m of additional quay is required, including the 1,735m that is required by 2030
Dry Bulk	**2025 –** In the immediate future, cement operations need a dedicated berth with a depth of 13.5m, to accommodate a design vessel with a draft of 12.5m. **2030 & 2050 –** Stabilisation of demand, no additional capacity needed.
Liquid Bulk	**2025** – LNG handling and storage facilities are required immediately to avoid operational delays of the new gas-fired power plant. Additionally, new refining capacity is required and the old pipelines need to be renewed. **2030** – Possible relocation of the dolphin jetty, in case of North Port construction and operations. **2050 –** No additional capacity requirements.
General Cargo	**2025 –** Development of JCT berth 1 for general cargo. **2030 –** Dedicated multipurpose terminal to handle general cargo and RoRo. **2050 –** No additional capacity needed.
RoRo	**2025 –** UCT needs to be transformed into a dedicated general cargo and RoRo facility. **2030 –** Dedicated multipurpose terminal to handle general cargo and RoRo. **2050 –** No additional capacity needed.

Proposed Terminal Layout 2050

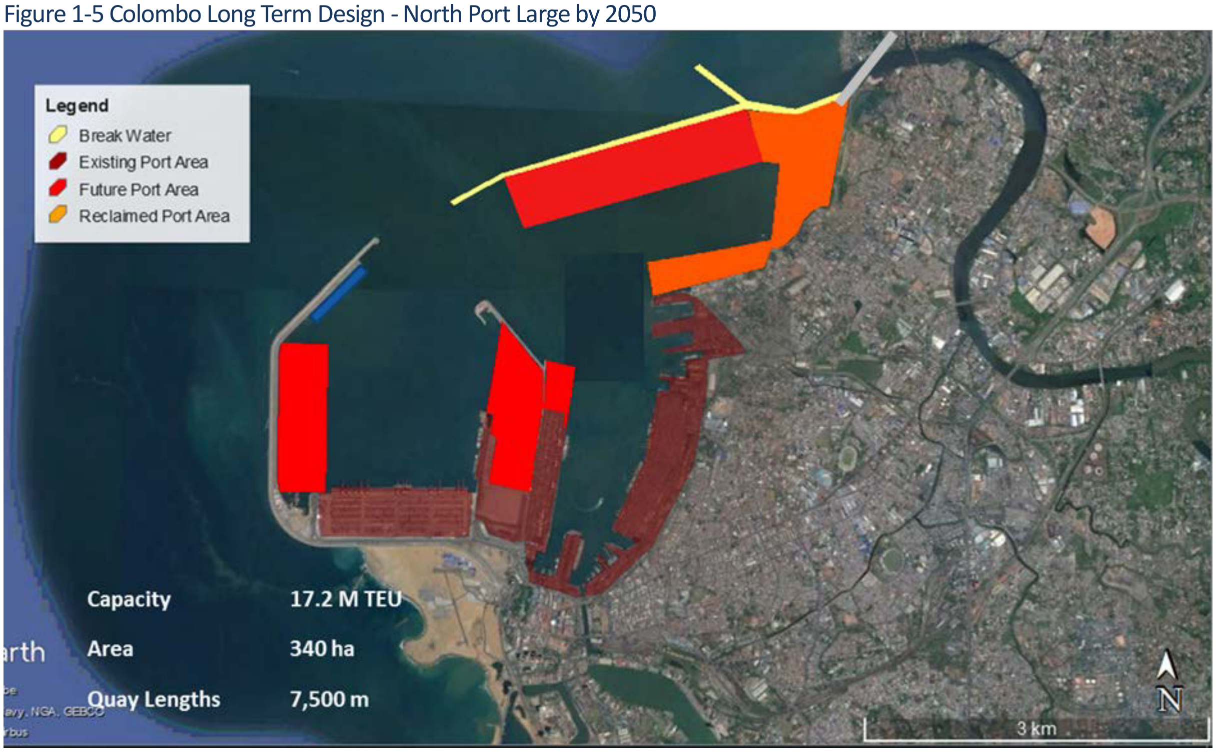
Two port layout options are prepared handling the Base Case cargo forecast in 2050.
The two port layouts are:

- South Port Max – The South Port Max design is to accommodate all incremental container demands by expansion of the South Port. This layout includes the extention of the West Breakwater and a wave protection on the north side of the port. The envisaged West Container Terminal I and West Container Terminal II should have a quay length of 1,400 m each, in order to enable accommodation of 3 mega vessels simultaneously in each terminal. West terminal II development will precede East Container Terminal II development. It requires a new wave protection on the north side of the port. The wave protection can be converted into a breakwater when North Port is developed to accomodate further expansion.
- North Port Large – This option is to handle incremental cargo in the North Port after saturation of the existing South Port. Besides meeting additional cargo capacity demand in the sectors containers, liquid bulk and RoRo , the development option will offer sufficient space for logistics development near the quay side. As the Western Breakwater is not extended, the alignment of the northern breakwater is towards the end of the current Western Breakwater. adjusted to bring it in line with the western breakwater. An underwater guide pier should direct sedimentation from the river estuary further to the north.

The figures below visualise the two long term development layouts.

Figure 1-4 Colombo Long Term Design - South Port Max by 2050

Figure 1-5 Colombo Long Term Design - North Port Large by 2050



In order to identify the preferred development option, a multi criteria analysis has been carried out. The table below summarizes the scores of the two development options; based on these scores, the South Port Max design is selected as the preferred long term development plan for Colombo Port.

Category	Score South Port Max	Score North Port Large
Capacity creation	**0.9**	0.6
Development flexibility	**2.2**	0.4
Terminal & port aspects	0.6	**1.4**
Manoeuvrability	**1.3**	0.7
Social & environmental impact	**1.4**	0.6
Final Score (weighted average)	**6.4**	**3.7**

Phased development plan for South Port Max layout

For the South Port Max layout, a phased approach has been adopted in order to develop the port in line with increasing demand over time towards 2050. Specifically, additional layouts have been prepared for the short term (2025) and the medium term (2030). These two intermediate phases are visualised in the figure below.

Figure 1-6 Colombo South Port Max Phasing - 2025 (Left) and 2030 (Right)

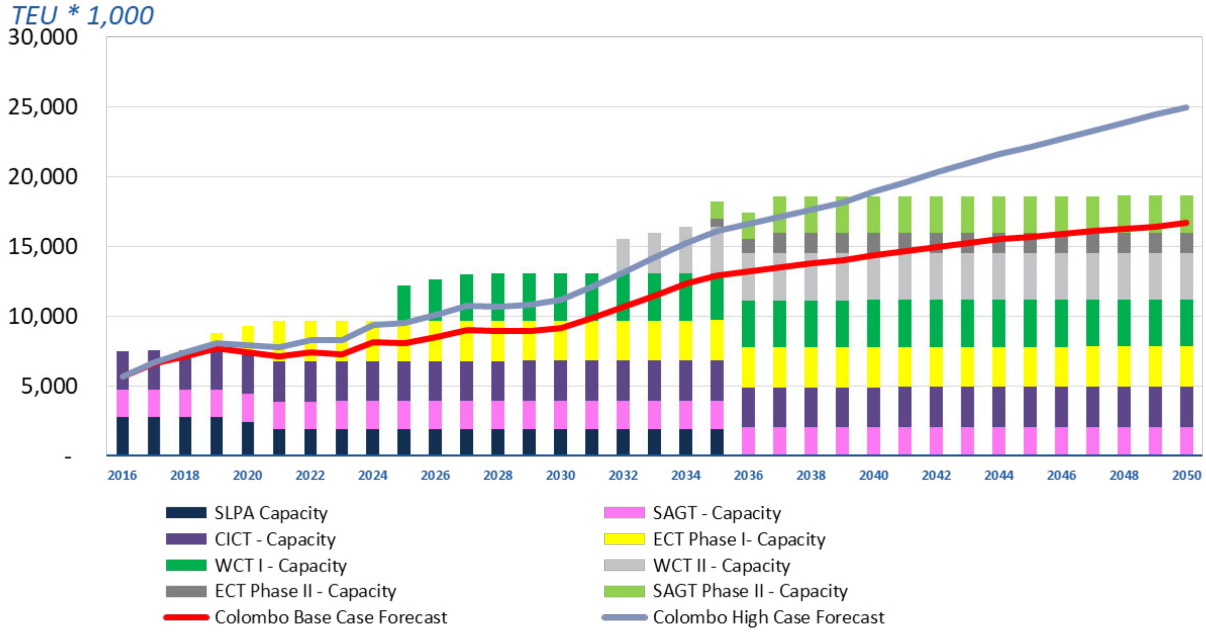
The figure below presents the phasing of the container terminals to reach South Port Max in line with expected demand. It presents the Base Case and High Case container forecast combined with the expected expansion path of terminals until 2050 under the Base Case.

The expansion path includes:

- 2019 start East Container Terminal Phase I operations
- 2025 start West Container Terminal Phase I operations
- 2032 start West Container Terminal Phase II operations
- 2035 start SAGT Phase II operations
- 2035 start East Container Terminal Phase II operations
- 2035 phase out Jaya Container Terminal operations

In the High Case the North Port development should provide for the capacity constraints towards 2050.

Figure 1-7 Colombo South Port Max Phasing and Demand Forecasts



Potential of North Port development

South Port Max layout is based on the Base Case scenario in 2050 in the cargo forecast. North Port development is required only when unforeseen developments needs (or High Case situation) emerge in the future. North Port development requires comprehensive technical and operational considerations, including vessel manoeuvring, water calmness in the basins, siltation, sand drift, flood- and river flows to determine its alignment (angle with the coast line) and layout. Some potential development options are preliminary assessed; these options are presented in the table below. Each option has its characteristics and of which pro and cons needs to be assessed during detailed studies.

Figure 1-8 North Port Initial Options

Category	Assessment & Discussion Design		
	Energy Hub Concept	JICA Recommendation	SLPA Concept
			
Terminal & Ports Aspects	Aims at energy hub (liquid bulk) combined with containers, general cargo, RoRo and logistics	Aims at liquid bulk, containers, multi purpose and logistics through an island development	Aims at containers and liquid bulk with less space for logistics

Category	Assessment & Discussion Design		
Special feature	Energy hub can be developed as a standalone island in early phases. Bridge towards the North	Island with bridges towards North and South. Island can be developed with or without expanding south port	Bridge towards the North

Supporting Processes & Activities

Logistics & Warehousing

Currently, MCC of transhipment boxes mainly takes place at the BQ2 and BQ4 warehouses. These activities are an important service to the transhipment business, as transhipment boxes can be reshuffled to optimise logistics. With the transformation of BQ into a passenger terminal, a new facility should be developed; the new location should be close to the container terminals to limit trucking distance to and from the warehouse.

The table below presents the forecast area requirements for the warehousing activities. Two hectares (20,000 m^2) should be reserved immediately to ensure expansion options. The first phase should be a shed of approximately 8,000 m^2. The warehouse should be designed as high as possible to make best use of the land. In the area requirement calculations, a free stacking height of 7m is assumed.

Item	Unit	2016	2025	2030	2050
TEU Forecast MCC	TEU	8,047	21,614	27,113	67,186
CFS Area Requirement MCC	ha	0,25	0,29	0,37	0,92
TEU Forecast LCL	TEU	27,297	46,350	56,966	84,059
CFS Area Requirement LCL	ha	0,37	0,63	0,78	1,15

Connectivity

Despite the considerable amount of road projects regarding the improvement of Sri Lanka's key transport corridors that are underway, projects that adequately address the direct connectivity of the port of Colombo are lacking – with the exception of the PAEH. To alleviate the current port road congestion, the following development requirements have been identified:

- Optimization of the gate process – automation of the gate process could substantially reduce the truck waiting times. Additionally, a flexible gate system, which enables most gates to function as entry (exit) gates when substantial truck inflows (outflows) occur, could further decrease truck waiting times.
- Widening of the port access road – irrespective of the PAEH development, the port access road should be widened from 4 to 6 lanes, in order to increase the capacity. The section underneath the Aluthmawatha road cross-over, shown in the figure below, should also be widened to a 6-lane road.
- Signalling should improve the use of the six lanes, for example two lanes for the gates and one lane for inter-terminal traffic.
- Ramps near Fort end should have gates with sufficient space to align trucks.
- Ramps near Ingurukade junction should not have cross-over traffic. This can be realised by an under-pass or an over-pass.

In the short term, a rail connection to the (South) port is not foreseen. However in order to enable rail connections in the future, potential rail tracks need to be considered in current connectivity plans. As such, a railway path should be assigned under the PAEH and sufficient space and height (5.2m) should be planned at the PAEH off-ramp near fort-end.

IT

In order to improve the efficiency of the processes in the port, the substantial amount of manual handlings involved with these processes needs to be reduced. Inter alia, IT systems need to be introduced or expanded in the following processes:

- Terminal handling at JCT
- Port Community Systems
- Gate processes
- Warehouse managent processes
- Warehouse cargo clearing process
- Cargo import and export processes
- Costs and revenue management systems and processes.

Customs

Customs should further improve and liberalise their activities to create a split between the physical flow of goods and the administrative flow of goods. In this way, the import flow can be better facilitated and import duties can be paid once goods are in transport. Digitalisation of the import duties payments can further improve the flow of goods.

Furthermore, customs should:

- promote the 24 hours availability of their services; and
- allocate more volumes to the green line, meaning that less containers should be inspected at the terminal and more through a scanning facility. The objective is to have less physical inspection, whilst keeping risk at acceptable levels.

Navy

Navy has ordered 2 new vessels with a length of 105m. As their current berthing area in Colombo Port cannot accommodate vessels of such size, they require a new adequate berthing area.

Auxiliary Functions

The table below provides an overview of the future operations of current auxiliary functions in the port of Colombo, as well as the envisioned role of SLPA for each of the services.

Auxiliary function	Colombo	Current Operations	SLPA Future Operations?	Main considerations
Tugs & Pilotage	x	SLPA	✓	Maintenance outsourcing
Linesman & Mooring	x	SLPA / 3rd Party	⦸	Private sector
Bunkering	x	3rd Party	⦸	Best operated by private sector
Water Supply	x	SLPA	⦸ ✓	Investments needed on barges & pumping capacity

Auxiliary function	Colombo	Current Operations	SLPA Future Operations?	Main considerations
Weighing and Scanning Facilities	x	3rd Party	⦸	Customs & private operators
Warehousing and CFS	x	SLPA	⦸	Competition from private sector
Maintenance workshops	x	SLPA	✓	As long as demand exists
Logistic Zones & Dry Ports	x	3rd Party	⦸	SLPA not as operator but as land lord
Ship Repair Yards	x	3rd Party	⦸	Outsource as much as possible
Container Maintenance and Repair	x	3rd Party	⦸	Private sector
Ship Registration & Classification	x	SLPA	✓	SLPA to invest in VTMS and databases
Training Centre	x	SLPA	⦸	Should operate as a standalone entity, SLPA remains as main stakeholder
Fishery Port	x	Min. of Fish	⦸	Private sector, ministry of fishing
Marinas		3rd Party	⦸	Private sector
Licensing	x	SLPA	✓	Future need less, open port boundary, secured terminal areas
Ship Chandlery	x	3rd Party	⦸	Private sector
Fire Department	x	SLPA	✓	Under harbour master’s control
Medical Services	x	SLPA	⦸	Merge with public medical institution
Financial Services	x	3rd Party	⦸	Private sector
Seamen club	x	3rd Party	✓	Private sector
Ballast Water Treatment		-	⦸	SLPA should facilitate

Recommendations & Short Term Priority Projects

Taking into consideration the forecasts and development requirements discussed in the previous sections, two sets of outputs have been compiled:

- **Recommendations** – Numbered in the sequence R1, R2, R3, etc.
- **Short term priority projects** – Numbered in the sequence SP1, SP2, SP3, etc.

Recommendations are given on soft matters that are not infrastructure related, such as port reforms. The numbering is done to provide clarity on the numerous recommendations and their topics.

The short term priority projects are mainly infrastructure projects that SLPA should undertake in <10 years’ time. A number of the projects will be selected for the pre-feasibility phase.

Appendix XV contains the detailed implementation plan for the recommendations, short termin priority projects and the long term development plans.

Recommendations

Cargo Terminals

R1. **East Container Terminal (ECT)** ads valuable capacity which is needed at the port. The **concession should be granted** as soon as possible to jeopardise Colombo's competitive position.

R2. **JCT modernisation** should be implemented to stretch the terminal's lifespan and prevent equipment malfunctions.

R3. **Increase the depth in the PVQ** basin to allow deeper draft grain and cement carriers, with a draft of up to 13m.

R4. The **condition of the dolphin jetty pipelines should be assessed**. Refurbishment of pipelines may be required, depending on the outcome of the technical surveys.

R5. The **dolphin terminal may be replaced** by a new facility once the north port development starts and the breakwater is no longer required.

R6. The **crude oil capacity should be improved** in parallel with the upgrade of the refinery. This upgrade may be realized together with the new LNG facility (integrating the dolphin jetty facility), through development of new oil jetties in the envisaged north port, or through development of new SBM facilities offshore. In case a new refinery is developed in Hambantota, plans for rehabilitation of the refinery near Colombo may be adjusted.

R7. **Create additional general cargo berths** in the old basin by freeing-up UCT for general cargo handling in the short term and JCT berth 1 in the longer term.

R8. **Extend the existing cruise berth** with a dolphin in order to be able to occasionally receive vessels between 200m and 265m in length; and

R9. **Develop a dedicated cruise terminal** able to handle the very large Cruise vessels, which have a LOA of 360m and a draught of 10m.

Logistics and Warehousing

R10. **To expand the Main Gate** complex from 3 in-gates and 3 out-gates to 5 in-gates and 5 out-gates, and increase automation of the gate processes;

R11. **To construct a new gate complex at South Port**, enabling direct access from the inner Port Road to the Port Access Elevated Highway (PAEH); and

R12. **To cooperate with the port community** to better distribute the truck arrivals over the available working hours.

R13. Design and construction of a **new warehouse to cover the MCC** operational requirements in the future.

R14. Investment in new equipment (pallet trucks, reach stackers) to **operate the logistics warehouse.**

R15. Procurement of a modern, state-of-the-art **Warehouse Management System (WMS).**

Nautical access and navigation

R16. **Vessel traffic guidelines and vessel traffic management should be further implemented**. Due to increased traffic to the South Port in the future, vessel traffic management will become more important. The traffic management guidelines need to be reviewed and sharpened in relation to vessel traffic and risks involved. For example, vessels moving from the old basin and from the South port should not coincide. A safe time buffer between moves could be simulated in order to identify suitable traffic guidelines.

R17. The existing **cruise berth needs maintenance** dredging and a new mooring dolphin to receive vessels of up to 260m.

R18. For **future port basins, a 700m wide turning basin is recommended**.

R19. For **future port basins, a width of approximately 600m is recommended.**

R20. **Maintain the water depths** in the two port basins at design drafts (South Port basin 18m, Old port basin 13-15m)

Roads

R21. **Optimization of the gate process** – automation of the gate process could substantially reduce the truck waiting times. Additionally, a flexible gate system, which enables most gates to function as entry (exit) gates when substantial truck inflows (outflows) occur, could further decrease truck waiting times.

R22. **Widening of the port access road** – irrespective of the PAEH development, the port access road should be widened from 4 to 6 lanes, in order to increase the capacity. The section underneath the Aluthmawatha road cross-over, shown in the figure below, should also be widened to a 6-lane road.

R23. **Signalling should improve the use of the six lanes**, for example two lanes for the gates and one lane for interterminal traffic.

R24. **Ramps near Fort end should have gates with sufficient space to align trucks.**

R25. **Ramps near Ingurukade junction should not have cross-over traffic**. This can be realised by an under-pass or an over-pass.

R26. **The slope of the ramps-up should not be more than 4%**

R27. In the port, a railway path should be assigned under the PAEH to **have the possibility to reach South Port by rail in future.**

R28. **The ramps-down from the PAEH near fort-end should give sufficient area and height space** (5.2m) for the development of a possible rail track.

R29. **Gates near fort-end of the ramp should be minimal 3 gate** In and three gates out with options to expand with one gate each in future.

Rail and Multimodality

R30. **A path for optional future rail development towards south port should be secured.**

R31. If rail is to function efficiently, **the rail head should be placed near the terminals** to avoid additional handlings.

Environmental Impact

R32. In view of SLPA's intention to adopt the 'Green Port Concept' in its mode of operations, **it is recommended to start routine monitoring of environmental quality parameters as soon as possible**. In this way, a reference level (existing baseline) of environmental quality can be established. This reference level can be used, in the future when greening concepts have been implemented, to assess the effect and success of the new strategy. Air measurement at two or three points in Colombo Port are recommended to be installed. Media and parameters to be monitored are:

Air quality: HC (hydrocarbons), CO (carbon oxide), NOx (nitrogen oxides), PM10 and PM5 (particulate matter) and SO2.

R33. **It is recommended to measure water quality at 5 locations in the port basin, including the outflow from Beira Lake.**

The following parameters to be measured: DO (dissolved oxygen), BOD (biological oxygen demand), COD (chemical oxygen demand, N-total and Ptot, Oil, EC (electrical conductivity), pH, T, faecal-coliform and e-coliform count.

The unloading facility, with conveyor belt at PVQ should be better isolated, reducing windblown dust.

R34. **Clear guidelines to be established for port concessionaires to contribute to a greener port**, including existing companies like Colombo Dockyard

R35. **Lighting on the port premises should be limited** to the essential (operational) areas only. For lighting, energy efficient led systems should be installed.

R36. **Establishment of a green policy** and implementation framework including measurement systems, monitoring and controlling emissions.

R37. **Establishment of HSSE department**. Attention for environmental issues within the operation of the port would be greatly served by establishing a dedicated, relatively independent Health, Safety and Environment (HSE) department. Such a department should conduct its task from the perspective of assuring optimum conditions for health, safety and environment. It should not be subordinate to a section with merely economical and efficiency interests.

The role and tasks of such a HSE-department is elaborated in the section on the Green Port Concept.

R38. **Complying to international relevant conventions.**

R39. Set up an **environmental Management System in line with ISO 14001** certification for the different parts of its operations.

IT and the Port

R40. **MIS – develop MIS information system linked to single window**

R41. **TOS – Upgrade Navis Sparcs to N4**

R42. **Warehouse Management System**

R43. **Single Window – Including sub systems works to provide the essential information**. They can be gradually incorporated, and will be unrestricted for time of introduction and automation. The system and the demand will automatically drive the need. Always a proven system is recommended. Knowledgeable people have done this before.

R44. **Shift Planning & Roster System** - it is manual, hence the costing and true picture for a vessel operation or any other operation cannot be traced in financial terms. Planning systems can be integrated with the TOS system.

R45. **Civil engineering and property management system**. This system is missing today. It would allow civil engineering to plan their maintenance and resources whilst, digitally keeping track of important drawings. Port development planning is an important element in the future of the port and process can be complex and time consuming. Hence such system would allow civil engineering to plan forward, understand the phase of a development project and the steps to be taken (procurement, tender, ESIA etc.). There are periodical and regular expenses that has to be monitored and not placed under a common expenditure heading. With manual or no computer system to trace, track and forecast this remains manually driven. This is linked to the Purchase Control System. However, there is no expenditure planning and projection system.

R46. **Accounting procedures**. **Lump Sum approval for divisions** and expenses under a heading is allocated instead of identified pre-planning and then charging to the respective cost heading. This would increase flexibility and accountability for the divisions. Management Expenses - Expenses recording of Management is not assigned or allocated to projects.

R47. **WIFI coverage and Fiber Optic backbone**. The hardware infrastructure in the port is poor including the fibre backbone which often is an issue during construction works. The WIFI coverage is poor at many sites within the port. (Port users like to obtain access as well)

R48. **Engineering and Technical workshop planning** and management system. The engineering and technical workshops have only manual systems for planning and administration. There is no business software in place to set tasks and to monitor progress.

R49. **Process flow & procedures manuals and audit system**. Generally speaking the port lacks a central point in which procedures are clearly addressed and explained by flow charts. This will help personnel to do their tasks (internal) and shall help port users (external) to understand the main Q&A for the port and will increase transparency.

R50. **CRM, Strategic marketing Modelling, Digital Document management system**. A customer relation management system is lacking at SLPA. This would enhance the marketing function of the port. Strategic marketing modelling would ensure that strategic clients are highlighted to support strategic decision making.

R51. Digital document system with **e-signatures and authorisation**. In order to become paperless a digital document system should be implemented supported by e-signatures and authorisations. This system would ensure that managers can approve the documents digitally and can authorize according to their responsibilities.

R52. Port security through **digital birds-eye view system**. Also drones can be used by authorized institutes and should be legally prohibited for non-authorised institutions and privates.

R53. **To set-up an port community wide task-force** with transport representatives and IT knowledge.

R54. **Representatives of the terminals should liaise with the taskforce of port community.**

R55. **To investigate which first steps to take to introduce such system in port of Colombo.**

R56. **The harbour master office should introduce VTMS and berth planning tool**

R57. **Harbour Masters services management system** - All handwritten paper based and sent to Finance Department to raise the sales invoice to the respective party. The harbour master services should be supported by a system in which berthing planning, pilot and tug times can be processed for billing. The system should be integrated with a vessel classification system.

R58. **The harbour master office should introduce ship classification** database and link this to the VTMS & berthing system

R59. **Introduce traffic flow management program** this would encompass truck plate recognition; electronic trucker pass; container number scanning; traffic flow signals and lane directions.

R60. In the future online port passes should be made available. Discounts could be provided to large port users applying for large quantities/frequent users. **Port passes should be made available** with discounts to agents applying for large quantities.

R61. **JCT needs to upgrade its systems** to stay efficient and be able to introduce more electronic data exchanges.

R62. Amend where needed the concession contracts with terminal operators with a **clause on providing key performance indicators.**

R63. **The online data exchange to a port community system shall enact a performance measurement tool for the Port Authority (and for port users on common data elements).**

Customs

R64. **Customs procedures should further improve and de-liberalise their activities** to create a split between the physical flow of goods and the administrative flow of goods. In this way, the import flow can be fastened and import duties can be paid once goods are in transport. Digitalisation of the import duties payments shall improve the flow of goods.

R65. Asycuda World is able to handle electronic payments and electronic payments should be encouraged. Eg Customs should facilitate e-payment more and industry needs to be educated to use it.

R66. Customs is recommended to further improve the **customs single window** and become paperless. Further it is recommended to facilitate and promote the development of a **single maritime window** (with which customs in the future, would electronically distribute their clearances)

R67. **Goods Clearance should become independent of the physical flow**. By promoting the use of EDI the E-declaration can be done whilst goods are in transport towards the port of entry. E-Clearance can therefore (based on risk management) already be provided before the goods arrive at the port. Customs in this respect should not interfere in the physical flow with exemption of the identified goods under the high risk profiles. Digitalisation is also the best method to reduce the level of bribery.

R68. **Risk management is key in the allowance of free movement of goods** when clearance is provided.

R69. Risk profiles in Sri Lanka is still set at high levels. **Once more trust has been built into the system the share of the green line can increase**. This can be obtained by increase fines for trespassers and reduce the costs for trustworthy consignees. "Intervention squads" should ensure that Green line consignees are indeed occasionally checked. Charge on manual declarations should be made rather than at computerized declarations to create incentives.

R70. **The gate procedure needs to be simplified and to become paperless**. This can be done through a digital gatepass. Seals with GPS will enable the truck to pass through a RFID identifier at the main gate. In that case the seal needs to be mounted at the terminal gates instead of at the main gate.

R71. **The Green line should be promoted and increased through proper risk management**. Due to the large number of small consignees and the rapid changes of consignees this is not easy but it is the only way forward to a more efficient transport system. Large and or regular consignees should be promoted to the green line. Customs is advised to increase the Green line volumes supported by random scanning checks at newly assigned Green line users. In the end shippers and consignees shall have a full paperless interface with customs through their customs single window and physical inspection is dramatically reduced.

R72. The **terminal inspection should be reduced to a minimum** and more containers should be send through Green Line or through to the Scanning line. Reasoning is that space at the terminals is required for cargo operations.

R73. **A Scanning Line is to be introduced next to the Green Line based on proper risk management**. This scanning is done before physical inspection is carried out and should have the aim to reduce the amount of physical inspection.

R74. Customs likes to implement 100% scanning. This is not advisable when the set-up and operational efficiency is not in place and the scanning results in unacceptable queuing and waiting times. So **the risk/reward of 100% scanning should be evaluated** as well as the cost incurred to society when 100% scanning leads to long waiting times of trucks as well as increased number of physical inspections.

R75. **The scanning is done preferably by fixed scanners in which the driver will exit the truck**. The health issue of exposure to radiation needs to be addressed and normally the truck-driver will exit the truck whilst the truck is pulled through the scanner.

R76. **Inspection should be concentrated among a few (preferably one) site(s**) to increase use of resources and planning.

R77. The area near Bloemandhal hill has been appointed for this. The total capacity on inspection should become more efficient to handle more containers simultaneously and have a **larger capacity by implementing fixed container scans** and to reduce the level of physical inspections.

R78. **The areas for customs detained goods should be allocated outside the port zone to free warehouse spaces.** Customs has several spaces in the port zone which is used for detained cargoes. These warehouses and spaces occupy valuable port land without any income for the port.

R79. **To accommodate office space to Customs it is proposed to convert an existing building near today's passenger terminal** with marine facilities alongside for the new customs vessels displayed in the figure below.

R80. The 100% scanning of container, as per directive of customs in the future will create a massive disturbance in the logistics. I**t is advised to have scanning for South Port containers near fort and the scanning for JCT and North side of the port** integrated with the customs facility at Bloumendhal hill.

Navy

R81. **The new navy vessels can be temporarily moored at BQ** (before passenger terminal is built) or at the old Passenger Berth once the passenger terminal is built. These locations are very near the Navy headquarters. If North Port is developed more space becomes available in the old basin in future.

Auxiliary Functions – Direct Supportive Functions

R82. Given the growth in demand for pilotage services, **it is recommended to purchase an extra tug of 80 ton Bollard Pull.** This could also avoid the costs of hiring tugs from private suppliers.

R83. **SLPA should reduce the crew size** assigned for tugs which is well above the required levels.

R84. It is advisable **to outsource the maintenance activities** of tugs in order to provide continuous pilotage service.

R85. **Tugs which perform salvage operations should be additional to the port operations** in order to the keep the port towage operations running whilst a salvage operation

R86. It is recommended **to form a company which is a fully owned subsidiary of SLPA to carryout pilotage services** in the long run as the company structure would be flexible and effective in operations and finance decision making. It should be independently operated as a profit centre.

R87. It is recommended **to develop capacity for bunkering services at Colombo port** considering short and medium term needs having duly assessed the services of competing ports such as Hambantota.

R88. **LNG** being a new source of fuel for ships which is currently being tested, could become category of fuel that port of **Colombo must be ready in the long run with appropriate capacity**.

R89. It is recommended SLPA to form **joint venture company with Ceylon Petroleum Corporation**(CPC) to benefit from synergies of both. SLPA has the infrastructure while CPC has the speciality in supplies. The newly formed joint venture company should be independently operated as a profit centre.

R90. **Water supply should remain in the same location**, but investments needed on water barges & pumping capacity

R91. **New quays should be equipped with water supply abilities.**

R92. **Terminals operators** must have a **VGM facilities** as each container should be verified otherwise they are not allowed to be loaded on a vessel

R93. The **digitalisation** and the **integration** of information of **weighing facilities** should be organised

R94. Investigate the **BWM regulation** and the way SLPA can conform to this.

Auxiliary Functions - Indirect Supportive Functions

R95. SLPA should consider to have the **periodic maintenance their own tugs and pilot boats** and other marine equipment done by third parties in order to concentrate to their core activities.

R96. It is advisable to **rent-out ship yard facilities** during idle times.

R97. It is recommended to **monitor Marine Engineering division as an identified business segment** of SLPA with separately tracking of revenue and costs.

R98. It is recommended to investigate to obtain **more stake in Colombo Dock Yard PLC** in the long run to be benefited from repair services given to the SLPA as a related party as well as a share of the overall profits of the company from its total operations.

R99. **Container maintenance & repair** services to remain with the private sector.

R100. Ship recognition and identification should be supported by a **fleet database** which ensures updated information on the vessels particulars and classifications.

R101. It is recommended to market the courses provided by the Centre among **external students to generate revenue** and sustain as a self-sufficient centre.

R102. It is advisable to **improve the current status of the centre** to campus through external affiliations and finding synergies with other training institutes in the world.

R103. It is recommended to restructure the centre as a **fully owned subsidiary company of SLPA** in the long run which independently operates as a profit centre.

R104. SLPA has no business with **fish port** developments unless being requested to provide infrastructural assistance outside of the port by the Min. of Fishing.

R105. It is recommended to develop **marina facilities outside the commercial port** boundaries of port of Colombo to minimize disturbances to commercial activities and possible accidents.

R106. The **licenses should be digitalised** where possible. An online system should show the status of licenses.

R107. It is advisable for ship chandlery service **to remain with private parties** as the SLPA should focus on core value added activities.

R108. should be strengthen with adequate number of **firing engines and staff** considering the development of more terminals at Colombo Port and expected increase in oil tankers of LPG & LNG.

R109. **Fire department** service should continue to be provided by SLPA as an **essential service** under harbour master control.

R110. It is recommended to **financially monitor fire division** as an identified business segment of SLPA with separately tracking of revenue and costs.

R111. Due to the continuing expansion and changing of Colombo port, the **emergency response plan** should be updated.

R112. It is recommended that port authority should consider **outsourcing medical services** to private/public entity to focus on more value added activities.

R113. SLPA should promote **electronic payments** among port users by providing required platforms.

R114. It is advisable for the **seamen club** activities to remain operated by private suppliers.

Auxiliary Functions- International Benchmark

R115. Port of Colombo lacks development space for **distribution centres and logistics**. This is either to be found in several sections North of Colombo (but preferably one) or at reclaimed land as part of north port development.

R116. Port of Colombo has to cater for new industries like the new **LNG powerplant**

R117. **Bunkering** is an auxiliary function which hold promises for the future. The port should prepare to offer this in a liquid bulk hub.

R118. Port of Colombo should be part of a **national unit which offer emergency response** and salvage through supplying heavy offshore tugs.

R119. The Sri Lankan **free trade zone policy** is not adequate, and should upgraded in this respect.

R120. **Tax incentives** are provided to new industries and port zones but a one-stop shop for FDI is required.

R121. Through **investments in the logistics chain** and port accessibility, Sri Lanka should move up in the ranking of the World Bank Logistic performance index.

R122. **Ease of doing business**. This is a ranking from the World Bank to summarize the ease of doing business. It includes customs bottlenecks and bureaucracy in general. Sri Lanka is to upgrade its position through implementing trade facilitation policies and a Single Window.

R123. The **airport to sea function** should be promoted to attract additional cruise vessels.

Short Term Priority Projects

From the list of recommendations, the following short term priority projects have been identified:

SP1. **JCT Modernisation Plan –** A modernisation plan must be developed for JCT, to enable the terminal to continue performing container handling operations safely and reliably over the coming years, after which the container activities are to be phased out from the JCT location.

SP2. **Dedicated berth for grains and cement –** The dedicated berth can solve immediate sea side operations bottle necks and the accompanying depth issues.

SP3. **PVQ Upgrade Plan –** To handle bigger vessel dredging works might dredging if possible is needed.

SP4. **Sapugaskanda oil refinery -** Sapugaskanda oil refinery is in poor state and operates near densely populated areas. As such, the oil refinery may need to be revamped and/or relocated.

SP5. **LNG Storage Facility -** An LNG handling and storage facility is to be developed, to serve the envisioned Kerawalapitya LNG power plant and enable LNG bunkering activities in the port. A floating LNG storage vessel with regassification units on board is recommended. Such a solution would reduce the need for LNG related structures ashore. The pipeline connection to the powerplant should take into consideration the future location of North Port.

SP6. **UCT Transformation Plan –** A plan should be developed to guide the transformation of UCT towards a general cargo facility, as it is expected that container activities will be phased out in the short term (2020).

SP7. **An adequate passenger terminal**, with adequate berthing space and a modern passenger building, is to be developed. The preferred location for this development is on the BQ (once the CFS activities have been relocated to the South Harbour). An adequate facility will also enable an efficient passenger arrival process.

SP8. **Port Gate Upgrade Plan**, including an expansion of the current main gate from 3 in-lanes and 3 out-lanes to 5 in-lanes and 5 out-lanes, and a new gate complex that directly connects the South Harbour to the PAEH.

SP9. **BQ Warehousing Relocation Plan –** Current Warehouses on BQ need to be relocated to ensure continuation of operations. Additionally, new equipment needs to be procured and a modern Warehouse Management System needs to be adopted.

SP10. **Mechanical and electric workshops. –** Due to the PAEH project, a number of buildings need to be relocated.

SP11. **The resettlement of underutilised buildings**

SP12. **Widening of the port access road -** Port road should be widened to a 6-lane road. In case the PAEH, which will run above the port road, hampers widening of the port road at a later stage, the widening should be carried out before the PAEH is completed.

SP13. **Port Gate Automation –** Automation of the gate process is an absolute necessity when dealing to achieve port efficiency and alleviation of congestion.

SP14. **PAEH Simulations –** Traffic simulations are required to help shape the design characteristics of the PAEH.

SP15. **PAEH Development -** Development should proceed as planned by RDA, with SLPA input on construction issues, ramp locations, and gates locations.

SP16. **Securing Future Rail Development Path –** A path for optional future rail development towards south port should be secured.

SP17. **Port Community System –** Port Community System to help data exchange and paperless environment in the port.

Pre-Feasibility Studies

Selection

For each of the identified short term priority projects presented in the previous section, a multi criteria analysis is carried out to select the key projects that are taken to the pre-feasibility stage. The table below presents the results of the analysis; based on the results, the following 6 projects are assessed in more detail in the pre-feasibility studies:

- SP1 – JCT Modernisation Plan
- SP3 – PVQ Upgrade Plan
- SP5 – LNG Handling and Storage Facility
- SP7 – Dedicated Passenger Terminal on BQ
- SP9 – BQ Warehousing Relocation Plan
- SP17 – Port Community System

Nr.	Short Term Priority Projects	SLPA Responsibility	Impact	Complexity	Score
	Cargo Operations				
SP1	**JCT Modernisation Plan**	✓	++	++	++++
SP2	Dedicated berth for grains and cement	✓	0	+	+
SP3	**PVQ Upgrade Plan**	✓	++	+	+++
SP4	Sapugaskanda oil refinery	⦸ **CPC**			
SP5	**(F)LNG Handling and Storage Facility**	✓	+	++	+++
SP6	UCT Transformation Plan	✓	0	+	+
SP7	**Dedicated Passenger Terminal on BQ**	✓	++	++	++++
SP8	Port Gate Upgrade Plan	✓	+	+	++
	Warehousing				
SP9	**BQ Warehousing Relocation Plan**	✓	++	+	+++
SP10	Relocation Mechanical and electric workshops	✓	0	+	+
SP11	The resettlement of underutilised buildings	✓	0	+	+
	Hinterland Connectivity				
SP12	Port road plan (widening & upgrading)	✓	+	+	++
SP13	Port Gate Automation	✓	+	+	++
SP14	PAEH Simulations	⦸ **RDA**			
SP15	PAEH Development	✓	+	+	++
SP16	Securing Future Rail Path to South Harbour	+	0	+	+

SP17 Port Community System	IT	✓	++	++	++++

JCT Modernisation Plan

The JCT modernisation plan comprises the development of the JCT in order to keep operations at competitive levels and enable berthing of 2 large-sized container vessels simultaneously. The main works proposed in the plan comprise (i) an extension of the berth; (ii) dredging; (iii) procurement of new equipment; and (iv) procurement of a new IT system. The table below compares the project case (i.e., the situation if the project is implemented) to the no project case (i.e., the status quo).

	Project Case	Non-project Case
Construction	Starts in 2019	-
Operations	Starts in 2020	Continuous
Service Level	Two 366m large vessels can be handled at the same time, resulting in higher service level to the shipping lines.	Malfunctions may hamper service
Terminal estimated lifespan	Until 2035	Until 2025
Throughputs	Diminishing with 4% per year until end of life time	Diminishing with 8% per year until end of life time

Subsequently, the table below summarizes the findings from the pre-feasibility study. For the economic feasibility assessment, the following value/cost drivers have been assessed:

- Incremental revenues from port operations (converted to economic cash flow).
- Incremental OPEX from port operations (converted to economic cash flow).
- Incremental CAPEX from port development (converted to economic cash flow).

Item	Unit	Required/Hurdle Value	Assessment	Pass / Fail
Technical Feasibility	Technical Issues	No unresolvable technical issues	No unresolvable technical issues	✚
Financial Feasibility	NPV	≥ 0	40.3 M USD	✚
	IRR	≥ 10.00%	16.2%	✚
Financial Feasibility	ENPV	≥ 0	88.8 M USD	✚
	ERR	≥ 7.83%	18.5%	✚
Overall Feasibility				✚

PVQ Upgrade Plan

The PVQ upgrade plan comprises the deepening of the PVQ to CD -14m to enable accommodation of larger bulk vessels. As the current quay wall is not suited for further dredging, a new quay wall will have to be placed in front of the old quay wall to enable dredging. The table below compares the project case (i.e., the situation if the project is implemented) to the no project case (i.e., the status quo).

	Project Case	Non-project Case
Construction	Starts in 2019	-
Operations	Operations at current quay until 2019; operations at renewed quay commence in 2020. Due to construction works in 2019, it is assumed that the berthing downtime causes a 25% reduction in 2019 grain and cement throughout, as opposed to the non-project case.	Continuous
Service Level	Panamax vessels, with capacities between 50,000 and 80,000 DWT, can be accommodated at the port.*	20,000 ton vessels remain the largest vessels to be berthed at PVQ
Business Case Scope	Until 2050	Until 2050
Throughputs	Throughput is assumed to remain the same as in the non-project case. However, cost savings can be realized using the larger vessels. It is assumed that the average vessel size deployed for the grain and cement trades at PVQ and New North Pier will gradually shift from the current 20,000 ton 40,000 tons (for PVQ and New North Pier operations combined).	Grain throughput is estimated to increase to 0.3 m tons by 2050; cement throughput is estimated to increase to 2.3 m tons by 2050.

Subsequently, the table below summarizes the findings from the pre-feasibility study. For the economic feasibility assessment, the following value/cost drivers have been assessed:

- Incremental revenues from port operations (converted to economic cash flow).
- Incremental OPEX from port operations (converted to economic cash flow).
- Incremental CAPEX from port development (converted to economic cash flow).
- Transport cost savings from deploying larger vessels.

	Item	Required/Hurdle Value	Assessment	Pass / Fail
Technical Feasibility	Technical Issues	No unresolvable technical issues	Navigational space will be very limited once the new quay wall is positioned in front of the old quay wall, prohibiting safe operations. There are no cost-efficient solutions for this issue.	

	Item	Required/Hurdle Value	Assessment	Pass / Fail
Financial Feasibility	NPV	≥ 0	-5.26 M USD	−
	IRR	≥ 10.00%	5.40%	−
Financial Feasibility	ENPV	≥ 0	-2.53 M USD	−
	ERR	≥ 7.83%	5.99%	−
Overall Feasibility				−

LNG Handling & Storage Facility

The LNG Handling & Storage Facility project comprises the development of a floating storage and regasification unit in the southern breakwater of the Port of Colombo, in order to serve the envisaged gas-fired power plant at Kerawalapitiya. The table below compares the project case (i.e., the situation if the project is implemented) to the no project case (i.e., the status quo).

	Project Case	Non-project Case
Construction	Starts in 2019	-
Operations	Starts in 2020	-
Terminal estimated lifespan	Until 2050	-
Throughputs	Per requirement of the power plant.	-

Subsequently, the table below summarizes the findings from the pre-feasibility study. For the economic feasibility assessment, the following value/cost drivers have been assessed:

- Incremental revenues from port operations (converted to economic cash flow).
- Incremental OPEX from port operations (converted to economic cash flow).
- Incremental CAPEX from port development (converted to economic cash flow).
- Reduced emissions resulting from the switch from coal to LNG power.

Item	Unit	Required/Hurdle Value	Assessment	Pass / Fail
Technical Feasibility	Technical Issues	No unresolvable technical issues	No unresolvable technical issues, but FSRU may need to be moved in the future, in case increasing demand necessitates the southern breakwater to be extended.	+
Financial Feasibility	NPV	≥ 0	0 M USD	+
	IRR	≥ 10.00%	10.00%	+
Financial Feasibility	ENPV	≥ 0	1.8 B USD	+

Item	Unit	Required/Hurdle Value	Assessment	Pass / Fail
	ERR	≥ 7.83%	529%	+
Overall Feasibility				+

Dedicated Passenger Terminal on BQ

The Passenger Terminal project comprises the transformation of BQ into a dedicated passenger terminal, in order to capitalize on the rapidly growing cruise sector in the region. The main works foreseen in the project include (i) revamping of the BQ berths; (ii) dredging; and (iii) construction of a passenger terminal building. The table below compares the project case (i.e., the situation if the project is implemented) to the no project case (i.e., the status quo).

	Project Case	No Project Case
Assumptions	• Current passenger berth is maintained • BQ is transformed into a passenger terminal, in line with the recommendations in the passenger terminal report.	• Current passenger berth is maintained • No new passenger terminal is developed
Implications	• Colombo port is able to accommodate expected growing demand in cruise vessels and passengers. • Envisioned private developments (cruise loops that call Colombo) are fully implemented. • Higher passenger terminal revenues and passenger spending in Sri Lanka • Higher CAPEX, OPEX and costs of emission.	• Colombo's ability to handle additional vessels and passengers is limited. • Envisioned private developments (cruise loops that call Colombo) are not fully implemented. • Lower passenger terminal revenues and passenger spending in Sri Lanka • Lower CAPEX, OPEX and costs of emission.

Subsequently, the table below summarizes the findings from the pre-feasibility study. For the economic feasibility assessment, the following value/cost drivers have been assessed:

- Incremental revenues from port operations (converted to economic cash flow).
- Incremental OPEX from port operations (converted to economic cash flow).
- Incremental CAPEX from port development (converted to economic cash flow).
- Sri Lankan value added from cruise passenger spending in Sri Lanka.
- Economic costs of increased CO2 emission, due to increased number of busses required to transport incremental cruise passengers on day trips.

Item	Units	Required/Hurdle Value	Assessment	Pass / Fail
Technical Feasibility	Technical Issues	No unresolvable technical issues	If the cruise vessel demand necessitates the use of the western side of BQ, navigational issues may arise when 2 large vessels are berthed at the West BQ berth and SAGT simultaneously. This can be resolved by diagonally cutting the BQ West berth.	+

Item	Units	Required/Hurdle Value	Assessment	Pass / Fail
Financial Feasibility	NPV	≥ 0	1.6 M USD*	
	IRR	≥ 10.00%	10.61%*	
Financial Feasibility	ENPV	≥ 0	42.9 M USD	
	ERR	≥ 7.83%	24.49%	
Overall Feasibility				

*Based on an analysis on the incremental cash flows.

The full passenger terminal pre-feasibility project is not part of the Colombo Port Development Plan. For the full assessment, the reader is referred to the separate Colombo Passenger Terminal Report, which is part of the Sri Lanka National Ports Master Plan.

Warehousing Relocation Plan

Due to the transformation of BQ into a passenger terminal, the warehousing activities need to be relocation. As such, the Warehousing Relocation Plan consists of (i) the construction of new LCL and MCC warehouses; (ii) the procurement of modern equipment; and (iii) the procurement of a modern warehouse management system (WMS). The table below compares the project case (i.e., the situation if the project is implemented) to the no project case (i.e., the status quo).

	Project Case	Non-project Case
Construction	Starts in 2018	-
Operations	Starts in 2019	-
Terminal estimated lifespan	Until 2050	-
Throughputs	LCL Cargo will be handled at facility	Capacity shortage for handling LCL cargo in the port.

Subsequently, the table below summarizes the findings from the pre-feasibility study. For the economic feasibility assessment, the following value/cost drivers have been assessed:

- Incremental revenues from port operations (converted to economic cash flow).
- Incremental OPEX from port operations (converted to economic cash flow).
- Incremental CAPEX from port development (converted to economic cash flow).

Item	Units	Required/Hurdle Value	Assessment	Pass / Fail
Technical Feasibility	Technical Issues	No unresolvable technical issues	No unresolvable technical issues.	
Financial Feasibility	NPV	≥ 0	2.5 M USD	

Item	Units	Required/Hurdle Value	Assessment	Pass / Fail
Financial Feasibility	IRR	≥ 10.00%	11.8%	+
	ENPV	≥ 0	15.9 M USD	+
	ERR	≥ 7.83%	16.4%	+
Overall Feasibility				+

Port Community System

A Port Community System is an electronic platform that connects the multiple systems operated by various organisations that operate in a seaport or inland port community. It is shared in the sense that it is set up, organised and used by firms in the same sector – in this case, a port community.

A PCS offers for the electronic exchange of information amongst all port and logistics sectors and is recognized as the most advanced method for the exchange of information within a single or national port community infrastructure. A PCS has the ability to serve as a National Single Window or to integrate into a National Single Window. A PCS is therefore pivotal in the Single Window concept and will reduce duplication of data input through efficient electronic exchange of information. Moreover it will cut communications and paper administration as information is enter once and re-used in multiple formats for users in the logistic chain. South Korea for example, calculated that their system save USD 3.8 billion per year on communication, documentation and logistics.

Direct influence and immediate benefits of having a Port Community System include the following:

- Easy, fast and efficient EDI information exchange, re-use and centralisation, available 24/7/365
- Customs has “service level agreements” with PCS users to manage the electronic exchange of information between different parties on their behalf.
- The Single Window allows parties involved in trade and transport to lodge standardised information and documents tightly integrated with reduction of paperwork by electronic handling of all information relating to exports, imports, transhipment, consolidations, hazardous cargo and maritime statistics reporting and declarations.
- Status information maritime and other statistics, control, tracking and tracing through the whole logistics chain
- Transparency of Port procedures and processes and practices.
- Support the ambitions to meet global carbon reduction requirements.

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1 Introduction

1.1 Background

On the 30th of November 2016, the Asian Development Bank (ADB) and Maritime & Transport Business Solutions B.V. (MTBS; representing the Consultant) signed the contract for the development of a National Port Master Plan for Sri Lanka (ADB reference 50184-001).

The National Port Master Plan (NPMP) consists of the following reports:

A. Executive Summary
B. The National Port Directions - Volume 1;
C. The Colombo Port Development Plan – Volume 2;
D. The Trincomalee Port Development Plan – Volume 3;
E. Passenger Terminal Concept Report – Volumes 4;
F. Pre-Feasibility Study for deepening JCT Terminal for Operating Larger Container vessels – Volumes 5; and
G. Port Elevated High Way – Volume 6; and
H. Port Reform – Volume 7.

1.2 Objective

The Colombo Port Development Plan covers the next 30 years and includes an investment plan for priority projects to be carried out in the next 10 years, following an assessment of the characteristics of existing port operations, and of existing and planned maritime and landside infrastructure.

The Colombo Port Development Plan is developed through the following reports:

- Passenger Terminal Concept report, covering a passenger terminal construction project in Colombo port;
- Draft Colombo Port Development Plan, covering the Colombo Port Development Plan up to the list of priority projects, i.e. part I in the table below; and
- Colombo Port Development Plan (this report), including the pre-feasibility of priority projects, which were decided by the stakeholders, based on the Draft Colombo Port Development Plan, i.e. including Part II in the table below.

1.3 Structure of the report

In order to enable easy navigation through the report, related topics have been grouped in overarching Parts. The following parts are distinguished:

- Part A covers the general introduction of the port, facilities and functions and the key bottlenecks observed.
- Part B covers per commodity segment the existing facilities, volumes handled, operations, the forecasts, the gap analysis, and the development requirements resulting in recommendations and short term priority projects. The main development options are also covered in this section.
- Part C covers the IT, Customs, Navy and other auxiliary port functions.
- Part D presents studies for the identified short-term priority projects.

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Part A: Colombo Port Environment

2 Colombo Port Overview

2.1 Introduction

This chapter describes the Port of Colombo and its role in the country. The main cargo statistics are discussed and an overview of the main facilities is provided. The chapter displays the key observations and main bottlenecks on several large topics such as infrastructure, equipment, operations, logistics, warehousing, environment and IT.

The following approach is applied:

- First, a general introduction of the Port of Colombo is provided in section 2.2: The port handled 81.8 million tons in 2016 including 5.7 million TEU of containers. In 2016 the port had about 4,405 ships arrivals and was ranked as the 23rd largest container port in the world. The port handles the largest container vessels in the world having dimensions of 400 m in length and a capacity of 21,500 TEU due to quays with ample water depths of CD -18 m and state of the art terminals.
- Section 2.3 presents an overview of the facilities and functions in the port.
- Section 2.4 provides marine traffic and cargo throughputs at the Port of Colombo between 2007 and 2016. The marine traffic increased 4,326 vessels in 2007 to 4,405 vessels in 2016 having some moderate years between 2013 and 2014 with figures below 4,000 vessel arrivals. The cargo throughputs of non-containerized traffic increased from 7.6 M tons in 2007 to 8.2 M tons in 2016. The container traffic, being the largest segment, increased from 3.2 M TEU in 2007 to 5.7 M TEU in 2016. This included a transhipment volume of 4.4 M TEU. The Gateway container grew at a CAGR of 4.9% whilst transhipment CAGR was 5.8% over the last decade.
- The key observations and bottlenecks are identified and discussed in section 2.5: The long-list is a collection of key observations throughput the chapters in this document.

2.2 Port of Colombo

2.2.1 Port of Colombo and National Strategy

> Port of Colombo will be leader in the Indian Ocean, Middle East and East African hub ports, and is to become an efficient logistic hub to attract sustainable investment and trade, to facilitate the national import and export strategies and to become an international maritime centre.

As such three tier focus applies to Port of Colombo:

- Maintaining a World Class Transhipment Hub, serving the Middle East, East Africa, India, Pakistan and the Bay of Bengal;
- Becoming an efficient logistic hub for imports and newly developed exports;
- Becoming a sustainable Port.
- Becoming an international maritime centre.

Colombo Port is leader in the Indian Ocean as Transhipment Hub port and should stay competitive with other national and international transhipment ports. To achieve this, focus should be on operational excellence both on the marine services, cargo handling services, auxiliary functions and on interterminal traffic. The marine activities and handling activities are one of the core activities of SLPA. Port designs are adjusted and future capacity is planned for in order to stay ahead of demand. Innovations and new technologies will support this development.

The Port of Colombo should also become more efficient to facilitate the National Export Strategy on targeted exports sectors, as well as improving the logistics on import cargoes. As many trades are transported by containers, the container logistics chain is prime focus to become more efficient. This can be catered for through better infrastructure on port and hinterland connections as well as on administration and procedures. The latter can be achieved through a combination of digitalisation through a single maritime window as well as through trade facilitation and improved customs procedures. Further the development of cargo villages or Free Trade Zones (FTZ) connecting to the port should cater for demands on export manufacturers and foreign direct investment (FDI).

The above shows that the port sector needs to move fast on the innovation and efficiency improvements through investments to stay competitive both to support the transhipment Hub as well as the exports visionary. The port of Colombo will be a reliable partner in developing the nation and serving new clients.

Sustainability has become an important element in the global production chain. Global supply chains focus on partners which have a sustainability policy in place. Port of Colombo wants to align with modern practises of sustainability standards and green policies, innovation in the priority export sectors and integrate the logistics operation in the green supply chain.

Port of Colombo and the city are under massive development and together with the new Port City ideally situated to become an International Maritime Centre (IMC). The Port of Colombo is to become a well recognized as International Maritime Centre, a place in which efficient maritime services are provided and which various trade related services and maritime industries are vested. The strategy is to be developed over time. Development in three main “centres”have been identified:

- Centre of trade sectors:
  - Finance / Insurance / Trading & Arbitration
  - Logistics companies
- Centre for port and shipping industries:
  - Shipping and classification societies;
  - Maintenance and Repair
  - Port Technology
  - Bunkering
- Accumulation of supporting industries
  - Education & Training
  - Research & Development
  - Consultancy

In each of the subsectors corporate companies and their agents should be attracted to create a well recognised international maritime centre in which a vibrant maritime business environment emerges over time. The development of Port City will add to the profiling of the maritime centre.

Several tasks are to be executed to create an international maritime centre:

- Profiling and branding Colombo Port
- Boosting Ease of Doing Business
- Creating a vibrant business and living environment
- Facilitate new business opportunities
- Provide incentives to attract business
- Partnership with other IMCs

Port role in the Country

The Port of Colombo is important for Sri Lanka and facilitates the majority of the import and exports trades today. The city is under large developments with the erection of many new hotels and resident flats and the rehabilitation of historic buildings. Furthermore, a new city port is under development, south of the existing port, including hotels, conference centres, residential flats, shops and marinas. The new port city will be connected through an elevated highway that also creates additional entrances to the port. The western region has several plans for city and urban developments and improvements. Combined, the western region developments and the city of Colombo generate high demands for the port of Colombo. This translates to required port improvements, a new cruise terminal, enhanced connectivity and major future port planning both for containers as well as for liquid bulk and multipurpose. Additional demand for warehousing and logistics needs to be captured in future planning as well.

2.2.2 General port overview

Colombo is located on the West coast of Sri Lanka and is the country's principal city and port. The port handles containerized cargoes, liquid bulk (crude oil and refined products), dry bulk (mostly grain and cement), general cargoes (mainly steel products, timber and RoRo) and cruise passengers. Colombo is located near the main East-West shipping routes and has become a major port for gateway cargo and the transhipment of containers. The port has two main basins that cover three large containers terminals, with a fourth terminal being under construction. Container transhipment accounts for approximately 75% of Colombo's total container traffic; the remaining 25% comprises local containerized cargo, mainly driven by the export of garment, tea, and rubber, and imports of consumer products, industrial and agricultural equipment. Whilst there is almost no effective competition for domestic cargo, Colombo competes with several major hub ports for transhipment traffic. In this cargo segment, the port has benefitted from its strategic location, both close to the main East-West trade lanes and close to the large and strongly growing Indian market.

The port handled 81.8 million tons in 2016 including 5.7 million TEU of containers. In 2016 the port had about 4,405 ships arrivals and was ranked as the 23rd largest container port in the world. The port handles the largest container vessels in the world having dimensions of 400 m in length and a capacity of 21,500 TEU due to quays with ample water depths of CD -18 m and state of the art terminals.

The port was developed along the natural bay at the city and the old basin covering approximately 201.5 ha. A major expansion program has resulted in the development of South Harbour which became operational in 2013. The new port basin consists of one state of the art terminal container terminal (58.0 ha) and another container terminal that soon will be launched. The basin has space for a third container terminal and a liquid terminal.

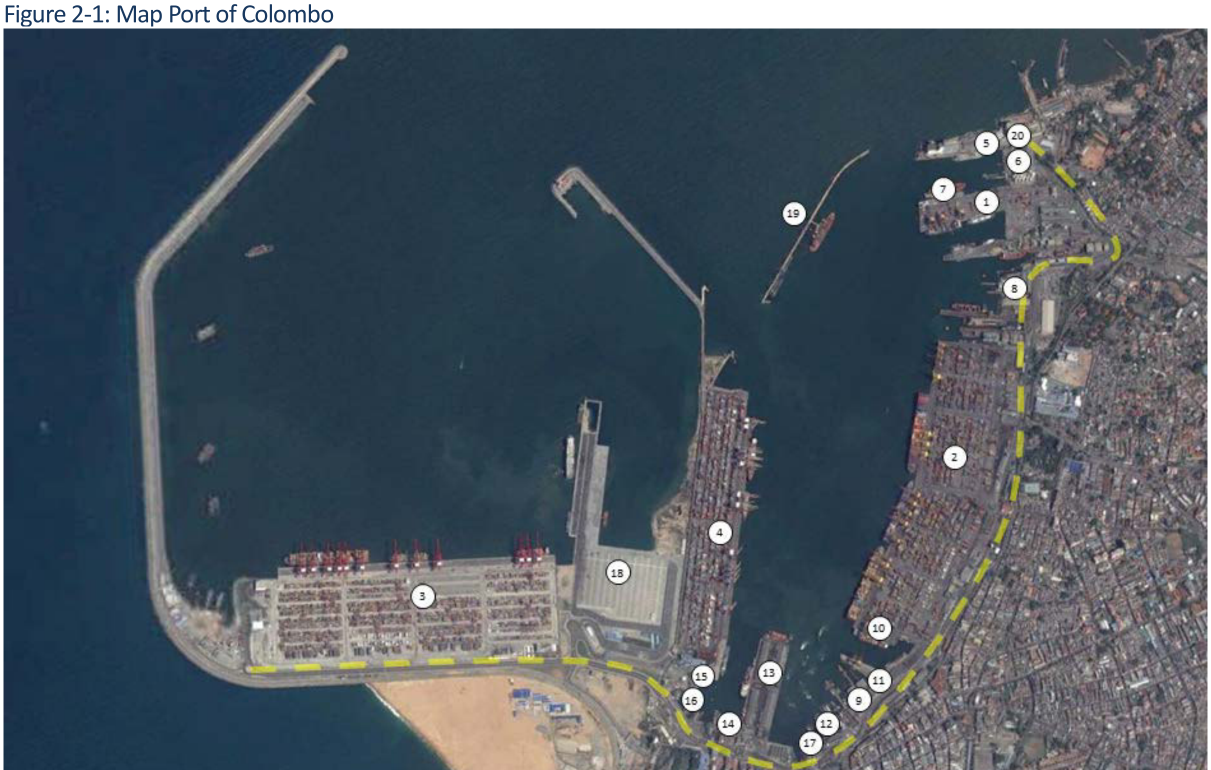
Additionally, to handling imports, exports and transhipment, the Port of Colombo offers non-cargo services including harbour master services, pilotage and tugging, bunkering, ship repair, warehousing, water supply, weighing and scanning services, firefighting, hospital services, financial services and ship chandlery. Also, the navy is situated within the port limits. To the north of the port a maritime training institute is situated.

2.3 Facilities and Functions

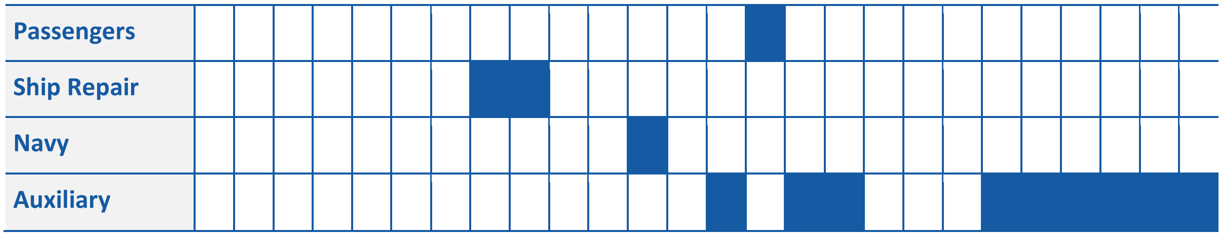
Terminals and functions

The map and table below present the main port facilities in Colombo and their function. The port's border is indicated by a yellow dashed line, which is a customs protected area. The port road follows the port boundary.

Figure 2-1: Map Port of Colombo



	UCT	JCT	CICT	SAGT	PVQ	South Jetty	New North Pier	Colombo Dockyard	Slipway	JCT Feeder Berth	New Feeder Berth	Coastal Berths	Bandaranaike Quay	Sydney/Melbourne	Passenger Berth	Water Supply	Canal Berth	ECT	Dolphin Tanker	Cement Storage	Warehouses	Weighing &	Hospital	Fire Brigade	Training Centre	Tug & Pilot Station
Number on Map	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*	*20*	*Not Indicated on Map*					
Containers	■	■	■	■						■	■							■								
Ro-Ro	■																									
Dry Bulk					■															■						
Liquid Bulk						■													■							
General Cargo					■		■						■													



2.4 Throughputs and Marine Traffic

Marine Traffic

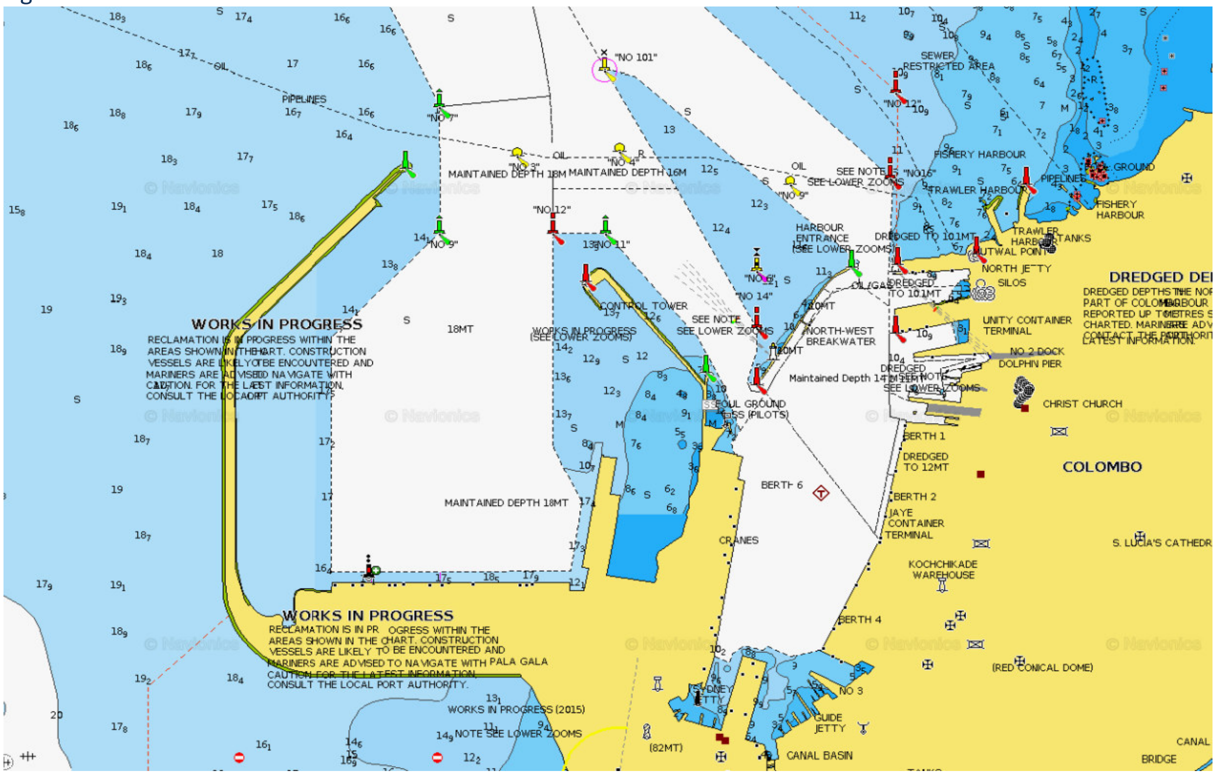
The majority of vessel calls in Colombo port comprises container vessels with 3,804 vessels in 2016. Since larger container vessels are calling the port resulting from the opening of new facilities, this number of vessel calls is likely to drop or stagnate. Another aspect to note is that the amount of bunker vessels calls is relatively low at 29 vessels.

Table 2-1: Marine Traffic Port of Colombo

Ship type	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Container	3,628	3,666	3,304	3,076	3187	3,092	3,142	3,239	3,643	3,804
Conventional	173	205	140	56	68	52	38	28	45	40
Other cargo	421	458	474	616	680	591	354	366	388	436
Ships for repairs	44	49	48	47	30	35	36	38	43	46
Ships-bunkering	12	21	106	68	65	51	50	25	30	29
Other ships	48	25	42	47	94	49	47	46	48	50
Total Ships Arrived	**4,326**	**4,424**	**4,114**	**3,910**	**4,124**	**3,870**	**3,667**	**3,742**	**4,197**	**4,405**

The access channel is maintained at a dredged depth of 20.0 m and the old port basin at 15.0 m. The South port has a dredged depth of 18.0 m, enough to accommodate the largest container vessels.

Figure 2-2: Nautical Chart Port of Colombo



Source: www.navionics .com

Cargo Traffic

Colombo is the largest port in Sri Lanka with about 81.8 million tons handled in 2016 and about 8.0 million tons handled per annum when containers are excluded. Between 2005 and 2015 the CAGR on “non-containerised cargo” was 1.1%. Over the past decade, dry bulk and liquid bulk volumes have grown by 1.6% and 1.3% respectively per year. Non-containerised general cargo declined by 0.2%. The 2015, share of break bulk was 14%, dry bulk represented 29% and liquid bulk 57%. Imports and transhipment of Ro-Ro cargo has been phased out to Hambantota as the latter port has ample space available for this cargo type.

Table 2-2: Throughput (000s) Bulk Colombo 2007-2016

Tons ‘000	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Non-containerised General Cargo	1,048	838	649	627	722	618	364	601	1,113	879
Dry Bulk	2,257	2,565	2,097	2,556	2,620	2,709	2,657	2,444	2,344	2,572
Liquid Bulk	4,264	4,068	4,026	4,159	4,565	4,839	4,265	4,420	4,579	4,746
Total	**7,568**	**7,471**	**6,772**	**7,341**	**7,906**	**8,165**	**7,286**	**7,465**	**8,036**	**8,197**

Table 2-3: Throughput (000s) Ro-Ro Colombo 2007-2016

Vehicles	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Domestic	30,047	21,875	6,732	45,779	90,824	38,886	6,651	21,296	71,738	31,888
Transhipment	10,065	2,154	4,973	2,455	993	183	466	-	13	778
Total	**40,112**	**24,029**	**11,705**	**48,234**	**91,817**	**39,069**	**7,117**	**21,296**	**71,751**	**32,666**

Table 2-4: Throughput (000s) Containers Colombo 2007-2016[1]

TEU '000	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Import Laden	*355*	*359*	*318*	*415*	*488*	*467*	*477*	*519*	*574*	*631*
Import Empty	*46*	*48*	*56*	*46*	*36*	*41*	*39*	*49*	*35*	*21*
Export Laden	*238*	*229*	*223*	*244*	*260*	*265*	*256*	*270*	*263*	*271*
Export Empty	*163*	*177*	*155*	*226*	*263*	*247*	*259*	*289*	*346*	*377*
Gateway	**803**	**813**	**752**	**932**	**1,047**	**1,020**	**1,032**	**1,127**	**1,218**	**1,300**
Transhipment	**2,469**	**2,785**	**2,633**	**3,096**	**3,124**	**3,065**	**3,208**	**3,700**	**3,888**	**4,355**
Total	**3,272**	**3,599**	**3,385**	**4,028**	**4,171**	**4,085**	**4,240**	**4,827**	**5,106**	**5,655**
Tons Handled (Mln)	**35.9**	**40.5**	**39.6**	**51.4**	**54.1**	**53.5**	**56.2**	**63.3**	**65.7**	**73.7**

Containers are dominantly handled at Colombo Port with so far only sporadic exemptions at other ports. Containers are the main cargo at the Port of Colombo in terms of volumes handled. In 2016 about 5.7 million TEU was handled. A large part of this volume is transhipment (about 75%) which means that these boxes are transferred between ships to reach their destination. The gateway containers amounted to 25% or 1.3 million TEU, which consists of imports and exports. About 82% of all containers handled are laden containers. The remainder 18% are empty containers handled. In the past decade, gateway throughput has grown with 4.9% and transhipment throughput with 5.8 % (CAGR 2007 – 2016).

2.5 Key Observations and Bottlenecks

The table below provides an overview of key issues that hamper capacity and efficient operations in the port of Colombo. Several issues have been classified as high severity. To name a few important initial observations:

- The ports faces port access road congestions;
- The largest container vessels (ULCS) can only be handled at South Port as the water depth in the old basin is insufficient;
- Equipment and quay cranes at JCT are outdated;
- The port is characterized by many paper works especially in the bonded warehouses and SLPA terminals;
- LNG handling capacity for the envisioned Kerawalapitya power plant should be planned for;
- The port has insufficient CFS area space for LCL and MCC cargo activities;
- SLPA has multiple roles within the Port of Colombo, as terminal operator and as landlord and as regulatory authority; and,

[1] Data is excluding re-stowage

- Decision making within SLPA is subject to substantial influence from the Ministry, resulting in suboptimal responsiveness.

Table 2-5: Colombo – Key Observations

Category	Reference*	Issue	Severity
Container Activities			
Infrastructure	UCT	CD -9.0m water depth at UCT is insufficient for large container vessels and therefore less suited for handling containers	High
Equipment	UCT	Investment in 2 mobile harbour cranes (newbuilt or second hand) for UCT	Low
Equipment	UCT	Gantry cranes are obsolete as feeder traffic has diminished at UCT	Low
Operations	UCT	Terminal is underutilised for container vessels and often used for RoRo cargo Terminal can be used for general cargo more often	High
Infrastructure	JCT	Quay length is insufficient to berth two mainline vessels simultaneously	High
Equipment	JCT	Technical status of feeder cranes at JCT I-II needs to be assessed	Medium
Equipment	JCT	Old tractors and trailers are obsolete and are occupying space in the terminal	Medium
Equipment	JCT	Part of the RTG fleet needs to be replaced	Medium
Systems	JCT	Upgrade of the Terminal Operating System (TOS) to N4 version is required	High
PVQ Activities			
Infrastructure	PVQ	Quay wall PVQ is deteriorated	Low
Infrastructure	PVQ	CD -9.0m water depth is insufficient for large bulk carriers	High
Superstructure	PVQ	PVQ warehouse near the quay is deteriorated (abandoned)	Medium
Equipment	PVQ	Grain operations carried out with 2 suction cranes with substandard performance (240t/hr)	Low
Equipment	PVQ	PVQ operations carried out with an inefficient belt system to a newly developed warehouse (240 t/hr)	Low
Berth	PVQ	Berth occupancy is too high, causing delays.	Medium
Cement			
Infrastructure	NNP	CD -11.0m water depth is insufficient for large bulk carriers	Low
Infrastructure	NNP	200m quay is insufficient for large bulk carriers	Low
Equipment	NNP	Discharge rate is substandard	Low
Berth	NNP	Berth occupancy is too high causing delays.	Medium
Fertilisers			
Equipment	PVQ	Mobile equipment lacks efficiency	Low
Liquid Bulk			

Category	Reference*	Issue	Severity
Infrastructure	DTB	Maximum vessel LOA is insufficient to accommodate large liquid bulk vessels at Dolphin jetty	Medium
Infrastructure	DTB	Pipelines to refinery are outdated	Medium
Infrastructure	DTB	A connection between Kollonnawa tank farm and Muthurajawela tank farm should be created in future	Medium
Infrastructure	DTB	Sapugaskanda oil refinery outdated; needs to be revamped or demolished and newly built at more suitable location	High
Infrastructure	DTB	A LNG handling capacity for the envisioned Kerawalapitya power plant should be planned for	High
Infrastructure	DTB	In case dolphin jetty is removed due to north port development new refined product jetties should be catered for	Medium
Warehousing & Logistics			
Logistics	PoC	Inefficient use of gate infrastructure, due to substantial amount of manual handlings and lack of automation.	High
Logistics	PoC	The complete logistic chain needs to adapt a 24-hour operational scheme to better distribute truck arrivals	High
Logistics	PoC	Number of in- and out gates is insufficient	High
Logistics	PoC	High traffic queues of over 5 km are present at several days in the week. Next to manual procedures at the Main gate also the congestion in the city and in front of the inspections yards is causing this queue. Often the queue in front of the inspection area is all the way from South Port to Grayline II.	High
Warehousing	PoC	Warehousing space is required	High
Warehousing	PoC	The warehouse LCL system is a manual driven process, no automation available (no barcodes scanning, no receipt alerts, no damage control systems, no track and trace)	High
Infrastructure	BQ	Transit sheds are used as warehouses, but are not adequately equipped to handle the MCC and LCL cargoes. Additionally, layout / spacing of the transit sheds is not suited for the current operations.	High
Warehousing	BQ	Warehousing operations are inefficient due to an excessive amount of manual documentation.	Medium
Warehousing	BQ	Warehousing equipment is outdated and in poor state.	Medium
Warehousing	BQ	There is a lack of an efficient automated warehousing system.	Medium
Environment			
Organisation	SLPA	The organisation has no department which coordinates, monitors and controls environmental issues	High
Emission	SLPA	SLPA has no emission measurement system installed; hence, the actual emissions cannot be measured	High
Health and Safety	PoC	Occupational Health & Workers safety is very important but, safety guidelines are not adequately implemented, monitored and enforced. At the terminals no specific hats, jackets and shoes are	High

Category	Reference*	Issue	Severity
		being used. Several terminals can be regarded as unsafe as movement of personnel and heavy traffic often coincide.	
Port equipment	SLPA	The majority of SLPA equipment is diesel based. Hence the emissions from the organisation is subject to improvement.	High
IT systems on revenue stream			
General	SLPA	Manual processes and paper based approvals cause high administration and time consumption	High
TOS	JCT	The TOS of JCT (Navis Sparcs 3.10 and Navis Express) are outdated and do not support modern yard utilisation, real time yard planning and web based applications, GPS and modern gate applications	High
TOS	JCT	Current TOS system lacks a dashboard management system with relevant management information (productivity and performances)	High
TOS	JCT	Current TOS systems lacks ability to upload files and amend records within the permitted timeframe	High
TOS	JCT	Current TOS lacks ability to bill activities directly on handlings and storage and share the invoice lines with the finance system.	High
TOS	JCT	Baplie files often have errors leading to communication and corrections by shipping agents	High
TOS/ harbourmaster	HM	Berth planning system is not shared between container terminals and harbourmaster and linked to scheduling system of vessels on calendar planning	High
Gate automation	JCT	JCT has no gate automation and lacks up to date TOS system to enable OCR gate system	High
Damage control	JCT	Equipment Interchange Reports (EIR) are made manually. These reports lack photo's. Accident reports and claim handling is subject to become more efficient through OCR scanning.	Medium
Harbour master	HM	Tug and pilotage recording and invoicing is inefficient due to manual registration.	High
Harbour master	HM	Ship registry, berth planning, mooring and de-mooring is not integrated with invoice recording. A Harbour Information Management System (HaMIS) is required integrating the ship registry file with actual ship history call records. The ship registry file is to be linked with the international ship file from IHS/Fairplay or Clarksons.	High
Harbour master	HM	HaMis system is lacking and planning on tugs and pilots including statistical data should be provided from HaMis to a management web based dashboard. Turnaround times to be integrated into the dashboard with information provided by the TOS systems (productivity & performances)	High
Single window	PoC	There is no single data window for port users. Approvals in the information chain are based on manual procedures and stamped	High

Category	Reference*	Issue	Severity
		documents. Communications in the process involves much non-automated correspondence through phones and even by fax. System should share specific and allowed data between terminal operators and management information systems	
Single window	PoC	There is no single window that provides sufficient data on procedures, rules and practices	High
Legal	SLPA	Contract management system is lacking; as such, alerts are not linked with TOS to respond effectively on disputes	Medium
Payment control	SLPA	Systems are not linked with unrestricted Payment Gateway and Pay online and submit digital receipts.	Medium
IT systems on costs stream			
CRM	SLPA	A Customer Relation Management system is lacking.	High
Manual document management	SLPA	The manual document management system should be digitalised to avoid business based on hard copies.	High
Shift planning & rostering	SLPA	Shift planning and rostering is done on a manual basis whilst services have to offered 24/7; optimisation is required in this respect.	Medium
WIFI networks	PoC	WIFI networks are lacking at various locations	High
Cable internet	PoC	Cable internet is often not reliable causing file transfer to fail	High
Customs			
IT	Customs	Asycuda World is able to handle electronic payments, yet the business is often still cash based	High
IT	Customs	Too limited consignees and shippers use the electronic declarations system that is available.	High
IT	Customs	Electronic clearance is not yet integrated in a Customs single window despite using the SAD	High
Gatepass	Customs	The Gatepass procedure is a manually intensive procedure which also involves wharf clerks to run around the trucks at main gate (safety issue). The original gatepass, the sealing and the issue of a new gatepass in all is rather a time consuming procedure.	High
Gate efficiency	PoC	The Main gate handles about 1 container each two to three minutes; this should be improved	High
Green line	Customs	A few shippers and consignees have been appointed to the green line which allows the container to pass directly without standard checks. Unfortunately, only a small part of the full container loads get the green line label, resulting in many inspections still today.	High
Inspection	Customs	Inspection areas are scattered over several sites and often not easily accessible due to traffic. The scattered locations cause sub-optimal use of resources and planning. The customs is not able to control the truck flow as consignees themselves plan the truck move to the inspection areas.	High

Category	Reference*	Issue	Severity
Inspection	Customs	The total capacity on inspection is limited to about 1,000 containers per day.	High
Scanning	Customs	Customs likes to implement 100% scanning (today about 70%). This will further increase the customs clearance times for containers, resulting in severe congestion in the port.	High
Detention	Customs	Customs has own detention areas near the inspection sites. Also in the port there are warehouses with goods under detention. The issue is here that these goods are not moved out frequently. Sometimes as auction are planned. The storage space in the port occupied by Customs is free of charge for Customs. This space is however very valuable for the port and should be cleared if possible.	High

*UCT = Unity Container Terminal; JCT = Jaya Container Terminal; PoC = Port of Colombo; PVQ = Prince Vijaya Quay; NNP = New North Pier; DTB = Dolphin Tanker Berth; BQ = Bandaranaike Quay; SLPA = Sri Lanka Ports Authority; HM = Harbour Master

Part B: Cargo Demand, Capacity and Port Development

3 Containers

3.1 Introduction

This chapter aims to define the development need for container business and the development options to cater for the required capacity. The chapter is structured as follows:

- This chapter starts in section 3.2 with an overview of the current container facilities.
- Section 3.3 presents the current situation and historic demand development - volume has grown from 1.0 M TEUpa in 1995 to 5.7 M TEUpa in 2016, with transhipment accounting for 75% of the total throughput.
- Section 3.4 provides an overview of the global and expected country-specific vessel trends for the container trade.
- Section 3.5 provides the container volume projection up to 2050 – it is estimated that Port of Colombo will handle 16.0 M TEUpa in 2050 in the Base Case, with a potential further upside towards 24.0 M TEUpa in the High Case.
- The capacity need is estimated in section 3.6 - Capacity shortage commences in 2025 and reaches 11.0 M TEUpa in the Base Case.
- An overview of the development options, as derived from SLPA's development plan 2016, is presented in chapter 3.6.2. These options will be integrally considered in the port lay-out development in section 10.
- Section 3.7 concludes with the recommended short term priority projects for the container business – a modernization plan for JCT is proposed; this plan will be further assessed in section chapter 17.

3.2 Overview current container facilities

3.2.1 Overview of Facilities

The current container terminals at the port of Colombo are spread across the port's old basin and South Harbour. The figure below provides an overview of the four current container terminals in the port, of which Colombo International Container Terminal is currently the only operational terminal in the new South Harbour. The individual container terminals are discussed in more detail in the following sections.

Item	Value	Unit
Main Container Berths	10	#
Feeder Berths	4	#
Quay Length	>4	km
Maximum Water Depth	18	m
Quay-side Gantry Cranes	47	#
RTGs / RMGs	142	#
Annual Container Handling Capacity	7,400,000	TEU

3.2.2 Unity Container Terminal

The Unity Container Terminal (UCT) is the smallest container terminal in the port of Colombo in terms of capacity, with a design capacity of 0.3 M TEU per annum. The table below presents the facilities at the terminal, as well as historic throughput figures.

The following key observations can be made regarding UCT's facilities and throughput:

- Container volumes have increased from approximately 32,000 TEU in 2005 to 114,000 TEU in 2015; however, container throughput volumes have dwindled substantially since 2011.
- UCT has sufficient water depth to accommodate vessels of up to 10.0 m draught.
- UCT has a terminal area of 7.5 ha.
- The UCT is fully owned and operated by the SLPA.

Category	Item	Value	Unit
	Reach Stackers	-	#
	Straddle Carriers	-	#
	RTGs / RMGs	8	#
	Gantry Cranes	3	#
	Mobile Harbour Cranes	-	#
	Berth Length	590	m
	Water Depth	9.0 – 11.0	m
	Terminal Area	75,000	m^2
	Yard Area	45,000	m^2
	Terminal Capacity	300,000	TEU
	Reefer Plugs	N/A	#

Item	Unit	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Throughput	x1,000 TEU	32	99	196	201	132	179	227	170	156	166	114	N/A

Operations

The following observations can be made from operation point of view:

- The UCT terminal is equipped with 3 ship-to-shore gantry cranes and 8 RTGs.
- The equipment fleet is relatively old and in a rather poor state.
- Currently, UCT gate complex consists of 2 in-lanes and 2 out-lanes, which is more than sufficient to cover the (limited) number of incoming and outgoing trucks.

Due to the limited water depth available at UCT (CD -9.0m to CD -11.0m), volumes have dwindled substantially last years. Hence, as feeder vessels have increased in size, the container terminal facility at Colombo is underutilised in terms of capacity and throughput. While no major rehabilitation works or upgrading works are scheduled, UCT will play a very limited role in the future development of container activities at Colombo.

Hence, we recommend to reconvert the UCT terminal into a general cargo terminal. The current pavement design fits both for container and for general cargo activities. Similarly, the gate complex will cater as well for the general cargo traffic at UCT. In terms of equipment, we advise to invest in two mobile harbour cranes which is the most suitable type of equipment to operate a general cargo terminal. While the 3 existing gantry cranes are less than 15 years old and have only produced about 25% of their expected design life cycle of 2 million moves, we propose to move these cranes towards the JCT terminal where they can continue to operate feeder vessels calling at JCT I and JCT II berths.

The following key observations can be made regarding UCT's infrastructure and operational setup:

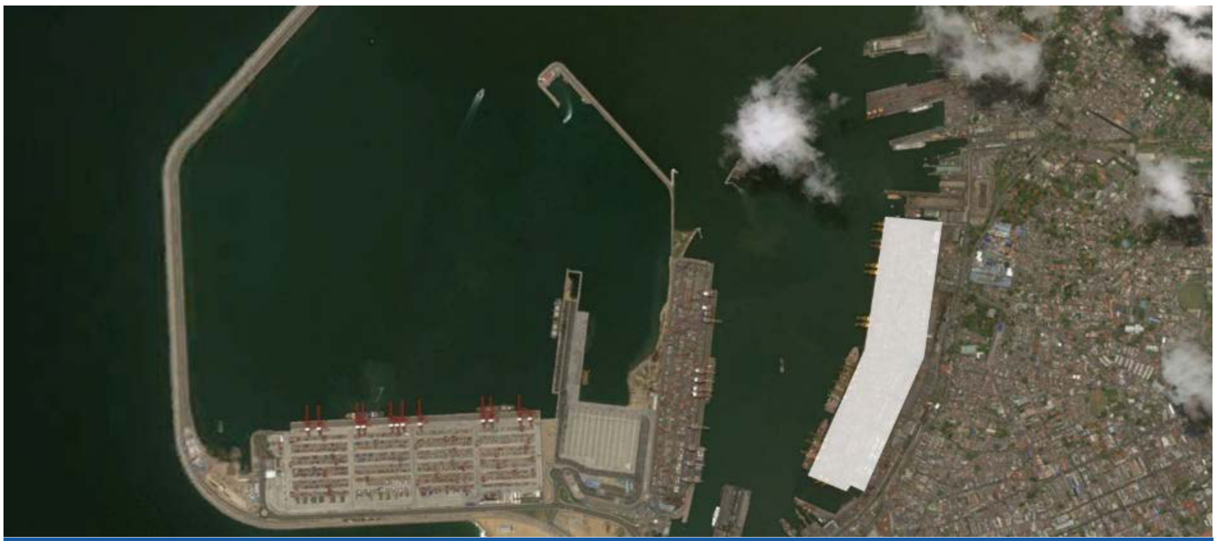
Category	Issue	Severity
Infrastructure	CD -9.0m water depth is insufficient for large container vessels and therefore less suited for handling containers	High
Equipment	Investment in 2 mobile harbour cranes (newbuilt or second hand)	Low
Equipment	Three gantry cranes need to be upgraded and moved towards JCT terminal	Low
Operations	Terminal is underutilised for container vessels and often used for RoRo cargo Terminal can be used for general cargo more often	High
Logistics	Gate (with two in-lanes and two out-lanes) is sufficient	Low
Logistics	UCT has space available for warehousing when it is converted to General cargo berth	High

3.2.3 Jaya Container Terminal

The Jaya Container Terminal (JCT) is one of the largest container terminals in the port of Colombo in terms of capacity, with a design capacity of 2.45 M TEU per annum. The table below presents the facilities at the terminal and historic throughput figures.

The following key observations can be made regarding JCT's facilities and throughput:

- Container volumes have increased from 1.5 M TEU in 2005 to 2.1 M TEU in 2015.
- The JCT III and IV berths have a water depth of approximately CD -15.0m; the JCT I and II berths have a water depth of approximately CD -12.0m.
- JCT has a terminal depth of approximately 300m.
- The JCT is fully owned and operated by the SLPA.



Category	Item	Value	Unit
	Reach Stackers	-	#
	Straddle Carriers	-	#
	RTGs / RMGs	59	#
	Gantry Cranes	20	#
	Mobile Harbour Cranes	-	#
	Berth Length	1,292 + 350	m
	Water Depth	12.0 – 15.0	m
	Terminal Area	455,000	m^2
	Yard Area	360,000	m^2
	Terminal Capacity	2,450,000	TEU
	Reefer Plugs	1,548	#

Item	Unit	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Throughput	x1,000 TEU	1,487	1,640	1,636	1,756	1,580	1,987	2,072	2,147	2,346	2,394	2,138	N/A

Operations
Several observations can be made from an operational point of view:

Ship sizes of container vessels have been growing tremendously during the last decade. The deepest draught berths at JCT – i.e. JCT III and JCT IV – have a total length of 660m, which is insufficient to berth 2 large vessels simultaneously at JCT III and ICT IV. Therefore, SLPA approved an expansion plan for JCT including the demolition of the existing feeder quay and a quay extension of 120m (next to JCT IV) with corresponding backyard area fill.

As mentioned before, the equipment fleet – and for sure the fleet of gantry cranes installed at the berth I and II – is outdated, hence not in line anymore with the current market demands to handle modern Ultra Large Container Vessels. Currently, there are 8 gantry cranes installed at JCT I and JCT II out of which 4 cranes have an outreach of 13 rows (Panamax type) and 4 cranes with an outreach of 16 rows (Post Panamax type). Apart from 2 cranes, all the cranes at JCT I and JCT II are already more than 20 years old; 4 cranes are even more than 30 years old. In general, a ship to shore crane is designed for 20 years of operations or about 2 million crane cycles, whatever comes first. Apart from 2 cranes, all the cranes at JCT I and JCT II have produced more than 2 million crane cycles in the meantime. One can conclude that most of these cranes have surpassed their economic and technical lifespan.

More recently, JCT procured 6 new gantry cranes; 3 cranes were commissioned in 2011 and another 3 came into operation in 2012. These cranes are installed at JCT III-IV. Apart from these six cranes, another 2 cranes of about 20 years old are still in operation at the same berths. All the cranes installed at JCT III-IV have an outreach of 18 containers across (Post Panamax type).

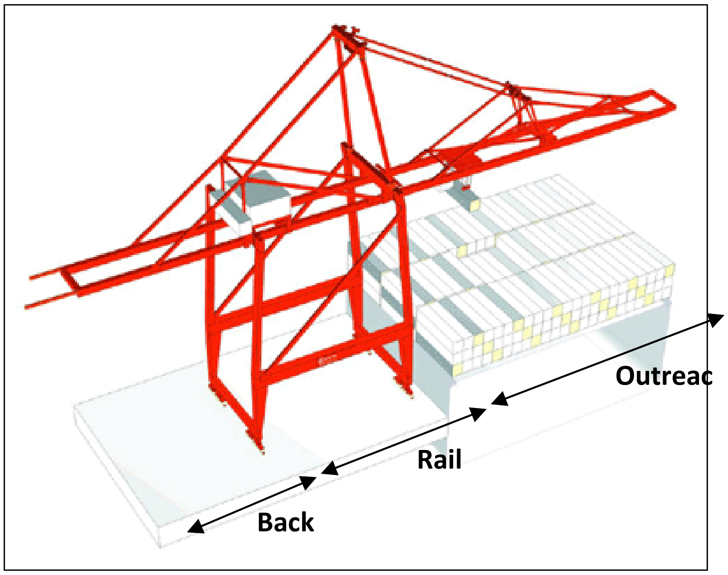
At the southern extremity of the JCT terminal, a feeder basin is available consisting of one feeder berth of about 180 metres at each side of the basin and with 2 feeder cranes installed at each side of the feeder basin. These cranes also reach the age of 20 years. The most southern feeder berth at the basin is not used for container operations anymore but only to berth a vessel

Out of the total fleet of gantry cranes, only 2 cranes (procured in 2012) do have twin-lift capacity, i.e. simultaneous hoisting of two 20-foot containers. Twin-lift hoisting allows for higher crane performance during operations. At present, a modernisation plan is ongoing at JCT: 6 of the oldest ship to shore gantry cranes will be removed and replaced by 3 new Post Panamax gantry cranes with an outreach of 19 container rows wide. At the JCT III-IV berths, in total 9 gantry cranes will be available, enabling the handling of Over-Panamax vessels at JCT at an acceptable service level. Taken into account the addition of the 3 UCT cranes from UCT and the removal of 2 old cranes at JCT I-II berths, still 11 cranes will remain available for feeder operations, which is more than sufficient. We advise to launch a technical and financial assessment of these 11 (feeder) cranes at JCT I-II to identify the potential of scrapping more cranes instead of continuing to maintain and operate this old and redundant fleet.

Awaiting the quay extension, for the time being Operations Department has introduced an alternative mooring configuration: in case 2 large vessels need to be handled simultaneously at JCT III and JCT IV, the vessel at JCT IV will moor port side at quay, while all other vessels are mooring starboard side at quay. Although this new configuration provides full accessibility for the cranes to both vessels at JCT III and JCT IV, the impact on the apron and yard side operations at the terminal is tremendous. Due to the alternative mooring configuration at JCT IV, the traffic flow rotation of the tractor-trailers is changing from clockwise to counter clockwise rotation. This creates a serious conflict both in terms of traffic flow and safety and comes on top of the already hampered traffic flow configuration due to the lack of operational back reach area underneath the gantry cranes.

The figure below shows the basic conceptual design drawing of a ship to shore gantry crane. The design of almost every gantry crane installed at the quayside of a (dedicated) container terminal is based on 3 main operational areas: the outreach area (above the vessel), the rail span area (in between the rail gauge) and the back reach area (behind the landside rail).

Figure 3-1 STS Gantry Crane



In general, the back reach area has two functionalities. On one hand, this area is used to temporary store the hatch covers at the quay side while operating containers in the corresponding holds of the vessel. On the other hand, the back reach area is also used to allow for internal traffic of tractor-trailers: in most cases, 2 traffic lanes are designed and used for internal traffic that need to cross the apron without driving underneath the rail span area where containers are loaded and discharged to/from tractor-trailers.

Figure 3-2 on the left below shows the current operations within the rail span area at JCT berth III and IV. While none of the gantry cranes at berth III and IV is equipped with a back reach area, the hatch covers can only be stored within the rail span area, which is limiting the operational area underneath the crane. On top of that, due to the alternative mooring configuration and the corresponding change in traffic flow rotation, tractor-trailers need to pass in the rail span area underneath the crane in two directions. Figure 3-2 on the right below shows the constraints in traffic flow during operations. Compared to the one-directional traffic flow (without alternative mooring configuration) this creates a serious bottleneck for the operations as well as an increased safety risk for the truck drivers.

Figure 3-2: Picture JCT Berth 3&4

The current layout of JCT shows 3 gate complexes:

- JCT gate N° 4/5 are located upper north of the JCT facility and is not in use for truck traffic.
- JCT gate N° 6/7 and JCT gate N° 8/9 are located next to the main JCT administration building and are used for external trucks, i.e. delivery of an export container or reception of an import container at JCT.
- JCT gate N° 10/11 and JCT gate N° 12/13 are located south of the JCT facility and are used for inter terminal traffic (ITT)

Segregating inter terminal traffic from 'regular' truck traffic definitely has a positive impact on the traffic flows. Compared to inter terminal traffic, the gate process to deliver an export container or to pick up an import container requires more administrative and physical interactions, hence this process requires more processing time and is less performant than the inter terminal gate process.

The gate complex for inter terminal traffic consists of 2 in-lanes and 2 out-lanes. In 2016, inter terminal traffic represented 4.4% of the total transhipment handled in the port of Colombo. On average, between 200 and 250 trucks per day need to pass through the inter terminal traffic gates of the various container terminals at Colombo port. The number of available lanes (2 in-lanes and 2 out-lanes) is more than sufficient to cope with these figures.

On the other hand, the import/export gate complex also consists of 2 in-lanes and 2 out-lanes but the number of trucks that need to pass this gate complex is much higher compared to inter terminal traffic. On average, between 900 and 1000 trucks per day need to pass the JCT gate complex for import/export handlings. In case the arrival process of the trucks would be equally distributed over 24 hours, the number of available in-lanes and out-lanes would be barely sufficient. Unfortunately, due to inefficient and time consuming administrative and financial processes at both the consignee and Customs level, the gate activity only starts just before noon time. Hence, all gate activity is compressed in about 12 working hours, instead of the 24 hours theoretically available. In order to handle the corresponding peak volumes of trucks arriving at the gates, the number of in-lanes and out-lanes need to be increased.

Similar to the other container terminals in the port of Colombo, the operations concept at JCT is based on RTGs (responsible for the stacking of laden containers at the container yard), RMGs (responsible for the handling of empty containers at the backyard of the terminal) and tractor-trailers (used for the horizontal transport between quayside and terminal yard or vice versa. For laden containers, the RTG concept is by far the most popular operations concept in the world. On the other hand, using RMGs for the stacking of empty containers is rather exceptional. RMGs allow for a very dense stacking of the empty containers but this type of machine is rather heavy and expensive to handle empty containers. In most other container terminals, empty containers are operated with Empty Container Handlers (ECH).

Currently, terminal operations at JCT are carried out using the Navis 3.7 terminal operating system (TOS). This is a rather outdated version of a terminal operating system with limited functionalities in terms of planning, organisation and communication. JCT terminal management confirmed that an upgrade to the state-of-the-art version Navis N4 is scheduled.

In terms of equipment and systems, the following recommendations can be made:

- Scrap/amortisation of old tractors and trailers (not in running condition anymore) - A huge area of several thousands of square metres is occupied with tractors and trailers that are out of service and which will/cannot be repaired anymore. Due to complicated administrative procedures, it seems to be difficult to amortise and/or scrap this fleet of equipment that by far exceeded both the financial and economic lifetime of these assets. Evacuation of this site could generate some revenues (scrap value) and would result in a much more clean, neat and tidy looking area with additional valuable space.
- RTG upgrade - In case additional RTGs will be required in the future, it is worthwhile to invest in a larger type of equipment, capable of stacking 1-over-6 high, instead of the current 1-over-5 machines. This can increase the yard capacity of the JCT terminal with almost 20% under the condition that the terminal pavement allows for stacking of one additional layer.
- TOS system upgrade - It is recommended to upgrade as quick as possible from the current ‘outdated’ terminal operating system Navis 3.7 version to the ‘state-of-the-art’ N4 version of the same supplier. This will enhance the terminal operations as well as the gate processes and the communication interfaces to the outer world: consignees, agents, shipping lines, port authority, customs, etc. While the conversion of a terminal operating system has a thorough impact on the ongoing terminal operations, it is of upmost importance to assign a dedicated team for this project. Compared to the current version of the TOS system, the newer version will add the following functionalities and improvements:
  - Advanced communication features and Electronic Data Interchange (EDI) options
  - Optimised yard planning
  - Optimised vessel planning
  - Scalable platform enabling gradual system development in line with volume increase
  - Real-time monitoring and management of all container handling equipment
  - Advanced yard options enabling optimised use of yard space and equipment fleet
  - Advanced rail options (if applicable)
  - Automated terminal option (supports unmanned automated equipment)

Additionally, the table below presents key observations and recommendations regarding JCT’s infrastructure and operational setup.

Table 3-1 JCT Key Observations & Recommendations

Category	Issue	Severity
Infrastructure	Quay extension with 120 metres (currently, the planning phase is in progress)	High
Equipment	Installation of 3 gantry cranes from UCT at JCT berths I-II	Medium

ADB

Technical Assistance Consultant’s Report

Project Number: 50184-001
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Democratic Socialist Republic of Sri Lanka: National Port Master Plan

(Financed by the Japan Fund for Poverty Reduction)

The Colombo Port Development Plan – Volume 2 (Part 2)

Prepared by

Maritime & Transport Business Solutions B.V. (MTBS)

Rotterdam, The Netherlands

For Sri Lanka Ports Authority

Asian Development Bank

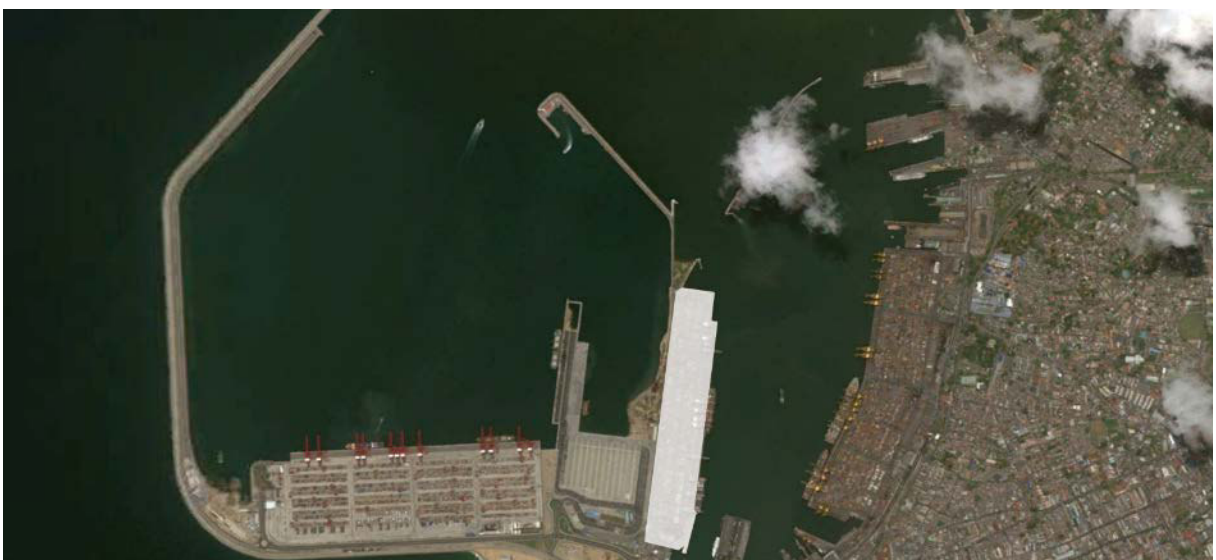
Category	Issue	Severity
Equipment	Technical and financial assessment on the feeder cranes at JCT I-II	Medium
Equipment	Scrap/amortisation of old tractors and trailers	Medium
Equipment	Over a period of time, the RTG equipment fleet need to be upgraded when additional investment for new RTGs and/or replacement of RTGs is required	Medium
Operations	Truck flow direction should be changed back into a one-directional flow	High
Logistics	Expansion of the gate complex for import/export containers	High
Systems	Upgrade of the Terminal Operating System (TOS) to N4 version	High

3.2.4 South Asia Gateway Terminal

South Asia Gateway Terminal (SAGT) is a Joint Venture between John Keells Holdings Plc, A.P. Møller-Mærsk Group, Evergreen International SA, Peony Investments SA, and the SLPA (15%). SAGT operates the terminal under a 30-year BOT arrangement that was signed in 1999. The table below provides an overview of the facilities at the terminal, as well as historic throughput figures.

The following key observations can be made regarding SAGT's facilities and throughput:

- Container volumes have increased from 0.9 M TEU in 2005 to 1.6 M TEU in 2016; however, container throughput volumes have declined since 2010, when throughput amounted to 2.0 M TEU.
- SAGT has a water depth of CD -15.0m.
- SAGT has a terminal depth of approximately 220m.
- Average crane productivity at SAGT is 29 moves per crane per hour.
- SAGT has several ongoing project to further increase efficiency, such as implementing expert decking and a new TOS module.



Category	Item	Value	Unit
	Reach Stackers	2	#
	Straddle Carriers	-	#
	RTGs / RMGs	31	#

Gantry Cranes	12	#
Mobile Harbour Cranes	-	#
Berth Length	940	m
Water Depth	15.0	m
Terminal Area	200,000	m^2
Yard Area	120,000	m^2
Terminal Capacity	1,950,000	TEU
Reefer Plugs	540	#

Item	Unit	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Throughput	x1,000 TEU	932	1,335	1,547	1,726	1,750	1,970	1,963	1,870	1,747	1,662	1,371	1,632

Operations
The following observations can be made from operation point of view:

SAGT operates 12 ship to shore gantry cranes. Out of the total fleet of 12 cranes, 3 gantry cranes are Post Panamax type with an outreach of 19 container rows across and 9 cranes are of the Super Post Panamax type with an outreach of 21 rows across.

The terminal operations concept is based on the classic Rubber Tyred Gantry (RTG) system for yard handling. The operations are driven by the NAVIS N4 Terminal Operating System (TOS), which is today's Global standard. About 60% of the container terminals world-wide are using this TOS system.

The terminal seems to be well managed. Current productivity is 29 moves per crane per hour; the target is set at 33 moves per hour. This is a competitive terminal operating performance. SAGT has projects ongoing to improve the terminal efficiency among others to apply Expert Decking, a new TOS module, to increase the efficiency of the yard. SAGT management is very focused on improving its service levels and as such to strengthen its competitive position in the Port of Colombo and in the region.

Figure 3-3 SAGT Terminal

The facility is blocked to future grow due to limited water depth – only 15 meters – and a very small footprint. While the SAGT terminal has a total quay length of 940 metres, the width of the terminal is only 220 m, which is extremely narrow for a modern container terminal. The very large container vessels, which have draughts exceeding 14.0m, can't berth at the SAGT terminal, so SAGT has to aim for another market segment than CICT and the future ECT and WCT terminal(s). Specifically, the SAGT is well suited to accommodate vessels

3.2.5 Colombo International Container Terminal

Colombo International Container Terminal (CICT) is a Joint Venture between China Merchant Port Holdings Ltd (85%) and the SLPA (15%). The CICT terminal is operated under a 35-year BOT agreement, which was signed in 2011. The table below provides an overview of the facilities at the terminal, as well as historic throughput figures.

The following key observations can be made regarding CICT's facilities and throughput:

- Container volumes have increased from 0.7 M TEU in 2014 to 2.0 M TEU in 2016.
- CICT has a water depth of CD -18.0m.
- CICT has a terminal depth of 435m.
- Average crane productivity at CICT is 33 moves per crane per hour.

Category	Item	Value	Unit
	Reach Stackers	6	#
	Straddle Carriers	-	#
	RTGs / RMGs	40	#
	Gantry Cranes	12	#
	Mobile Harbour Cranes	-	#
	Berth Length	1,200	m
	Water Depth	18.0	m
	Terminal Area	580,000	m^2
	Yard Area	400,000	m^2
	Terminal Capacity	2,800,000*	TEU
	Reefer Plugs	1,150	#

Item	Unit	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Throughput	x1,000 TEU	-	-	-	-	-	-	-	-	58	687	1,562	2,003

*The original design capacity of CICT was set at 2.4 M TEU per annum; however, during interviews and site visits it was noted that current capacity is estimated at 2.8 M TEU per annum.

Operations

The following observations can be made from operation point of view:

The CICT terminal is a modern container terminal equipped with 12 ship to shore gantry cranes (Super Post Panamax type) with an outreach of 23 container rows across. At the CICT quay, a water depth of 18 meter is available. The terminal is fully equipped to accept the newest 21,000 TEU vessels. The current crane productivity is 33 moves per crane per hour which is a very competitive handling speed. CICT is the only terminal in Colombo port handling the very large container vessels.

Similar to JCT and SAGT, the stacking of the containers at the terminal yard is managed with Rubber Tyred Gantries (RTGs). A total fleet of 40 RTGs is available for the terminal operations, capable of stacking the containers in the yard blocks six layers high and 6 rows wide which allows for a very high yard density.

In November 2017, CICT has completed a project to convert the complete fleet of diesel-driven Rubber Tyred Gantry cranes (RTGs) to electric-powered rubber-tyred gantry cranes or E-RTGs, making a major contribution to efforts by the Port of Colombo to create a sustainable and environmentally friendly port.

The terminal processes are steered by the corporate standard terminal system CTOS, which is a Chinese terminal operating system. CICT is working continuously on improving its service levels. The next step is automating the truck gates by applying Optical Character Recognition (OCR) technology.

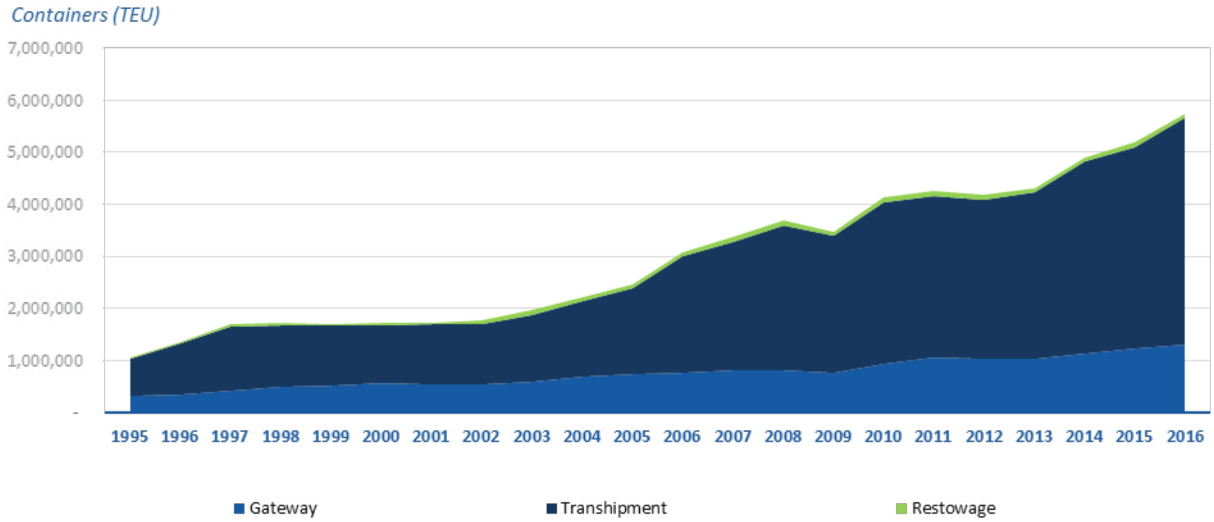
On the 3rd of July 2017, CICT won the award 'Best Container Terminal Asia' in the under four million TEUs category at the 2017 Asian Freight, Logistics and Supply Chain (AFLAS) Awards in Singapore.

3.3 Current situation and historic demand development

Historic Volumes

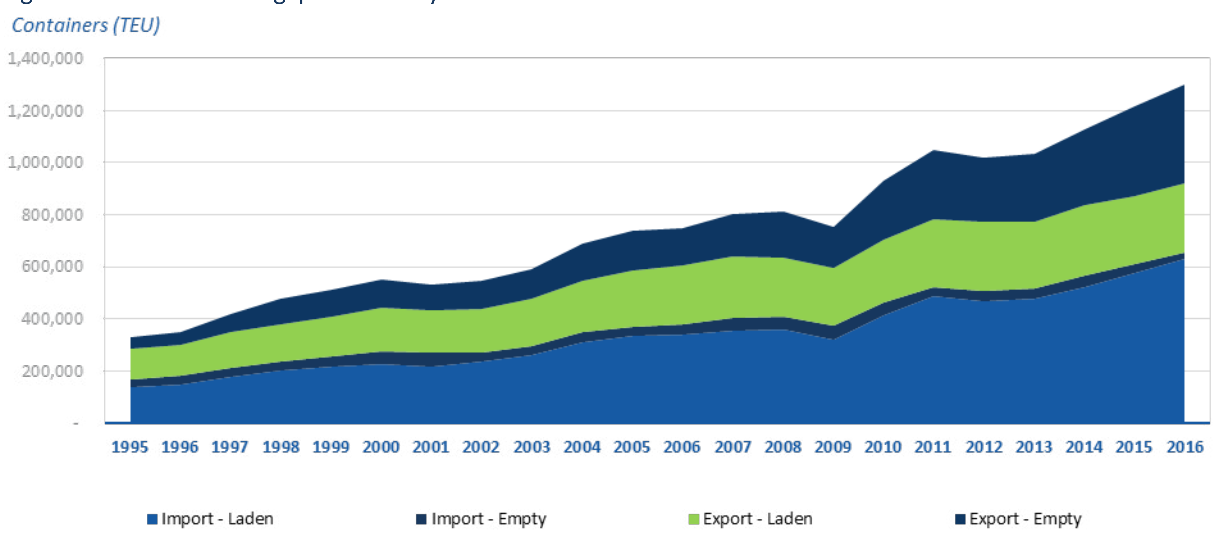
The container trade comprises the largest cargo segment in the port of Colombo in terms of volumes, accounting for approximately 90% of tonnage handled in 2016. The graph below presents the evolution of containerized cargo volumes over time, split between gateway, transhipment and re-stowage containers. It can be observed that container throughput increased from 1.0 M TEU in 1995 to 5.7 M TEU in 2016 (CAGR: 8.43%). Transhipment volumes account for the majority of container throughput in the port, with a share of 75.9% in 2016. This share has increased gradually, from 66.8% in 1995.

Figure 3-4 Container Throughput - Total Volumes



Subsequently, the figure below presents a more detailed view of the gateway containers, split between laden imports, empty imports, laden exports, and empty exports. It can be observed that nearly all imports are laden, whereas more than 50% of export containers were empty in 2016. Moreover, the share of laden export containers has decreased from 72.6% in 1995 to 41.8% in 2016; this indicates a growing trade imbalance.

Figure 3-5 Container Throughput - Gateway Volumes



3.4 Container Vessel Size Development

The shipping companies are continuously ordering more of the largest vessels, Ultra Large Container Vessels/Mega vessels, which are deployed on the main East West trades. This results in a cascading effect to smaller direct trades, which also receive larger vessels. The table below presents the various classes of container vessels, and assesses the ability of Colombo's south port and old basin to accommodate these classes.

Table 3.2 Container Vessel Types

Container vessels	TEU capacity	LOA (m)	Beam (m)	Draught (m)	CICT	SAGT	JCT-IV	JCT-III	JCT-I / II	UCT
Small Feeder	<1,000	70 - 160	13 - 25.5	4 -8.4	YES	YES	YES	YES	YES	YES
Feeder	1,000 - 1,999	146 - 205	22 - 32.2	8.3 - 11.0	YES	YES	YES	YES	YES	YES
Feedermax	2,000 - 2,999	189 - 237	22 - 32.2	11.5 - 12	YES	YES	YES	YES	YES	YES
Panamax	3,000 - 4,999	237 - 294	32.2	12.4	YES	YES	YES	YES	YES	YES
Post Panamax	5,000 - 9,999	300 - 366	49	15.2	YES	Partly	Partly	Partly	NO	NO
New Panamax	10,000 – 14,000	336 - 365	48.7	15.5	YES	Limited	Limited	NO	NO	NO
Ultra Large Container Vessel	14,000 and larger	366 - 400	49 - 59	15.2 - 16	YES	NO	NO	NO	NO	NO

From the table it can be observed that there are no size restrictions in the South Port. However, it is noted that CICT was designed for 366m LOA vessels; currently, the largest vessels have a length of 400m. Therefore, the terminal is not suited to handle three ULCS simultaneously.

The old basin has restrictions both in terms of water depth (maximum water depth of 15m, which results in a maximum arrival draft of 14m) and maximum vessel length (the maximum vessel length is around 300m - 350m). UCT in the port basin has limited depth and is restricted through its panamax cranes (16 containers across at limited heights). In the table "partly" would reflect the situation that either length or depth is an issue. The text "limited" would refer to the situation that both depth and length play a restrictive role. For example at Berth IV only two post panamax cranes (50t) are high enough to handle 14,000 TEU vessels. Vessels have to turn at berth IV to discharge also behind the deckhouse.[2] Whilst other 4 cranes at berth IV-III are post panamax cranes (41t) suited for 18 containers across under limited heights. At berth I-II only panamax cranes (35.5t) are available suitable for 13 containers across.

[2] This observation results in recommendations of new cranes and JCT V construction under JCT modernisation project.

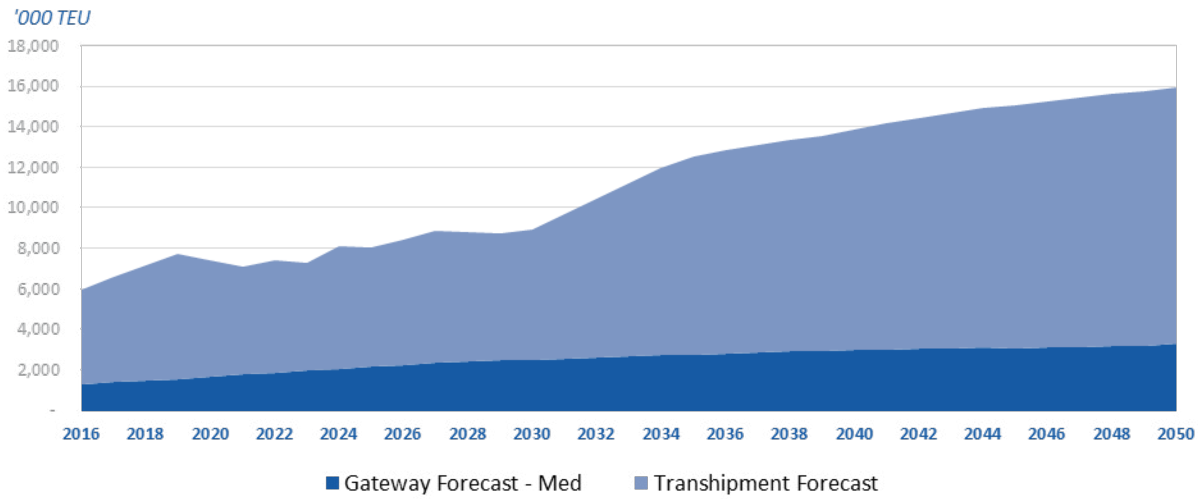
For the forecast, it is expected that South port will continue to receive the ULCS vessels and that future terminals will have a length of 1,400m instead of 1,200m. For the old basin it applies that the basin will be optimized to also be able to handle 10-13,000 TEU, 300m- 340m more dominantly. Further the basin will focus on larger feeder vessels (from 1,000 – 2,000 TEU today to 3,000 – 4,000 TEU tomorrow). The future vessel size may go beyond the 400m but as width would become a more difficult constraint it is expected that the future largest vessel size dominantly stay at length between 400m and 450m.

3.5 Forecast

Base Case

The figure below presents the Base Case container demand forecast for the port of Colombo, split between gateway and transhipment containers. In the Base Case, it is assumed that Hambantota does not develop any transhipment capabilities and handling is limited to gateway cargo in that port. In total, Sri Lankan transhipment container throughput is estimated to reach 12.7 M TEU by 2050; total Sri Lankan gateway container demand is estimated to reach 3.2 M TEU by 2050. The drops in the period 2020 and 2024 are related to assumed growth in direct trades and increased competition from other transhipment hubs.

Figure 3-6 Containers - Base Case Forecast



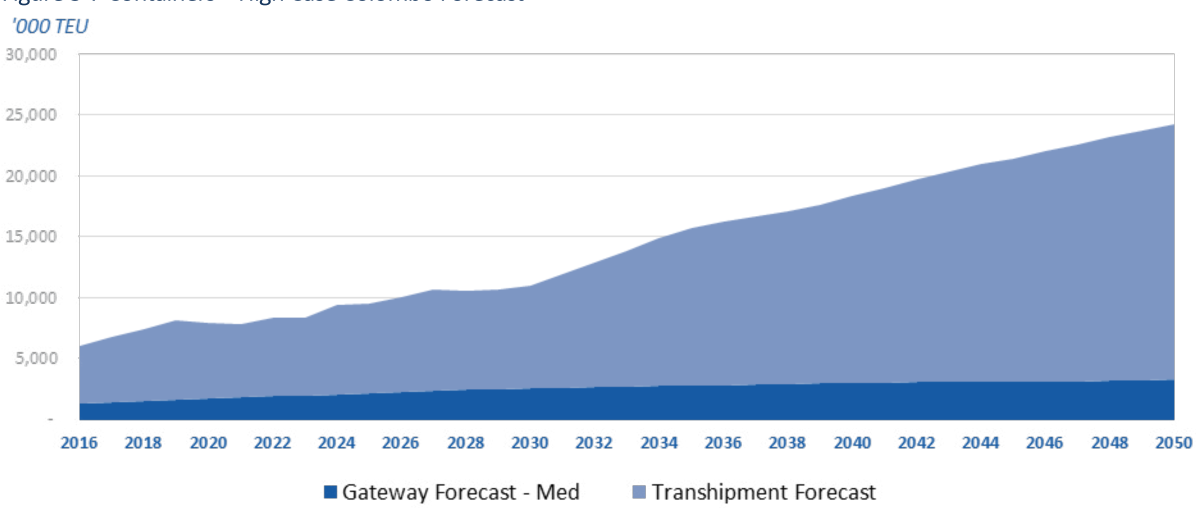
Subsequently, Table 3-3 provides an overview of the Base Case forecast Colombo which is the Base Case gateway forecast and the Base Case transhipment forecast. In the Base Case, it is assumed that transhipment will not be brought to Hambantota. In this scenario, the port will merely focus on industrial developments and shall not become a main competitor for transhipment in Colombo. Obviously, Hambantota will handle containerized cargoes but this will merely consist of gateway (import/exports) cargoes. Colombo faces competition from regional transhipment hubs. Assumptions of the transhipment forecast are outlined in Appendix II.

Table 3-4: Forecast Colombo Base Case

		2016	2020	2025	2030	2050
Gateway						
National Demand	'000 TEU	1,300	1,660	2,197	2,630	3,737
Colombo Share	%	100.0%	99.0%	98.0%	95.0%	88.0%
Colombo Demand	'000 TEU	1,300	1,643	2,153	2,498	3,289
Transhipment						
National Demand	'000 TEU	4,355	5,775	5,873	6,433	12,671
Colombo Share	%	100.0%	100.0%	100.0%	100.0%	100.0%
Colombo Demand	'000 TEU	4,355	5,775	5,873	6,433	12,671
Total						
Colombo Demand	**'000 TEU**	**5,655**	**7,418**	**8,026**	**8,931**	**15,960**

High Case
The High Case assumes that Colombo remains the dominant regional transhipment hub, combined with a slower development of direct trades. Under the High Case, gateway container volumes in the Port of Colombo follow the high economic growth scenario.

Figure 3-7 Containers – High Case Colombo Forecast



The table below details the forecasts. The gateway forecast follows the high growth economic scenario, the transhipment forecast for Port of Colombo in the High Case reaches approximately 21.0 M TEU in 2050.

Table 3-5 Containers - High Case Colombo Forecast

		2016	2020	2025	2030	2050
Gateway						
National Demand	‘000 TEU	1,300	1,660	2,252	2,855	4,549
Colombo Share	%	100.0%	99.0%	98.0%	95.0%	88.0%
Colombo Demand	‘000 TEU	1,300	1,643	2,207	2,713	4,003
Transhipment						
National Demand	‘000 TEU	4,355	6,304	7,311	8,473	20,996
Colombo Share	%	100.0%	100.0%	100.0%	100.0%	100.0%
Colombo Demand	‘000 TEU	4,355	6,304	7,311	8,473	20,996
Total						
Colombo Demand	**‘000 TEU**	5,655	7,947	9,518	11,186	24,998

Potential Hambantota Transhipment Development.

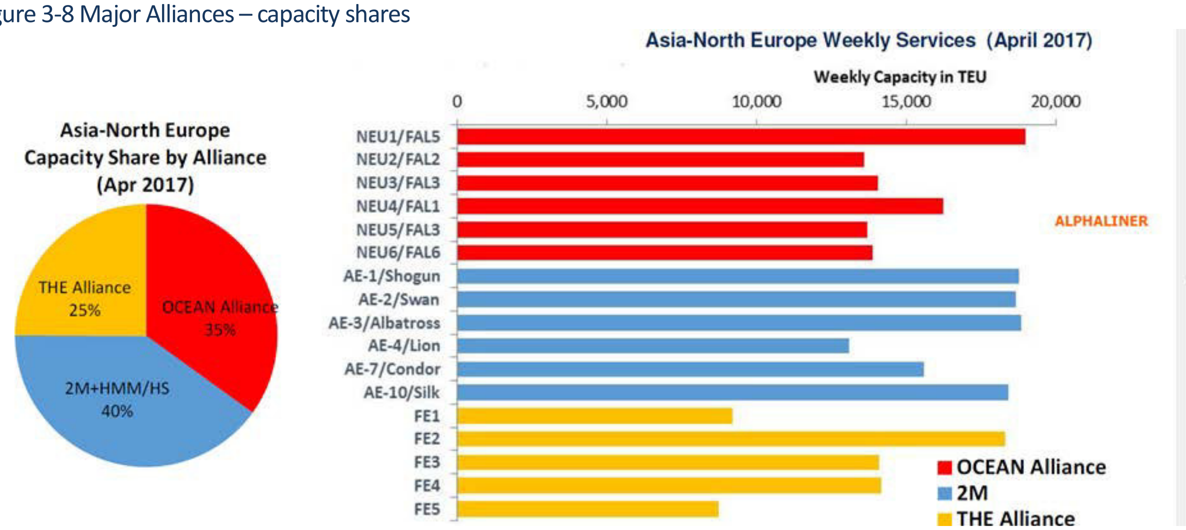
To account for possible development of transhipment in Hambantota, an allocation scenario is presented below. The 40% allocation of transhipment to Hambantota under this scenario is based on the effect of the Alliances. There are three main Alliances on the main east west trades.

- 2M consisting of Maersk Line, MSC and Hyundai
- Ocean Alliance consisting of COSCO, CMA CGM (incl. APL), Evergreen and OOCL
- The Alliance consisting of United Arab Shipping, Yang Ming, Hapag-Lloyd, MOL, “K”- Line and NYK

Today, these alliances have shares of respectively 40%, 35%, and 25% on the main East West Trades. Within The Alliance, the Japanese carriers are trying to combine their shipping lines into “ONE”. Under the Base Case scenario, it is expected that Ocean Alliance will grow in future, as they have a substantial amount of additional mega vessels on order (similar to what Maersk and MSC have done rather recently); The Alliance is estimated to experience less growth, due to a smaller current orderbook. Furthermore, it is assumed that the Chinese interests in Hambantota will attract Ocean Alliance to call at Hambantota in future.

Taking these developments into account, it is expected that Hambantota will experience (rapid) growth in their transhipment business, resulting in a reduced market share for Colombo, where MSC and Maersk Line remain the largest carriers. Over time, Hambantota’s transhipment share is expected to grow to 40%, mainly consisting of services by Ocean Alliance members and other feeder services that connect to these main lines.

Figure 3-8 Major Alliances – capacity shares



Additionally, it is expected that the vessels that call at Hambantota for transhipment cargo also load/discharge some gateway cargo. Hence, Hambantota is assumed to capture a larger share of the gateway container volumes under the Hambantota development scenario. Specifically, 67% of gateway cargo is allocated to Colombo, 30% is allocated to Hambantota, and the remaining 3% of gateway cargo in 2050 in this scenario flows to Trincomalee. The two tables below provide the forecasts for the Base Case and High Case container forecasts, assuming development of Hambantota is successful.

Table 3-6 Colombo Container Demand - Base Case Forecast with Hambantota Development

		2016	2020	2025	2030	2050
Gateway						
National Demand	'000 TEU	1,300	1,660	2,197	2,630	3,737
Colombo Share	%	100.0%	99.0%	94.2%	86.3%	67.0%
Colombo Demand	'000 TEU	1,300	1,643	2,068	2,270	2,504
Transhipment						
National Demand	'000 TEU	4,355	5,775	5,873	6,433	12,671
Colombo Share	%	100.0%	100.0%	100.0%	88.6%	60.0%
Colombo Demand	'000 TEU	4,355	5,775	5,873	5,698	7,602
Total Colombo Demand	**'000 TEU**	**5,655**	**7,418**	**7,941**	**7,968**	**10,106**

Table 3-7 Colombo Container Demand - High Case Forecast with Hambantota Development

		2016	2020	2025	2030	2050
Gateway						
National Demand	'000 TEU	1,300	1,660	2,252	2,855	4,549
Colombo Share	%	100.0%	99.0%	94.2%	86.3%	67.0%
Colombo Demand	'000 TEU	1,300	1,643	2,121	2,464	3,048
Transhipment						
National Demand	'000 TEU	4,355	6,304	7,311	8,473	20,996
Colombo Share	%	100.0%	100.0%	100.0%	88.6%	60.0%
Colombo Demand	'000 TEU	4,355	6,304	7,311	7,505	12,597
Total Colombo Demand	**'000 TEU**	**5,655**	**7,018**	**9,432**	**9,969**	**15,645**

The two tables show that major development of Hambantota in the transhipment segment would harm the development plans of Colombo for the same market.

3.6 Capacity Development & Requirement

In this section, we will look at the outlook of the current infrastructure and facilities, to assess the future capacity of all current facilities. Subsequently, we will compare the resulting capacity to estimated demand, for each of the planning horizons.

3.6.1 Outlook for Current Capacity

From the physical and operational assessments, as summarized in section 3.2.1, the following is concluded:

- The UCT facility is inadequate to efficiently handle containerized cargo, given water depth alongside the berths and terminal dimensions. As such, it is proposed that container activities are removed from the UCT area in the short term, once the East Container Terminal (ECT) becomes operational. Specifically, it is foreseen that UCT will be phased out after 2019.
- The JCT facility is currently one of the most important container terminals in the port of Colombo, handling 41.2% of containerized cargo in 2015. However, water depth limitations prohibit accommodation of the largest container vessels; this issue is not expected to be resolved as the quay wall structure hampers dredging activities alongside the berth. As additional deep-water capacity comes on stream in the South Harbour, it is expected that feeder services will increasingly call at the South Harbour terminals, in order to avoid costs related to Inter Terminal Trucking (ITT). If no action is taken, it is expected that JCT's market share will deteriorate in the near future. *This analysis will make a conservative estimate by using the worst-case scenario that JCT will be phased out in about 15 years.*
- The CICT terminal is modern, providing adequate water depth for the largest container vessels, best practice terminal dimensions and layout, modern equipment, and benchmark operational service levels. As such, it is expected that CICT will remain functional over the forecast period. Additionally, capacity is

expected to increase from the current 2.8 M TEU to 2.9 M TEU, as operational efficiency measures are implemented.

- Similar to JCT, the SAGT terminal lacks adequate water depth to handle the largest container vessels. Moreover, the terminal has limited yard depth, hampering efficient operations. Nevertheless, the terminal boasts high service levels, due to modern equipment and IT systems. Additionally, the SAGT terminal can be combined with the adjacent deep-water ECT in the future, resulting in more efficient terminal dimensions and enabling the terminal to handle both main liners and feeder vessels. Hence, it is expected that SAGT will remain functional over the forecast period. Additionally, capacity is expected to increase from the current 2.0 M TEU to 2.1 M TEU, as operational efficiency measures are implemented. Clearly additional upsides on efficiency gains could be reached through synergies between ECT and SAGT, however these additional gains are not incorporated to the maximum for conservative reasons.

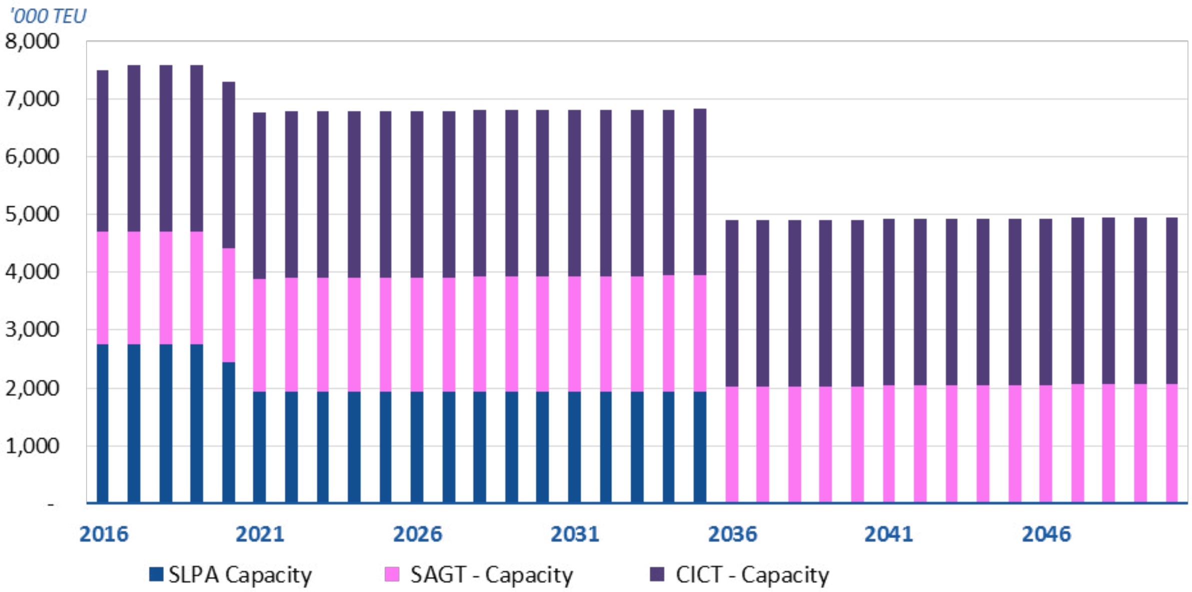
In line with the assumptions posited above, the table below presents the estimated capacity development of each of the current container terminals, as well as the operational productivities applied to calculate the future capacities.

Table 3-8 Containers - Capacity Development Assumptions

Item	Unit	2016	2020	2025	2030	2050
UCT						
UCT Berth Productivity	TEU / m Quay	508	-	-	-	-
UCT Berth Length	m	590	-	-	-	-
UCT Capacity	**'000 TEU**	**300**	**-**	**-**	**-**	**-**
JCT						
JCT Berth Productivity	TEU / m Quay	1,492	1,492	1,492	1,492	-
JCT Berth Length	m	1,642	1,642	1,642	1,642	-
JCT Capacity	**'000 TEU**	**2,450**	**2,450**	**2,450**	**2,450**	**-**
SAGT – Phase I						
SAGT Berth Productivity	TEU / m Quay	2,074	2,108	2,108	2,126	2,200
SAGT Berth Length	m	940	940	940	940	940
SAGT Capacity	**'000 TEU**	**1,950**	**1,981**	**1,981**	**1,999**	**2,068**
CICT						
CICT Berth Productivity	TEU / m Quay	2,333	2,400	2,400	2,400	2,400
CICT Berth Length	m	1,200	1,200	1,200	1,200	1,200
CICT Capacity	**'000 TEU**	**2,800**	**2,880**	**2,880**	**2,880**	**2,880**
Total Capacity	'000 TEU	7,500	7,311	7,311	4,879	4,948

The figure below plots the resulting capacity development of the current facilities in the port of Colombo over the forecast period. Over the long term, capacity of current facilities is estimated to decline from 7.5 M TEU to 4.9 M TEU, as UCT and JCT are phased out in the conservative estimate. The decline in capacity is slightly compensated by the increased efficiency of the SAGT and CICT terminals.

Figure 3-9 Containers - Capacity Development of Current Facilities



3.6.2 Development Requirement

Based on the demand forecast, presented in section 3.5, and the capacity development of current facilities, discussed in section 3.6, the capacity gap for each of the planning horizons is derived. The figure below plots the Base Case and High Case demand against the capacity in the port.

It can be observed that, under the Base Case scenario, the capacity gap reaches 1.2 M TEU by 2025; subsequently, the capacity gap further increases to 11.0 M TEU by 2050. Under the High Case scenario assumptions, the capacity gap will be more severe, with an estimated capacity gap of 20.0 M TEU by 2050.

The figure displays the expected container volumes under the Base Case and High Case, with the current capacity in the Port of Colombo. The graphic shows that there is a large demand for additional port development to fill the gap.

Figure 3-10 Containers - Supply vs Demand

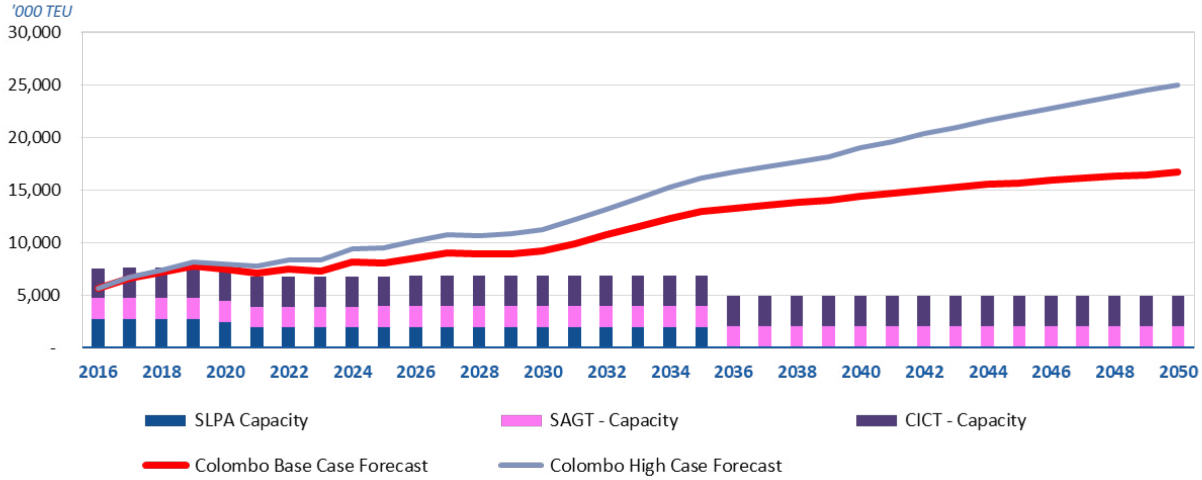


Table 3-9 Containers – Capacity / Supply gap

		2016	2020	2025	2030	2050
Base Case						
Demand	'000 TEU	5,655	7,418	8,026	8,931	15,960
Capacity	'000 TEU	7,500	7,294	6,789	6,806	4,948
Capacity Gap	'000 TEU	1,845	(124)	(1,237)	(2,125)	(11,012)
High Case						
Demand	'000 TEU	5,655	7,947	9,518	11,186	24,998
Capacity	'000 TEU	7,500	7,294	6,789	6,806	4,948
Capacity Gap	'000 TEU	1,845	(653)	(2,729)	(4,380)	(20,050)

The table below provides an overview of the required additional facilities to accommodate the forecast demand, presented as the required additional quay length and storage yard area for each of the planning horizons. For the calculation of the required quay length and storage yard area, the following assumptions have been applied:

- Newly introduced facilities will have an average berth productivity of 2,400 TEU per m quay over the forecast period.

Table 3-10 Containers - Required Infrastructure Development

		2016	2020	2025	2030	2050
Base Case						
Capacity Gap	‘000 TEU	1,845	(124)	(1,237)	(2,125)	(11,012)
Quay Productivity*	TEU / m Quay	2,400	2,400	2,400	2,400	2,400
Additional Quay	m	-	52	515	885	4,588
High Case						
Capacity Gap	‘000 TEU	1,845	(653)	(2,722)	(4,380)	(20,050)
Quay Productivity*	TEU / m Quay	2,400	2,400	2,400	2,400	2,400
Additional Quay	m	-	272	1,134	1,825	8,354

*Productivities for new developments.

The following factors need to be considered when planning new container terminal facilities in the port of Colombo:

- Water depth needs to exceed CD -17.5m, to enable accommodation of the largest container vessels.
- The terminal needs to have sufficient depth, to enable efficient operations.
- Terminals should be planned near each other if possible, to reduce costs related to Inter Terminal Trucking and to enable centralized stripping and stuffing activities for Multi Country Consolidation (MCC) cargo.
- New terminals should be able to access the Port Access Elevated Highway (PAEH) or should otherwise have adequate connectivity to the hinterland.

3.6.3 Development Options

In the SLPA Master Plan, the following development options have been proposed:

- South Harbour
  - East Container Terminal (ECT) phase 1 – The ECT phase 1 development has already been completed and can commence operations once an operator has been selected.
  - ECT phase 2 – The ECT phase 2 development is foreseen for the short term (< 5 years) and will be developed by the selected ECT investor.
  - Integration of ECT and SAGT I – The SAGT I/ECT integration can be implemented at any time.
  - SAGT Phase II – Extension of SAGT is only feasible once the North Port is developed, as it entails the removal of the current northern breakwater, resulting in unsheltered operations if the North Port breakwater is not developed. As such, the integration and extension project is a long term (30 years) project.
  - West Container Terminal (WCT) phase 1 – In the 2016 SLPA Master Plan, the WCT phase 1 development will be required by 2023, once the ECT fills up.
  - WCT phase 2 - The WCT phase 2 development comprises the extension of the WCT, which is envisioned for the long term (30 years). It is noted that such a development would require the removal and reconstruction of the western South Harbour breakwater, making it a very costly development.
- North Port – Once the South Harbour is fully developed (with the exception of the SAGT/ECT integration, which can only be implemented after the North Port development), the North Port development is envisioned to accommodate growing demand. It should be noted that integration of ECT and SAGT, like

WCT 2 expansion, also requires a demolishment of the breakwater. These are typical costs one like to possibly avoid in port development.

3.7 Recommendations & Short Term Priority Projects

The main recommendations related to the container business are to:

R1. **East Container Terminal (ECT)** ads valuable capacity which is needed at the port. The **concession should be granted** as soon as possible to safeguard Colombo's competitive position.

R2. **JCT modernisation** should be implemented to stretch the terminal's lifespan and prevent equipment malfunctions.

The following short-term priority projects, which will be further discussed in section 15, result from the container activities assessment:

SP1. **JCT Modernisation Plan –** A modernisation plan must be developed for JCT, to enable the terminal to continue performing container handling operations safely and reliably over the coming years, after which the container activities are to be phased out from the JCT location.

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4 Dry Bulk

4.1 Introduction

This chapter aims to define the development need for dry bulk business and the development options to cater for the required capacity. The chapter is structured as follows:

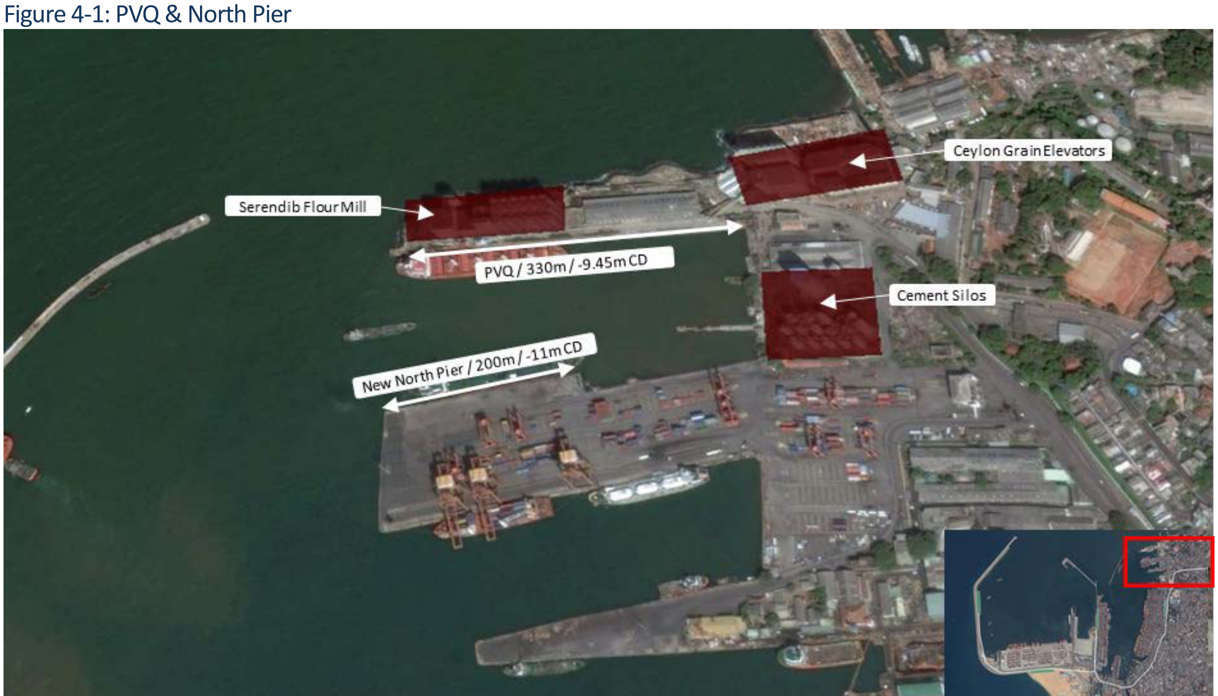
- This chapter starts in section 4.2, with an overview of the current dry bulk facilities for fertiliser, cement, and wheat / maize / corn.
- Section 4.3 presents the current and historic demand development - Since 2007, a stable total volume between 2.5 Mtpa and 2.7 Mtpa.
- Section 4.4 provides an overview of the global and expected country-specific vessel trends for the dry bulk trades.
- Section 4.5 presents the dry bulk volume projection up to 2050 - A medium term increase towards 3.5 Mtpa is estimated, as a result of a temporary increase in cement demand for large-scale infrastructure projects.
- The capacity need is estimated in section 4.6 - A dedicated berth is required for cement, as well as for wheat / maize / corn.
- Section 4.7 concludes with the recommended short term priority projects – The construction of a dedicated berth for grains and cement and the establishment of a PVQ Upgrade Plan are proposed as short-term priority projects relating to Dry Bulk.

4.2 Overview current dry bulk facilities

Facilities & Capacities

Dry bulk is mainly handled in the north-eastern corner of Colombo port where Tokyo cement has a bagging facility for cement and grain operations are carried out. Figure 4-1 presents an overview of the terminals and capacities available

Figure 4-1: PVQ & North Pier



Commodity handled	Operators	Terminal	Quay Side	Estimated Capacity ('000 Tons)	2016 Throughput ('000 Tons)	Free Capacity ('000 Tons)
Wheat / Maize / Corn	Ceylon Grain Elevators (Prima Group) / Serendib Flour Mill	PVQ	New North Pier &PVQ	900	190	710
Cement	Tokyo Cement Group & INSEE Cement Group	Cement Silos	New North Pier &PVQ	2,250	2,185	65
Fertilisers	Various	*No dedicated Terminal*	New North Pier & BQ	-	313	-

Dry bulk operations in Colombo face several key issues; these issues are listed in the table below.

Table 4-1 Dry Bulk - Operational Bottlenecks

Category	Issue	Severity
PVQ Activities		
Infrastructure	Quay wall PVQ is deteriorated	Low
Infrastructure	CD -9.0m water depth is insufficient for large bulk carriers	High
Infrastructure	Ceylon Grain Elevators quay warehouse is deteriorated (abandoned)	Medium
Equipment	Grain operations carried out with 2 suction cranes with substandard performance (240t/hr)	Low
Equipment	PVQ operations carried out with an inefficient belt system to a newly developed warehouse (240 t/hr)	Low
Berth	Berth occupancy is too high, causing delays.	Medium
Cement		
Infrastructure	CD -11.0m water depth is insufficient for large bulk carriers	Low
Infrastructure	200m quay is insufficient for large bulk carriers	Low
Equipment	Discharge rate is substandard	Low
Berth	Berth occupancy is too high causing delays.	Medium
Fertilisers		
Equipment	Mobile equipment lacks efficiency	Low

4.3 Current situation and historic demand development

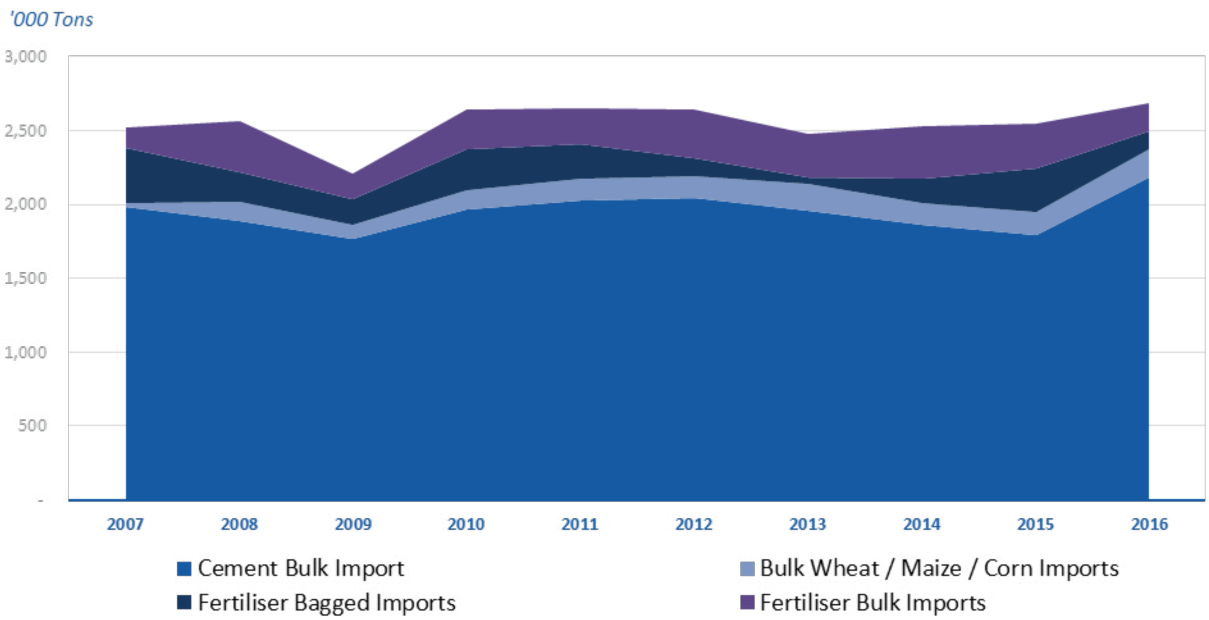
Historic Volumes

Dry bulk handling in the port of Colombo takes the following forms:

- Bulk cement imports
- Bulk wheat, maize and corn imports
- Bulk and bagged fertiliser imports

Bulk cement imports account for the majority of the dry bulk volumes at the port of Colombo. The cement is bagged at the Tokyo cement factory and distributed further inland. Wheat, maize and corn imports show little change historically. Fertiliser imports are split in bulk and bagged imports. The bulk imports are directly processed in mobile bagging facilities and distributed further.

Figure 4-2: Historic Throughput Dry Bulk



('000 Tons)	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Bulk Cement Import	1,985	1,889	1,763	1,971	2,027	2,047	1,961	1,863	1,795	2,185
Bulk Wheat / Maize / Corn Imports	26	129	96	127	147	147	178	146	157	190
Fertiliser Bagged Imports	372	202	175	275	239	119	44	165	292	118
Fertiliser Bulk Imports	136	342	172	269	235	334	291	355	307	196
Total	**2,518**	**2,562**	**2,206**	**2,642**	**2,648**	**2,646**	**2,475**	**2,528**	**2,550**	**2,689**

4.4 Dry Bulk Vessel Size Developments

In the dry bulk market, vessel sizes are continuously increasing to achieve economies of scale. Today, most of the grain trades are handled by panamax vessels; these panama vessels are changing due to the new panamax canal dimensions. Port of Colombo cannot benefit from the size increase, due to water depth constraints at PVQ, which has a water depth of 9.1m.

Table 4-2 Dry Bulk Vessel Classes

Dry bulk vessels	DWT (tons)	LOA (m)	Beam (m)	Draught (m)	Able to call old basin?	Future at PVQ*
Handysize	10,000 - 40,000	140 - 180m	22 - 28m	8 - 10.5m	YES	YES
Handymax (supramax)	40,000 - 65,000	169 - 200m	31 - 32.4m	9.8 - 12.3m	Partly	YES
Panamax (incl. new)	67,000 - 99,000	223 - 233m	32 - 48m	13.2 - 14.1m	NO	YES
Capesize	100,000 - 200,000	250 - 300m	43 - 50m	14.2 - 18.5m	NO	NO
UltraLarge cape	250,000 - 320,000 +	300 - 360m	50 - 64m	18 - 24m	NO	NO

Source: Clarksons; MTBS

*Assuming that the PVQ quay wall is renewed and deepened.

It is noted that Sri Lanka should prepare to scale up existing facilities in the dry bulk trades, in order to capitalize on the economies of scale achieved by using larger vessels. In order to support competitiveness of the flour mill and the cement industry in Colombo, the PVQ basin needs to be deepened to handle 13m drafted vessels.

This is still insufficient to handle the largest dry bulk vessels, but small (new) panamax vessels of around 80,000 DWT are considered sufficient to efficiently transport Sri Lanka's grain volumes. Currently, handymax vessels with capacities of approximately 40,000 DWT are predominantly deployed for this trade.

In the cement trade, vessel sizes globally have not increased significantly; the most common vessel types remain around 35,000 DWT to 45,000 DWT. Often, either larger vessels cannot be handled at the loading and/or discharge port, or the facilities at either end are not suited for volumes that would require larger vessels.

The expectation for the future grain trade is that the Port of Colombo will receive (new) panamax vessels with lengths of up to 230m and draughts of up to 13m. For the longer term future, a berth that enables accommodation of vessels with draughts of up to 14m can be realized in the envisaged north port development.

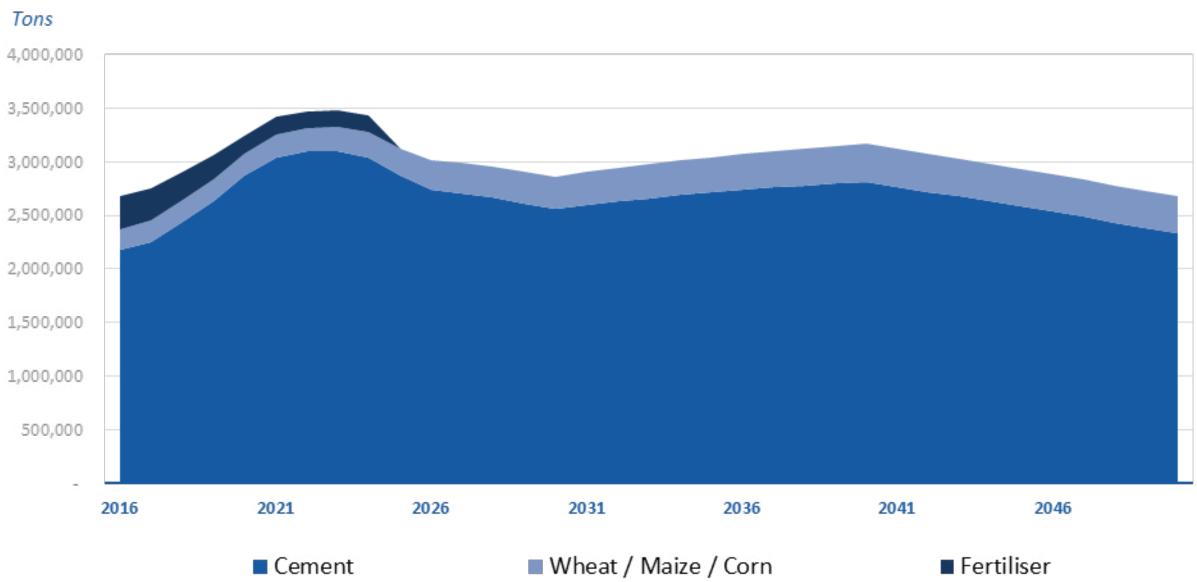
The expectation for the future cement trade is that the Port of Colombo will receive cement vessels with deeper draught (11m – 12m), but the size is not expected to increase a lot.

4.5 Forecasts

The figure below presents the forecasts for the three dry bulk commodities. For the forecast, the following key assumptions are made regarding expected developments:

- **Fertiliser –** The imports of fertilisers is expected to almost entirely diminish, as Sri Lanka is expected to develop fertiliser production in the years to come. This would be cost effective compared to the volatile imports. It is expected that some fertiliser imports will remain, but it is expected that these volumes will increasingly be imported in containerised form, thereby reducing the need for bulk capacity.
- **Cement –** The cement imports are subject to several key developments:
  - The Megapolis developments boost the imports in the period until 2025.
  - Although national cement demand rises, the share of Colombo stays more or less the same due to demand being serviced through Trincomalee and Hambantota.
  - After 2040, the stagnant Sri Lankan population is expected to result in a reduction of cement demand.
- **Wheat / Maize / Corn –** The demand for these products is expected to rise slightly as the export business picks up. However, an envisaged efficient Trincomalee-Colombo corridor would increase the ability of the port of Trincomalee to service the Western province.

Figure 4-3: Colombo Forecast Dry Bulk



('000 Tons)	2016	2020	2025	2030	2050
Cement	2,179	2,866	2,871	2,560	2,334
Wheat / Maize / Corn	190	211	257	302	342
Fertiliser	314	160	-	-	-
Total	**2,683**	**3,237**	**3,128**	**2,861**	**2,676**

4.6 Capacity Development & Requirement

4.6.1 Cement

For cement, the current terminals are working at maximum, with a bottleneck at the sea side operations. In the period up to 2025, the imports will reach a peak volumes, resulting in the need for a dedicated deep-water berth. No current SLPA plans exist regarding dry bulk operations in the documents reviewed.

The table below presents the results of the capacity calculations, followed by the assumptions. The capacity requirements per timeframe are:
2025 – In the immediate future, cement operations need a dedicated berth with a depth of 13.5m, to accommodate a design vessel with a draft of 12.5m.
2030 & 2050 – Stabilisation of demand, no additional capacity needed.

Table 4-3: Capacity Requirement Cement

Item	Unit	2016	2020	2025	2030	2050
Cement Forecast	'000 Tons	2,179	2,866	2,871	2,560	2,334
Berth Requirements	#	1	1	1	1	1
Quay Wall Requirement	m	230	230	230	230	230
Terminal Area Requirement	h	1.5	2.0	2.3	2.2	2.1

Assumptions Capacity Requirements

- Quay Wall:
  - LOA 200 m - Draught 12.5 m of design vessel
  - Discharge rate of 700 tons / hr
  - Berth Occupancy 55%
- Terminal Area:
  - Benchmark capacity 1.4 M Tons per ha (Jurong Cement Terminal)

Formulas used:

(1) $Berth\ Capacity = Discharge\ Rate * Berth\ Occupancy * Operational\ Hours\ Per\ Year$
(2) $Berth\ Requirement\ (whole\ numbers) = \frac{Forecast}{Berth\ Capacity}$
(3) $Quay\ Wall\ Requirement = Number\ of\ Berths * LOA\ Design\ Vessel + ((Number\ of\ Berths + 1) * 15)$
(4) $Terminal\ Area\ Requirement = \frac{Forecast}{Productivity\ Benchmark\ Terminal}$

Example 2030:

(1) 700 * 0.55*7,200= 2,772,000 tons
(2) 2,560,000 / 2,772,000 = 1 (roundup)
(3) 1 * 200 + (2*15)=230m
(4) 2,560,000 / 1,415,094 = 2.2 ha

4.6.2 Wheat / Maize / Corn

The grain throughputs are forecasted to increase gradually, for which the terminal has ample capacity. The future capacity requirements per time frame are:
2025 – In the immediate future operations need a dedicated berth with a depth of 14 m.
2030 & 2050 – Stabilisation of demand, no additional capacity needed.

Table 4-4: Capacity Requirement Wheat / Maize / Corn

Item	Unit	2016	2020	2025	2030	2050
Cement Forecast	'000 Tons	190	211	257	302	342
Berth Requirements	#	1	1	1	1	1
Quay Wall Requirement	m	280	280	280	280	280
Terminal Area Requirement	ha	0.8	0.8	1.0	1.2	1.4

Assumptions Capacity Requirements

- Quay Wall:
  - LOA 250 m
  - Draught 13m
  - Discharge rate of 700 tons / hr
  - Berth Occupancy of 55%
- Terminal Area:
  - Benchmark capacity - 250,000 Tons per ha (Current grain elevators)

Formulas used:

(1) $Berth\ Capacity = Discharge\ Rate * Berth\ Occupancy * Operational\ Hours\ Per\ Year$
(2) $Berth\ Requirement\ (whole\ numbers) = \frac{Forecast}{Berth\ Capacity}$
(3) $Quay\ Wall\ Requirement = Berth\ Requirement * LOA\ Design\ Vessel + (2 * 15)$
(4) $Terminal\ Area\ Requirement = \frac{Forecast}{Benchmark\ Capacity\ Terminal}$

Example 2030:

(1) 700 * 0.55*7,200= 2,772,000 tons
(2) 302,000 / 2,772,000 = 1 (roundup)
(3) 1 * 250 + (2*15)=280m
(4) 302,000 / 250,000 = 1.2 ha

4.7 Recommendations and Short Term Priority Projects

The main recommendation is to:

R3. **Increase the depth in the PVQ basin** to allow deeper draft grain and cement carriers, with a draft of up to 13m.

This recommendation leads to the following short-term priority projects, which will be further discussed in section 15.

SP2. **Dedicated berth for grains and cement –** The dedicated berth can solve immediate sea side operations bottle necks and the accompanying depth issues.

SP3. **PVQ Upgrade Plan –** To handle bigger vessel dredging works might dredging if possible is needed.

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5 Liquid Bulk

5.1 Introduction

This chapter aims to define the development need for the liquid bulk business and the development options to realise the required capacity. Commodities labelled as liquid bulk in this section are crude oil, refined oil (consisting of various many petroleum based products) and LNG as a future commodity.

The chapter is structured as follows:

- This chapter starts in section 5.2 with an overview of the current liquid bulk facilities: Colombo port has 3 CBM's for crude and LPG imports, a dolphin jetty for refined oils and loading arm.
- Section 5.3 presents the current and historic demand development: Historic liquid bulk throughputs are relatively constant at 4 M tons per annum.
- Section 5.4 presents the vessel size development and its effects on the port of Colombo: Small and medium tankers will keep dominating the supply to Colombo till additional facilities are developed.
- Section 5.5 provides the liquid bulk volume projection up to 2050: The growth in liquid bulk is expected to be driven by LNG imports.
- The capacity need is estimated in section 5.6: LNG handling capacity and location of the import terminal is combined with the operational state of the current dolphin jetty which are the main issues for liquid bulk facilities.
- Section 5.7 concludes with the recommended short term priority projects:

5.2 Overview Current Liquid bulk facilities

Facilities & Capacities

The liquid bulk volumes at Colombo are handled at the following facilities:

- SBM1 – located offshore. Mainly used for import of crude oil, which is pumped into Sapugaskanda refinery and the Orugodawatta tank farm.
- SBM2 – located offshore. Mainly used for import of refined oil, which is pumped into the Muthurajawela tank farm or the Kollonnawa tank farm
- Dolphin jetty at mid-breakwater of the old port basin – Mainly used for import of refined products (Fuel Oil, Diesel Petrol and lube oil). The lube oil is connected to the Kollonnawa tank farm, the Muthurajawela tank farm, and the Bloemandhal Lanka Marine Service depot. Bunkering is also possible at the Dolphin jetty.
- South jetty – located near UCT pier; the south jetty is used for bunkering of vessels.
- Shell LPG CBM – A mooring point to discharge LPG.

Figure 5-1: Oil Supply Chain Overview

Facility	Capacity
Crude Oils	
SBM 1 Jetty	• Pump capacity: minimum 1,406 tons/hr • 180,000 DWT • LOA 298m, beam 43m • Draughts 18.9m
Sapugaskanda Refinery	• 2.5 M tons / annum distilling capacity • 0.54 M tons' crude storage capacity
Orugodawatta Tank Farm	• 0.16 M tons' storage capacity
Refined Oils	

Dolphin Jetty	• Pump capacity: minimum 278 tons/hr • 40,000 DWT • LOA 210m • Draught 11.8
SBM 2 Jetty	• Pump capacity: minimum 2500 tons/hr • 60,000 DWT • LOA 210m • Draught 11.8m
Sapugaskanda Refinery	• 60,000 tons' storage capacity
Kollonnawa Tank Farm	• 248,000 tons' storage capacity
Muthurajawela Tank Farm	• 205,000 storage capacity
Gas	
Shell LPG CBM	• LOA 165m • Draught 7.0m • Gas capacity 20,000m^3

Source: Ceylon Petroleum Company

The following text box provides additional information on the refinery and the tank farms near Colombo.

The refinery located in Sapugaskanda consists of 50,000 barrels/day processing plant and a 540,000-tonne crude oil tank farm. The refinery gets crude oil either directly from the Single Point Buoy Mooring (SPBM) facility installed about 10 km offshore or from the four crude oil storage tanks of 40,000 tonnes (each), located in Orugodawatta. Part of the refinery output is stored at Sapugaskanda storage facility for distribution and the balance is pumped to the Kollonnawa storage facility. The Sapugaskanda tank farm (mini-distribution facility) receives products only from the refinery. This has a total storage capacity of 60,000 tonnes in twelve tanks for diesel, kerosene and fuel oil.

Refined products from the refinery as well as imported products are received via pipelines to tanks at Kolonnawa. The Kolonnawa installation has a total capacity of 250,000 tonnes in 40 tanks for finished products and product loading facilities for loading railway bogies, which transport products to most of the bulk depots and to road tankers. Aviation fuel to the Katunayake airport is supplied from the Kolonnawa terminal through rail and road tankers.

The Muthurajawela tank farm commenced operations in 2004. With the construction of this tank farm, Sri Lanka's storage capacity for finished petroleum products increased by 250,000 tonnes. Muthurajawela tank farm consists of 21 tanks of 10,000 m3 capacity and 8 tanks of 5,000 m3 capacity. These tanks store and distribute diesel and kerosene. Along with the tanks, CPC installed a new SPBM system, where 60,000 DWT (deadweight tonnage) ships could use the buoy for discharging imported finished products direct from sea to tanks via a submarine pipeline. This terminal includes a loading facility to distribute products by road tankers. However, rail transportation of petroleum products stored in the Muthurajawela tank farm is constrained due to the absence of a railway line.

Petroleum supply for retail sale is done at the following storage/distribution facilities
1. Muthurajawela
2. Kolonnawa
3. Sapugaskanda mini distribution facility
4. China Bay storage facility
5. 13 regional depots.

Lanka Marine Services (LMS) located at Bloemandhal in Colombo receives imported products directly as well as from the Kolonnawa terminal via pipelines, and provides bunker fuel to ships via pipelines connected to Dolphin pier and also from South jetty. LMS terminal has a storage capacity of 23,000 tonnes of fuel oil and 6,800 tonnes of diesel. The dolphin jetty has unloading arms for (i) fuel oil; (ii) crude oil; (iii) diesel; (iv) petrol; and (v) lubricants.

Some amount of LPG is produced at the CPC refinery for local consumption. However, most of the country's LPG requirement is met through direct imports. LPG is imported through the Colombo Port, and also via a conventional buoy mooring system (CBM) for Litro Gas Lanka Limited facilities at Muthurajawela.

Residual oil (heavy furnace oil) is transferred directly from the refinery to the CEB owned 160 MW Sapugaskanda power plant and to the Asia Power owned 51 MW residual oil power plant to produce electricity for the national grid. The LPG produced at the refinery is delivered to the private distributor by means of road tankers and then filled into bottles for onward distribution to consumers.

Source: Sri Lanka Energy Balance 2015

Several issues have been identified concerning the liquid bulk operations in Colombo; these issues are presented in the table below.

Table 5-1 Liquid Bulk - Operational Bottlenecks

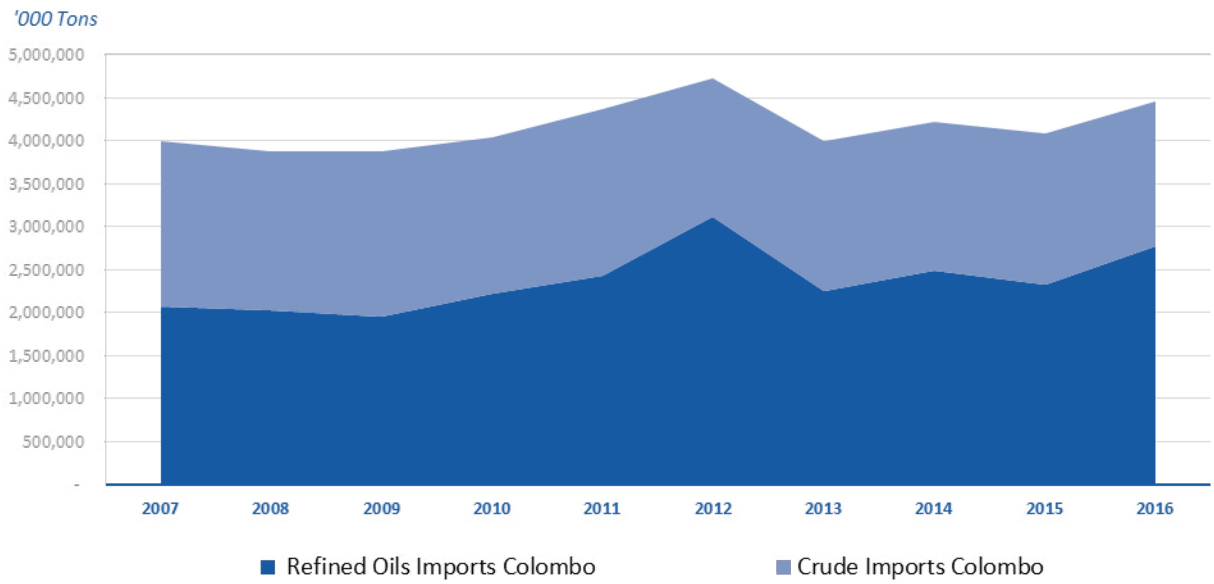
Category	Issue	Severity
Infrastructure	Maximum vessel LOA is insufficient to accommodate large liquid bulk vessels at Dolphin jetty	Medium
Infrastructure	Pipelines to refinery are outdated	Medium
Infrastructure	A connection between Kollonnawa tank farm and Muthurajawela tank farm should be created in future	Medium
Infrastructure	Sapugaskanda oil refinery outdated; needs to be revamped or demolished and newly built at more suitable location	High
Infrastructure	A LNG handling capacity for the envisioned Kerawalapitya power plant should be planned for	High
Infrastructure	In case dolphin jetty is removed due to north port development new refined product jetties should be catered for	Medium

5.3 Current situation and historic demand development

Historic Volumes

Sri Lanka is dependent on refined white oil imports for its national supply. These imports also include gasoline. From Figure 5-2, it can be noted that there has not been a substantial change in crude oil imports over the past decade; this is due to the fact that refining capacity has remained stable over this period.

Figure 5-2: Historic Imports Crude & Refined Colombo



Tons '1000	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Crude Imports	1,939	1,854	1,932	1,819	1,934	1,625	1,743	1,740	1,761	1,685
Refined Imports	2,064	2,025	1,945	2,224	2,431	3,111	2,253	2,483	2,330	2,778
Total	**4,003**	**3,879**	**3,877**	**4,043**	**4,365**	**4,736**	**3,996**	**4,223**	**4,091**	**4,463**

Source: SLPA

5.4 Liquid bulk Vessel Size Developments

The table below presents the main vessel types used for global refined oil trades; these vessels range from 10,000 DWT for short range transport to 120,000 DWT for long range transport. Larger liquid bulk vessels are typically only used for crude oil transport.

Table 5-2 Liquid Bulk Vessel Classes

Product tankers	DWT (tons)	LOA (m)	Beam (m)	Draught (m)	Dolphin jetty	Future at north port
Small tankers	10,000 - 45,000	135- 185m	22 - 28m	8 – 11.2m	YES	YES
Medium range (MR)	45,000 - 65,000	183 - 207m	31 - 32.2m	12 – 13.5m	YES	YES
Long Range (LR1)	65,000 - 80,000	200 - 228m	32m	13.0 - 14.5m	NO	YES
Long Range (LR2) (aframax)	80,000 - 120,000	228 - 250m	34 - 45m	13.0 – 14.5m	NO	YES

Source: Clarksons; MTBS

Refined fuels are currently handled at the Dolphin jetty. This jetty is able to handle vessels of up to 40,000 DWT, with draughts of up to 11.8m and lengths of about 210m. The expectation is that the small and medium tankers will keep dominating the supply to Colombo till additional facilities are developed.

Such facilities may be realized through development of a liquid bulk hub island or new liquid bulk facilities in the envisaged north port. Once new facilities are provided, long range tankers (LR2) of up to 120,000 DWT can call Colombo port, resulting in substantial economies of scale.

For the LNG trade, capacities of the globally deployed vessel classes range from 75,000 m3 (Medmax) to 267,000 m3 (Qmax); the range of vessel classes is presented in the table below.

Table 5-3 LNG Vessel Classes

LNG type	Vessel size
Medmax	75,000 m3
Conventional or standard	125,000 – 145,000 m3
New conventional or standard	150,000 – 175,000 m3
Qflex	210,000 - 216,0000 m3
Qmax	260,000 – 267,000 m3

It is expected that a new LNG terminal will be developed in the Port of Colombo, in order to supply the envisaged gas fired power plant. Additionally, the LNG terminal can be used to supply vessels with LNG as a fuel source in the future.

The new facility is expected to be a Floating Storage and Regassification Unit (FSRU), which should have a capacity of approximately 175,000 m3. The envisaged design vessel has the following characteristics:

- DWT: 93,500
- GT: 113,000
- LOA: 300.0m
- Beam: 46.0m
- Draught: 12.5m

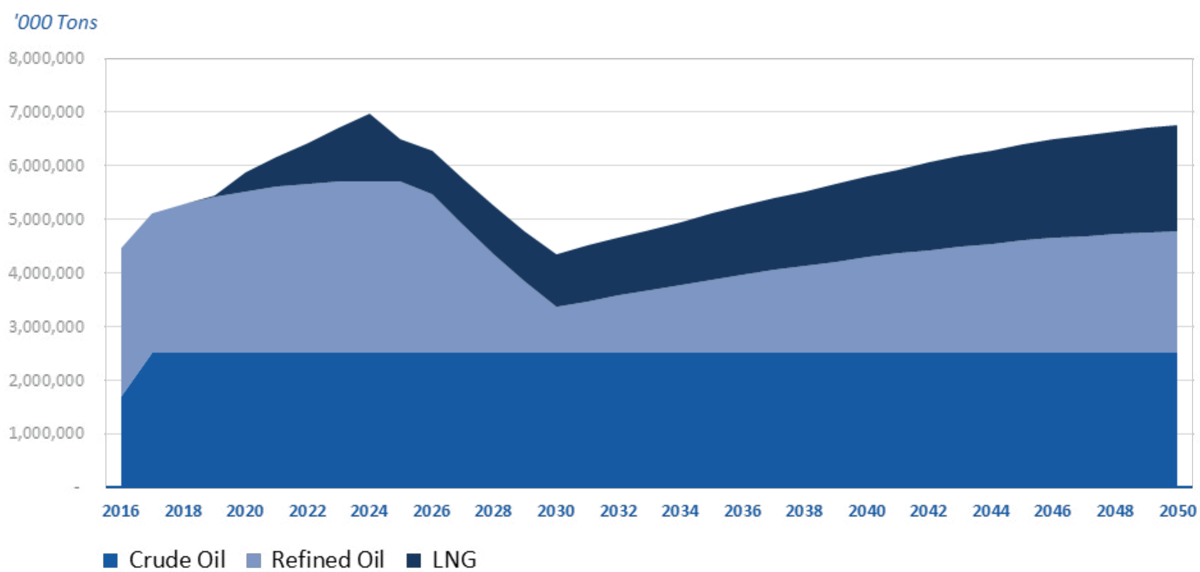
The design supply vessel is expected to be a conventional/standard class vessel, with a capacity of around 145,000 m3.

5.5 Forecasts

The figure below presents the forecasts for the three liquid bulk commodities. The following assumptions have been applied concerning expected developments:

- **Crude Oil –** The imports of crude oils are directly linked to the hinterland refining capacity. The current refinery is inadequate to serve the market; additionally, the refinery is in poor state. It is expected that the current refinery is revamped in the near future, and remains active at its current capacity. Additionally, it is expected that a new 100,000 bbl/day capacity refinery is established in Hambantota in 2025.
- **Refined Oil** – Colombo has a roll to play in servicing the demand for refined oils; however, it is expected that Colombo's market share will decrease as refining capacity is established in Hambantota.
- **LNG** – LNG is expected to be an important commodity for meeting the nation's energy demand. In 2019, the first imports of LNG are expected to take place to serve the envisioned Kerawalapitya LNG power plant (2 x 300 MW).

Figure 5-3: Colombo Forecast Liquid Bulk



('000 Tons)	2016	2020	2025	2030	2050
Crude Oil	1,685	2,512	2,512	2,512	2,512
Refined Oil	2,778	3,010	3,193	845	2,264

('000 Tons)	2016	2020	2025	2030	2050
LNG	-	343	781	995	1,994
Total	**4,463**	**4,936**	**6,485**	**4,352**	**6,769**

5.6 Capacity Development & Requirement

The sea side pumping capacities for SBM 1 and 2 and the Dolphin are sufficient, with sufficient storage for current use. LNG handling facilities will have to be developed immediately. The requirements per timeframe are:

2025 – LNG handling and storage facilities are required immediately to avoid operational delays of the new gas-fired power plant. Additionally, new refining capacity is required and the old pipelines need to be renewed.
2030 – Possible relocation of the dolphin jetty, in case of North Port construction and operations.
2050 – No additional capacity requirements.

5.7 Recommendations and Short Term Priority Projects

The preceding analyses result in the following recommendations for liquid bulk:

R4. The **condition of the dolphin jetty & pipelines should be assessed**. Refurbishment of pipelines may be required, depending on the outcome of the technical surveys.

R5. The **dolphin terminal may be replaced** by a new facility once the north port development starts and the breakwater is no longer required.

R6. The **crude oil capacity should be improved** in parallel with the upgrade of the refinery. This upgrade may be realized together with the new LNG facility (integrating the dolphin jetty facility), through development of new oil jetties in the envisaged north port, or through development of new SBM facilities offshore. In case a new refinery is developed in Hambantota, plans for rehabilitation of the refinery near Colombo may be adjusted.

The recommendations lead to the following short-term priority projects, which will be further discussed in section 15:

SP4. **Sapugaskanda oil refinery -** Sapugaskanda oil refinery is in poor state and operates near densely populated areas. As such, the oil refinery may need to be revamped and/or relocated. It is noted that the Sapugaskanda refinery is not an SLPA facility.

SP5. **LNG Storage Facility -** An LNG handling and storage facility is to be developed, to serve the envisioned Kerawalapitya LNG power plant and enable LNG bunkering activities in the port. A floating LNG storage vessel with regassification units on board is recommended. Such a solution would reduce the need for LNG related structures ashore. The pipeline connection to the powerplant should take into consideration the future location of North Port.

6 General Cargo and RoRo

6.1 Introduction

This chapter aims to define the development need for general cargo and RoRo business and the development options to cater for the required capacity. The following approach is applied.

- This chapter starts in section 6.2 with an overview of the current general cargo and RoRo facilities.
- Section 6.3 presents the current and historic demand development - It is observed that general cargo throughput at the Port of Colombo has remained stable at around 800,000 tons between 2007 and 2016. RoRo throughput has declined substantially, due to recent policy changes that elicited the shift of RoRo transhipment from Colombo to Hambantota.
- Section 6.4 provides an overview of the global and expected country - specific vessel trends for the general cargo and RoRo trades.
- Section 6.5 provides the general cargo and RoRo volume projection up to 2050 – It is estimated that general cargo demand will increase to approximately 1.0 M tons in the coming decade, due to the ongoing large-scale infrastructure projects, such as the Port City, the PAEH, and the Megapolis plans; subsequently, it is expected that general cargo demand will decline to a long term demand of approximately 0.5 M tons per annum. Despite growing national demand, RoRo demand at the Port of Colombo is expected to keep declining, to an estimated 23,569 vehicles in 2050.
- The capacity need is estimated in section 6.6 – It is observed that the envisaged transformation of BQ and the start of container operations at ECT will result in a decrease in general cargo capacity in the port. Conversely, it is envisaged that UCT and JCT berths 1 and/or 2 will be transformed to accommodate general cargo operations.
- Section 6.7 concludes with the recommended short term priority projects – It is recommended that a plan is established to guide the transformation of UCT towards a terminal that is capable of handling general cargo efficiently.

6.2 Overview current general cargo and RoRo facilities

Facilities & Capacities

Currently, there are no dedicated terminals for handling general cargo and RoRo. RoRo is handled at Unity Container Terminal (UCT) as the diminishing container operations have resulted in adequate space to store vehicles.

General cargo is handled at several places in the port, but mainly at BQ. Additionally, the partially constructed ECT facility is temporarily used to accommodate deeper draft general cargo vessels. The capacities presented below provide an indication of general cargo capacities; however, it is noted that capacities may vary substantially across specific commodity types (e.g., steel versus other cargo types, due to its weight and required handling equipment).

Figure 6-1: General Cargo and RoRo Handling

The table below presents the port's RoRo capacity and throughput. Subsequently, Table 6-2 provides an overview of the port's general cargo capacity and throughput.

Table 6-1: Capacity RoRo

Terminal	Quay Length (m)	Berths (#)	Water Depth (m)	Terminal Area (ha)	Estimated Capacity (Vehicles)	2016 Throughput (Vehicles)
UCT	590	2	-9 to -11	4 ha	50,000	33,000

Table 6-2: Capacity General Cargo

Terminal	Quay Length (m)	Berths (#)	Depth (m)	Estimated Capacity ('000 Tons)	2016 Throughput ('000 Tons
UCT	*590*	*2*	*-9 to -11*	*500*	
*ECT**	*600*	*1*	*-18*	*500*	
Guide Pier	*330*	*1*	*-9.15*	*250*	
PVQ	*330*	*1*	*-9.5*	*250*	
BQ	*608*	*4*	*-4.8 to -9.5*	*500*	
Total	**2,458**	**9**		**2,000**	**710**

*Once fully constructed and operational, ECT will only be used for handling containerized cargoes.

6.3 Current situation and historic demand development

Historic Volumes

Through policy changes, the entire vehicle transhipment business has been moved to Hambantota, relieving Colombo port from the space constraints resulting from handling vehicles; the resulting reduction in transhipped vehicles in Colombo can be observed from the table below. The relocation of vehicle transhipment to Hambantota has also resulted in Colombo losing market share in the gateway vehicle trade. In the long term future, Colombo may regain market share in the vehicle trade, if adequate space is developed (e.g., as part of the envisaged North Port development).

Table 6-3: Historic Volumes RoRo

Vehicles	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Gateway	30,047	21,875	6,732	45,779	90,824	38,886	6,651	21,296	71,738	31,888
Colombo Share of Gateway	*100%*	*100%*	*100%*	*100%*	*100%*	*86%*	*20%*	*36%*	*51%*	*50%*
Transhipment	10,065	2,154	4,973	2,455	993	183	466	-	13	778

Source: SLPA

General cargo volumes comprise a multitude of commodities, but project cargo and bagged fertiliser are the only categories with substantial volumes. Bagged fertiliser imports are discussed in chapter 4. Steel and iron imports are project cargo imports destined for the many construction projects in the city of Colombo; the steel and iron imports have increased substantially, due to the Port City development and Megapolis developments.

It is further noted that several commodities presented in the table below, such as timber, are still handled in substantial volumes. However, the majority of timber volumes nowadays are transported in containers; hence, these volumes are not included in the presented general cargo volumes.

Table 6-4: Historic Volumes General Cargo

('000 Tons)	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Iron / Steel	-	-	-	-	-	-	232	356	623	672
Rice	7	7	-	6	-	-	-	-	65	-
Sugar	9	22	35	27	20	-	-	-	-	-
Fertiliser Bagged	372	202	175	275	239	119	44	165	292	118
Cement Bagged	-	-	-	-	-	-	-	-	1	2
Timber	-	-	-	-	-	-	1	-	-	-
Other	433	400	296	293	428	484	51	21	22	10
Total	**821**	**630**	**506**	**601**	**687**	**603**	**328**	**541**	**1,002**	**801**

Source: SLPA

6.4 General Cargo Vessel Developments

The table below presents examples of various general cargo vessel classes. The “small size multi-purpose” vessels, with capacities between 7,000 DWT and 10,000 DWT are predominantly used for coastal services. The geared handysize vessels, with capacities between 10,000 DWT and 40,000 DWT, are typically used for the longer distance ocean services. The handysize are the main general cargo vessel type for large multi-purpose operators like BBC, Coscol, Gearbulk, NYK, and Spliethoff.

The global trend in the sector comprises a move towards even larger handymax vessels, which have capacities between 40,000 DWT and 65,000 DWT. These vessels are increasingly used for transporting large and heavy project cargoes.

Table 6-5 Examples of Geared General Cargo Vessels

Company	Vessel	DWT	LOA (m)	Beam (m)	Draught (m)	Gear
Coscol	Daxia	56,800	190	32.2	12.8	4 cranes, each up to 36 mt
BBC	BBC Neptune	37,500	190	28.5	10.4	4 cranes, each up to 30 mt
BBC	BBC Weser	17,500	143.14	22.8	9.7	3 cranes up to 80 mt combinable to 160 mt
BBC	BBC Arizona	12,780	138.5	21	8.0	2 cranes each upto 150 mt combinable to 300 mt
BBC	BBC Asia	7,500	119.8	20.2	7.6	2 cranes each 250mt combinable 500mt
BBC	BBC Ocean	6,150	115.5	16.5	5.7	2 cranes each 60mt combinable 120mt

For Colombo, it is expected that the general cargo trade will increasingly be served by larger multi-purpose vessels. These larger vessels are expected to be in the range from 35,000 DWT to 65,000 DWT. The 65,000 DWT handymax vessels typically have deeper draughts of up to 13m.

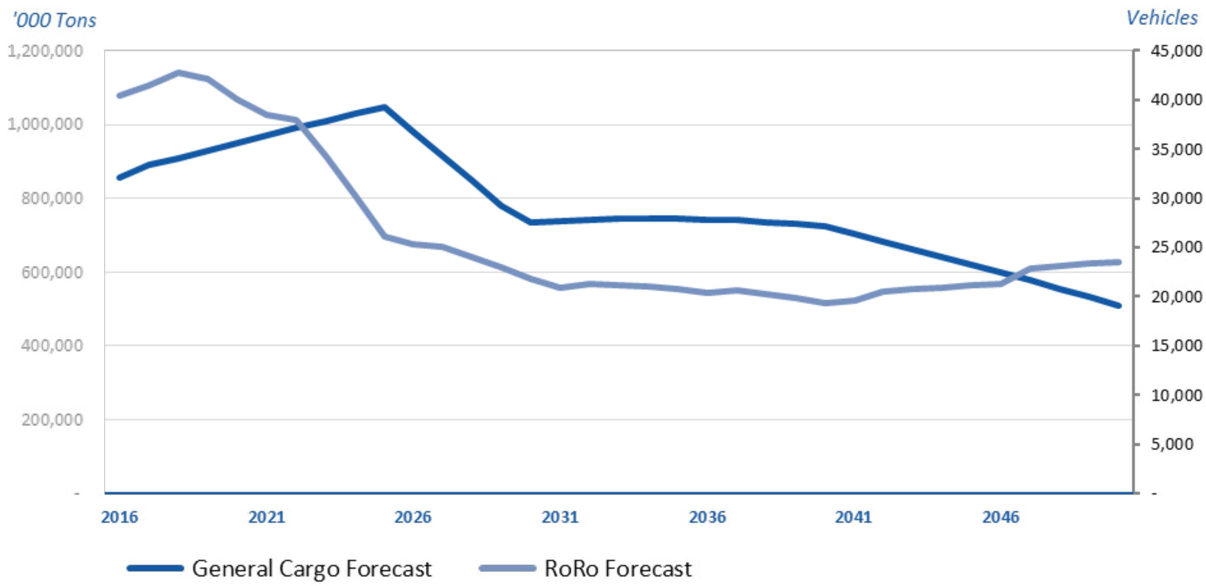
Currently, the old basin does not have berths with adequate water depth to accommodate such vessels – at UCT, maximum water depth is CD -11m. However, it is expected that these vessels can be accommodated in the old basin in the future, once JCT 1 is converted to a general cargo berth. The North Port development may further expand the deep water berth capacity catered to general cargo vessels.

6.5 Forecasts

The table below presents the forecasts for the two commodities. The following assumptions have been applied concerning expected developments:

- **General Cargo** – General cargo imports are expected to spike in the period leading up to 2025, due to the large-scale Megapolis and Port City developments.
- **RoRo** – National imports of vehicles are expected to increase, but Colombo's share drops, as it is assumed that Hambantota absorbs the majority of additional demand. This is under the assumption that these operations can continue in Hambantota; as new terminals are being developed at Hambantota, the space that is currently used for RoRo transhipment may decrease.

Figure 6-2: Forecast General Cargo & RoRo



Item	Unit	2016	2020	2025	2030	2050
General Cargo Forecast	'000 Tons	801	948	1,045	733	509
RoRo Forecast	Vehicles	40,387	40,048	26,171	21,770	23,569

6.6 Capacity Development & Requirement

General Cargo

Several general cargo capacity developments are foreseen for the next 3 to 10 years:

- The Bandaranaike Quay will be transformed to serve as a passenger terminal, resulting in a decrease in general cargo capacity.
- ECT will become operational as soon a bidder is selected, resulting in a shift in ECT's function from a general cargo terminal to a container terminal.
- UCT will be transformed to handle general cargo and RoRo.
- As soon as JCT berths 1 and/or 2 are no longer required for container handling, one of these berths can be transformed into a multi-purpose berth for general cargo and RoRo. Under the Base Case scenario, this transformation will take place in 2025. Under the High Case scenario, the new multi-purpose facility can be extended to JCT berths 3 and 4, due to the additional container handling capacity at the envisaged North Port.

Several measures have to be taken in order to guarantee access for deep draught general cargo vessels:
2025 – Development of JCT berth 1 for general cargo.
2030 – Dedicated multipurpose terminal to handle general cargo and RoRo.
2050 – No additional capacity needed.

Table 6-6 Capacity Requirement General Cargo

Item	Unit	2016	2020	2025	2030	2050
General Cargo Forecast	'000 Tons	801	948	1,045	733	509
Berth Requirements	#	2	3	3	2	2
Quay Wall Requirement	m	525	780	780	525	525
Terminal Area Requirement	ha	2.5	2.7	3.1	2.2	1.5

Assumptions Capacity Requirements

- Quay Wall:
  - Design vessel LOA: 240.0m
  - Design vessel draught: 14.1m
  - Discharge rate: 100 tons / hr
  - Target berth occupancy rate: 60%
- Terminal Area:
  - Average dwell time: 5 days
  - Cargo stacking height: 2m

Formulas used:

(1) $Berth\ Capacity = Discharge\ Rate * Berth\ Occupancy * Operational\ Hours\ Per\ Year$

(2) $Berth\ Requirement\ (whole\ numbers) = \frac{Forecast}{Berth\ Capacity}$

(3) $Quay\ Wall\ Requirement = Number\ of\ Berths * LOA\ Design\ Vessel + ((Number\ of\ Berths + 1) * 15)$

(4) $Terminal\ Area = \frac{Throughput*Factor\ Gross\ Net\ Area*Bulking\ Factor*Average\ Dwell\ Time*}{Cargo\ Density*Stacking\ Height*Occupancy\ Rate*365} * \frac{1}{10{,}000}$

Example 2030:

(1) 100 * 0.60*7,200= 432,000 tons
(2) 733 / 432 = 2 (roundup)
(3) 2 * 240 + (3*15)=525m
(4) (733,000*1.5*1.2*5)/(0.6*2*0.7*365) * (1/10,000)=2.2ha

RoRo

The table below presents the results of the capacity calculations, followed by the assumptions. The capacity requirements per timeframe are:
2025 – UCT needs to be transformed into a dedicated general cargo and RoRo facility.
2030 – Dedicated multipurpose terminal to handle general cargo and RoRo.
2050 – No additional capacity needed.

Furthermore, the JCT 1 conversion to a general cargo terminal is explained in the short term priority project regarding the JCT modernisation, which was identified in section 3.7. It is noted that, if assumed RoRo volumes cannot be shifted to Hambantota, additional RoRo volumes can be handled at JCT 1. The JCT 1 will need to be converted in time to absorb excess volumes.

Table 6-7: Capacity Requirement RoRo

Item	Unit	2016	2020	2025	2030	2050
RoRo Forecast	Vehicles	31,888	40,048	26,171	21,770	23,569
Berth Requirements	#	1	1	1	1	1
Quay Wall Requirement	m	230	230	230	230	230
Terminal Area Requirement	ha	3.5	3.4	2.2	1.9	2.0

Assumptions Capacity Requirements

- Quay Wall:
  - Design vessel LOA: 200.0m
  - Design vessel draught: 10.0m
  - Discharge rate: 20 vehicles / hr
  - Target berth occupancy rate: 60%
- Terminal Area:
  - Average parking space: 20m^2 / vehicle
  - Offloading rate: 20 vehicles / hr / gang
  - Dwell time: 12 days
  - Peak factor: 1.3

Formulas used:

(1) $Berth\ Capacity = Discharge\ Rate * Berth\ Occupancy * Operational\ Hours\ Per\ Year$
(2) $Berth\ Requirement\ (whole\ numbers) = \frac{Forecast}{Berth\ Capacity}$
(3) $Quay\ Wall\ Requirement = Number\ of\ Berths * LOA\ Design\ Vessel + ((Number\ of\ Berths + 1) * 15)$

(4) $$Terminal\ Area\ Requirement = \frac{Forecast * Average\ parking\ space * terminal\ peak\ factor * dwell\ time}{365} * \frac{1}{10{,}000}$$

Example 2030:

(1) 20 * 0.60 * 7,200 = 86,000 vehicles
(2) 21,770 / 86,000 = 1 (roundup)
(3) 1 * 200 + (2*15) = 230m
(4) 21,770 * 20 * 1.3 * 12 / 365 * 0.0001 = 1.9 ha

6.7 Recommendations and Short Term Priority Projects

The main recommendation is to:

R7. **Create additional general cargo berths** in the old basin by freeing-up UCT for general cargo handling in the short term and JCT berth 1 in the longer term.

The recommendation leads to the following short-term priority projects, which will be further discussed in section 15:

SP6. **UCT Transformation Plan –** A plan should be developed to guide the transformation of UCT towards a general cargo facility, as it is expected that container activities will be phased out in the short term (2020).

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7 Cruise

7.1 Introduction

This chapter aims to define the development need for cruise business and the development options to cater for the required capacity. The section is structured as follows:

- This chapter starts in section 7.2 with an overview of the current cruise facility: The cruise jetty at SAGT and the shops cater to the increasing cruise demand in the port.
- Section 7.3 presents the current and historic demand development: Between 2005 and 2016, cruise vessel arrivals grew at an compound annual growth rate (CAGR) of 6.7%, to 43 arrivals in 2016.
- Section 7.4 presents the cruise vessel trends: it is expected that more mid-sized cruise vessels, with lengths between 250m and 300m, and more post panamax cruise vessels, with length between 300m and 350m, will call Colombo in the future.
- Section 7.5 provides the cruise vessels arrivals projection up to 2050: it is estimated that vessel arrivals will increase from 29 in 2017 to 207 in 2050, under the assumption that adequate cruise facilities are developed at Colombo port.
- The need for additional capacity is estimated in section 7.6: In order to meet estimated growing cruise demand at Colombo port, an adequate passenger terminal is required. It is proposed that BQ is transformed into a passenger terminal, in order to substitute/complement the existing cruise berth.
- Section 7.7 concludes with the recommended short term priority projects: The envisaged transformation of BQ into a passenger terminal is selected as the sole short-term priority project for the cruise business in Colombo.

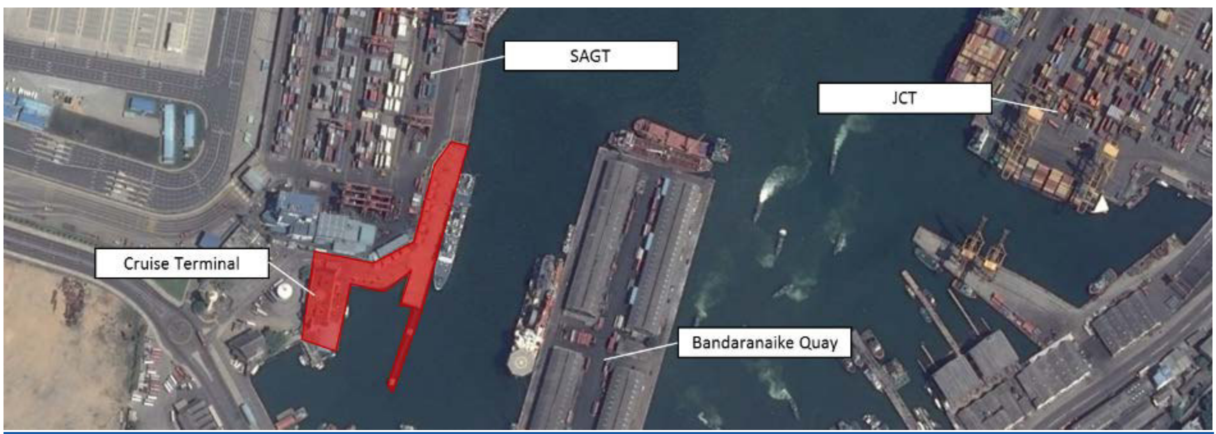
7.2 Overview of current cruise facility

Facilities & Capacities

Currently, the SLPA operates a cruise berth adjacent to the South Asia Gateway Terminal (SAGT), as depicted below. The terminal handles approximately 30 to 40 cruise vessels per annum. However, the terminal faces several issues, which prevent rapid cruise sector growth in the port of Colombo:

- The cruise berth accommodates vessels with a length of up to 200 m LOA and a water depth of up to -9.5m CD. This is insufficient to accommodate the larger cruise vessels, with vessel lengths of up to 360 m LOA and draughts up to -10 m CD. Cruise vessels with dimensions that exceed the maximum dimensions accommodated at the cruise berth currently berth at SAGT.
- The terminal has an underdeveloped passenger building, lacking the facilities to efficiently handle customs and immigrations processes.
- The terminal lacks activities for the disembarking passengers, as it only provides for 10 small duty-free shops.
- The terminal has insufficient facilities for buses and other ground transport, required to guide the cruise passengers to the city or tour destinations.

Figure 7-1: Oil Supply Chain Overview



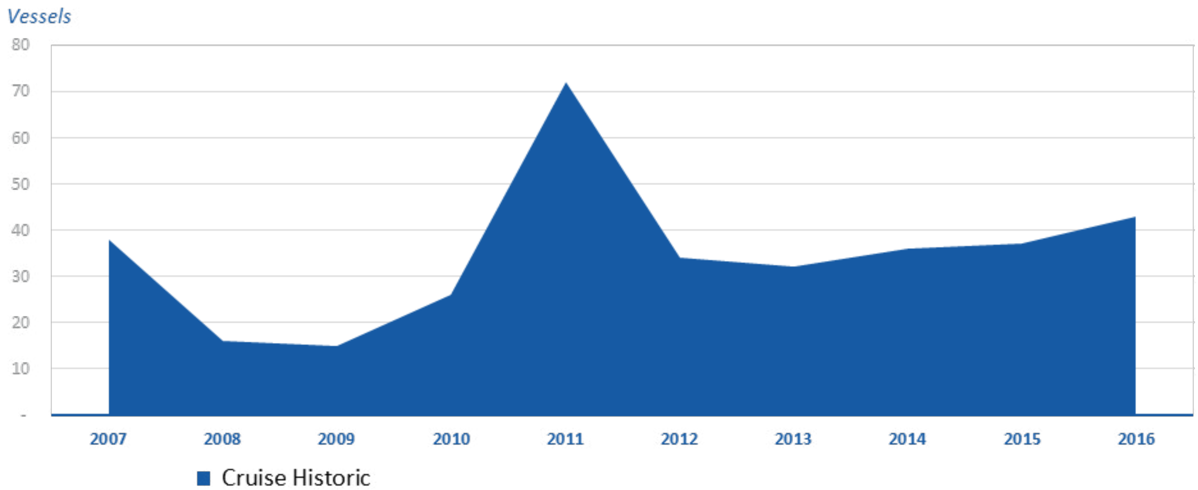
Colombo Port Passenger Terminal		
Berth Length (Including Berthing Dolphins)	265	m
Water Depth	9.0 - 11.0	m

7.3 Current situation and historic demand development

Historic Volumes

The table below provides an overview of cruise vessel arrivals in Colombo between 2005 and 2016. It can be observed that growth of the cruise vessel arrivals in this period (CAGR: 6.7%) is substantially lower than the recent overall growth in vessel calls in the Asia region, which nearly doubled between 2013 and 2016. This lagging growth is mainly attributable to the underdeveloped cruise terminal in Colombo, prohibiting large vessels from berthing in the port and impeding efficient embarking and disembarking operations.

Figure 7-2: Colombo Cruise Vessel Arrivals – Historic



Item	CAGR (%)*	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Vessel Arrivals	6.7%	38	16	15	26	72	34	32	36	37	43

*CAGR for the period from 2005 to 2016.

7.4 Cruise Vessel Developments

The table below presents the dimensions of typical cruise vessels classes. It can be observed that Colombo's current cruise berth has substantial restrictions regarding the vessels that can be accommodated, both in terms of the maximum length (265m) and maximum draught (10m).

Table 7-1 Cruise Vessel Dimensions

DWT (t)	LOA (m)	Beam (m)	Draught (m)	Passenger Capacity
Cruise Liners (Post Panamax)				
220,000	360.0	55.0	9.2	5,400 – 7,500
160,000	339.0	43.7	9.0	3,700 – 5,000
135,000	333.0	37.9	8.8	3,200 – 4,500
115,000	313.4	36.0	8.6	3,000 – 4,200
105,000	294.0	35.0	8.5	2,700 – 3,500
95,000	295.0	33.0	8.3	2,400 – 3,000
80,000	272.0	35.0	8.0	2,000 – 2,800
Cruise Liners (Panamax)				
90,000	294.0	32.2	8.0	2,000 – 2,800
80,000	280.0	32.2	7.9	1,800 – 2,500
70,000	265.0	32.2	7.8	1,700 – 2,400
60,000	252.0	32.2	7.6	1,600 – 2,200
60,000	251.2	28.8	7.6	1,600 – 2,200
50,000	234.0	32.2	7.1	1,400 – 1,800
50,000	232.0	28.0	7.4	1,400 – 1,800
40,000	212.0	32.2	6.5	1,200 – 1,600
40,000	210.0	27.1	7.0	1,200 – 1,600
35,000	192.0	32.0	6.3	1,000 – 1,400
35,000	205.0	26.3	6.8	1,000 – 1,400
30,000	190.0	25.0	6.7	850 – 1,200
25,000	180.0	24.0	6.6	700 – 1,000
20,000	169.0	22.5	6.5	600 – 800
15,000	152.0	21.0	6.4	350 – 500
10,000	134.0	18.5	5.8	280 – 400
5,000	100.0	16.5	5.6	200 – 300

Source: MTBS, based on Pianc

Despite the restrictions at the cruise berth, the Port of Colombo received the Queen Mary 2. The Queen Mary 2 belongs to the Cunard Class "Queen Mary", which comprises some of the largest cruise vessels. The Queen Mary 2 has a LOA of 345m, a draught of 10.3m, and a beam of 41m. Due to the classic model, the vessel carries around 2,620 passengers; more modern vessels with similar dimensions already have capacities of approximately 7,000 passengers.

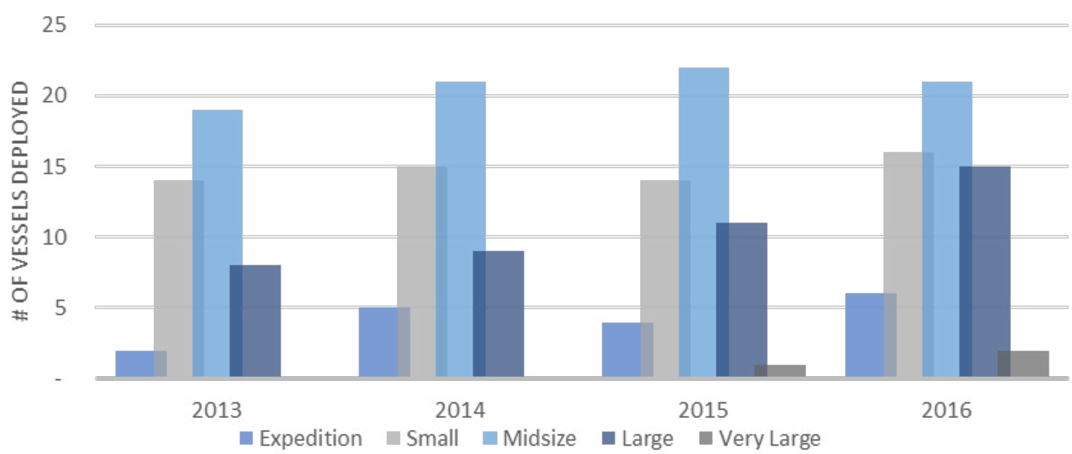
Table 7-2 Examples of Cruise Vessels that Call Colombo Port

Company	Vessel	Calls	LOA (m)	Beam (m)	Draught (m)	Passenger Capacity
Cunard /Carnival	Queen Mary 2	1	345.0	41.0	10.30	2,620
Princess Cruises	Majestic Princess	1	330.0	38.4	8.53	3,560
Cunard /Carnival	Queen Elizabeth	1	294.0	32.3	7.80	2,092
Holland America Line	Amsterdam	1	237.8	32.3	8.10	1,380
Costa Cruises	Costa NeoClassica	4	220.5	30.8	7.60	1,578
Costa Cruises	Costa NeoRomantica	1	220.5	30.8	7.60	1,578
Seabourn	Seabourn Encore	2	210.0	28.0	6.40	604
Oceania Cruises	Nautica	1	181.0	25.5	5.95	684
Regent Seven Seas Cruises	Seven Seas Navigator	1	170.7	24.0	7.30	490

The largest vessel in the cruise business globally, in terms of length, is the Royal Caribbean "Harmony of the Seas" vessel class. The vessels in this class have a LOA 362m, a beam of 47m, a draught of 9.32m, and a capacity to transport approximately 6,360 passengers.

The figure below provides an overview of the development in the number of deployed cruise vessels in Asia between 2013 and 2016, showing an increase in the relative share of large and very large cruise vessels, in line with global shipping trends.

Figure 7-3 Development of Asian Cruise Sector – Vessel Deployment



Hence, it is expected that Port of Colombo will attract more post panamax vessels with lengths between 300m and 360m and draughts between 9m and 10.5m; additionally, it is expected that Colombo will be called by more mid-sized class vessels, with lengths between 250m and 300m.

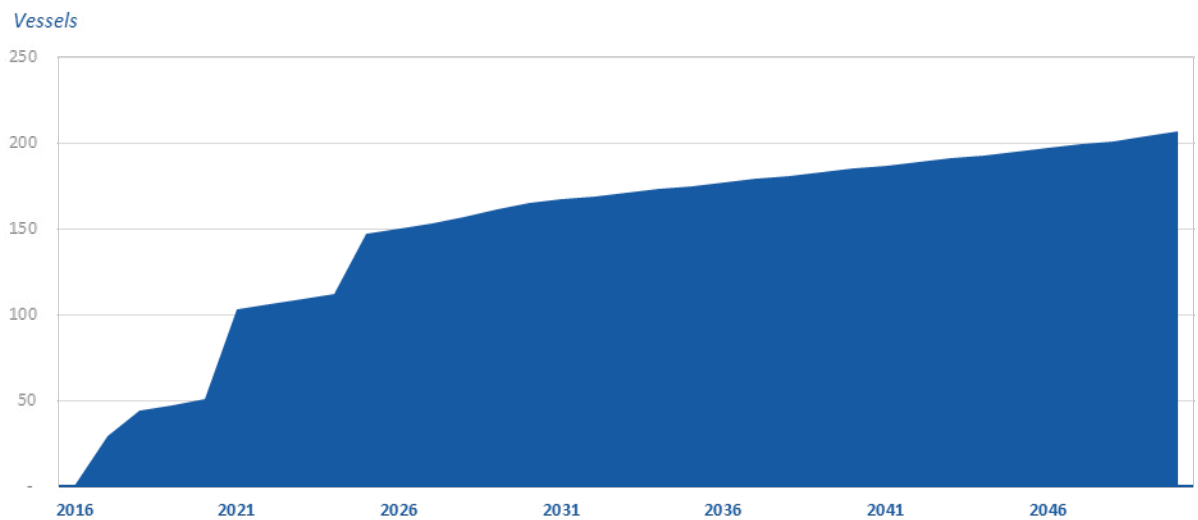
7.5 Forecasts

Based on (i) historic vessel arrival growth figures; (ii) overall market trends; (iii) specific key developments in the Colombo region, such as the Port City Development and improving infrastructure between the port and airport; and (iv) stakeholder interviews, the following assumptions have been applied for the vessel forecast[3]:

- Phase 1 of the cruise terminal development will be completed by the start of 2021.
- Port city development will boost demand for cruise.
- Vessel arrival growth:
  - 2018 – 2020: 6.7% (in line with historic CAGR)
  - 2021: 52 calls added (a year-round weekly service, with Colombo as the homeport, is introduced). Inter alia, specific key developments in the Colombo region, such as the Port City development, overall tourism development, and improving infrastructure between the port and airport, are expected to boost Colombo's attractiveness to act as a homeport.
  - 2022 – 2024: 2.0% (decreased growth rate)
  - 2025: 35 calls added (addition of a year-round 10-day service)
  - 2026 – 2030: 2.0%
  - 2031 – 2050: 1.0% (further decreased growth rate)

Applying these assumptions, vessel arrivals are forecast to increase from 29 in 2017 to 207 in 2050 (CAGR: 6.1%); the development of the forecast vessel arrivals is visualised in the figure below.

Figure 7-4: Colombo Cruise Vessel Arrivals - Forecast



Item	Unit	2020	2025	2030	2050

[3] The forecast assumes the development of a modern passenger terminal in the port of Colombo, as further detailed in the separate "Colombo Passenger Terminal Report".

Vessel Arrivals	Vessels	51	147	165	207
Passenger Arrivals	Passengers	51,000	134,652	202,620	380,466

7.6 Capacity Development

Table 7-3 outlines the required number of berths required to accommodate the forecast passenger vessels, based on the following assumptions:

- Berth utilization will be higher in the "peak period", especially during the initial ramp-up period. Specifically, 33% of the annual vessel arrivals is expected to take place in the peak month up to and including 2020; afterwards, the share of annual arrivals during the peak month is estimated to decrease to 17%.
- Average berthing time per vessel is estimated at 16 hours in the short term; after introduction of Colombo home-port cruise loops, the average berthing time per vessel is estimated to increase to 20 hours.
- Due to the inflexibility of cruise line schedules, average berth utilization is expected to be 40%.

Table 7-3 Colombo Cruise Terminal – Berth Requirement

Item	Unit	2020	2025	2030	2050
Vessel Arrivals	Vessels	51	147	165	207
Berths Required	Berths	1	2	2	3

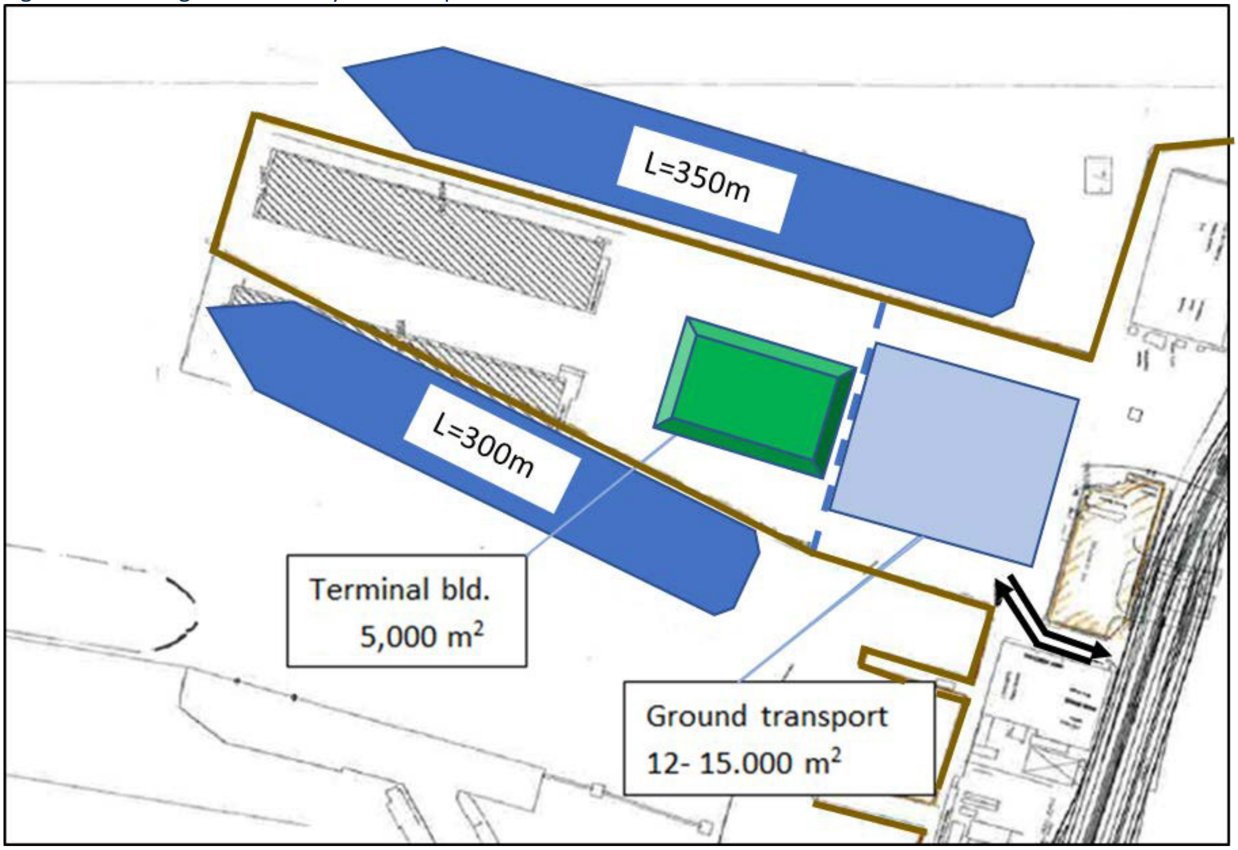
Berth Requirement Calculation Example 2030:

- Peak month vessel arrivals (17% * 165 vessels): 29 vessels
- Peak month berthing hours (29 vessels * 20 hours): 580 hours
- Peak month berthing hours available (365 * 24 / 12 * 40%): 292 hours
- Peak month berth requirement (580 / 292): 2 berths

The number of berths outlined in the table above includes the current cruise berth; as such, 2 new berths need to be created for the long term cruise terminal development. The figure below presents an initial terminal layout concept. The following observations can be made:

- In the first phase of the cruise terminal development (2021), the BQ will be cleared from the warehouses and will require some minor repairs and dredging. As no need for berthing 3 vessels simultaneously is foreseen until phase 2 (2033), the BQ quay structure will not be redesigned.
- In phase 2 of the cruise terminal development, the BQ pier will be cut diagonally, to create a sufficiently wide basin between BQ-west and the current cruise berth. This will allow for simultaneous berthing operations at the current berth and BQ-west.
- The ground transport area is foreseen to be developed between the current SLPA heritage administration building and the new passenger terminal building.
- The connection between the passenger terminal and the public road network is foreseen to pass around the SLPA administration building, as indicated by the black arrows on the layout sketch.

Figure 7-5 Passenger Terminal Layout Concept



7.7 Recommendations and Short Term Priority Projects

The main recommendations are:

R8. **Extend the existing cruise berth** with a dolphin in order to be able to occasionally receive vessels between 200m and 265m in length; and

R9. **Develop a dedicated cruise terminal** able to handle the very large Cruise vessels, which have a LOA of 360m and a draught of 10m.

This recommendation leads to the following short-term priority project, which will be further discussed in section 15

SP7. **An adequate passenger terminal**, with adequate berthing space and a modern passenger building, is to be developed. The preferred location for this development is on the BQ (once the CFS activities have been relocated to the South Harbour). An adequate facility will also enable an efficient passenger arrival process.

8 Logistics and Warehousing

8.1 Introduction

This chapter aims to define the development needs for logistics and warehouse business and focuses on the development options to cater for the required capacity in the future. The chapter follows the following structure:

- Section 8.2 provides an overview of the current logistics situation and future expected developments - It is observed that (i) the main gate is inadequate to handle the current amount of trucks; (ii) the automation of gate processes is lagging behind international standards; and (iii) truck arrivals are concentrated on weekdays between 11 AM and 11 PM, despite 24 hour operations on each day of the week. Hence, it is recommended that (i) the main gate is expanded from 3 in-lanes and 3 out-lanes to 5 in-lanes and 5 out-lines and gate processes are further automated; (ii) a separate gate complex is constructed to connect the south port to the PAEH; and (iii) cooperation among port community members is improved to better distribute the truck arrivals over the available working hours.
- Section 8.3 presents current warehousing facilities and future expected developments – It is observed that (i) operations at the current warehouses are not in line with global best practice, in terms of operations, stacking height, and automation; and (ii) several of the current warehouses need to be shut down in the short term, in order to enable the development of the passenger terminal and the PAEH. Hence, it is recommended that a new warehouse is developed, in adherence with international standards.
- Section 8.4 presents the plans and recommendations concerning relocation and demolishment of underutilised buildings and buildings that interfere with current development plans: The port has several buildings and warehouses that are subject for demolishment due to their end-of structural life and or to be disposed because of new developments like the PAEH. Some of the buildings are still in function and it remains questionable whether safety of goods and personnel can be assured.

A further analysis concerning CFS and Dry Port facilities outside the bounds of the Port of Colombo is presented in the National Port Directions Report.

8.2 Logistics

8.2.1 Introduction

This section focuses on the logistics infrastructure within the 'secured' boundary of the Port of Colombo, i.e. the internal roads within the port and the gate infrastructure, both at port level and at the terminal level.

8.2.2 Overview of current situation

The figure below provides an overview of the existing gates (indicated in blue) at the port complex, enabling access from the public road network into the dedicated port area or vice versa. Subsequently, Table 8-1 provides an overview of the functions of each of the gates.

Figure 8-1 Colombo Port - Gates and Internal Roads Map

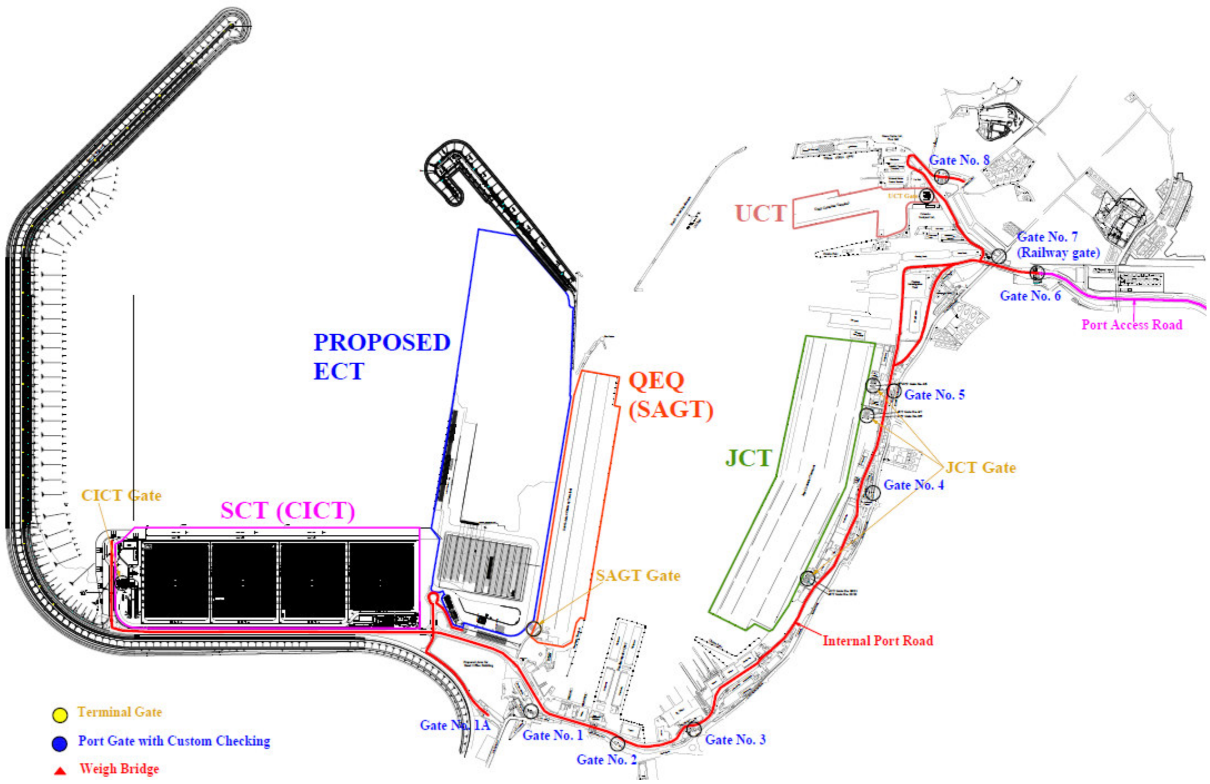


Table 8-1 Gate functionality

Gate No.	Functionality
Gate No. 1 – 1A	vehicles
Gate No. 2	vehicles
Gate No. 3	vehicles
Gate No. 4	vehicles
Gate No. 5	vehicles
Gate No. 6	trucks
Gate No. 7	vehicles
Gate No. 8 (hardly in use)	trucks

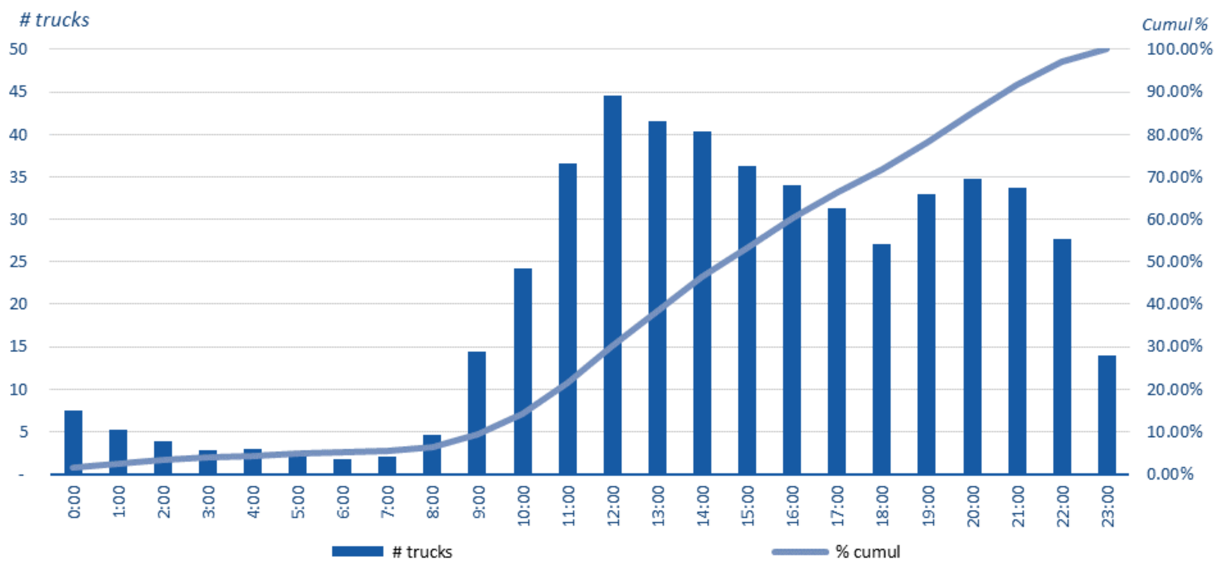
Port Access – Main Gate

A detailed analysis of the current situation is required in order to define the future requirements for port access roads and gate infrastructure. SLPA shared a database of 15,683 data entries, covering all truck movements in and out of the port of Colombo through main gate N° 6, during the month of December 2016.

For each truck, gate clerks at the main gate register the license plate number and the time at which the truck enters and exits the port. This is extremely valuable information, enabling more detailed statistical analysis of the gate flows in and out of the port.

The figure below shows the arrival pattern of the trucks entering the port of Colombo. Theoretically speaking, port access is available 24 hours per day but in practice only 12 hours out of the 24 available hours are intensely used. From 11.00 pm until 11.00 am, only 16.8% of the daily truck volume is handled, while the remaining 83.2% is operated between 11.00 am and 11.00 pm. Or, in other words, more than 80% of the truck volume is handled within 50 % of the available time.

Figure 8-2 Truck visit distribution per hour



Source: MTBS, based on SLPA gate registration data

One can conclude that the available gate capacity is not very efficiently used under the current conditions, neither at the port level, nor at the terminal level. The peak arrivals in the afternoon create congestion at the main port access gate and on the internal port road.

JCT case study

In 2016, the port of Colombo handled 1,299,850 TEU gateway containers (import/export), or 920,459 boxes. Assuming gate activities are available 24 hours a day and assuming an equal distribution over the 24 hours, on average this would generate a traffic flow of 2,522 trucks entering and leaving the port to pick up or deliver a container. JCT handles about 37% of the total container volumes at Colombo port, hence 923 trucks will visit the JCT terminal on a daily basis.

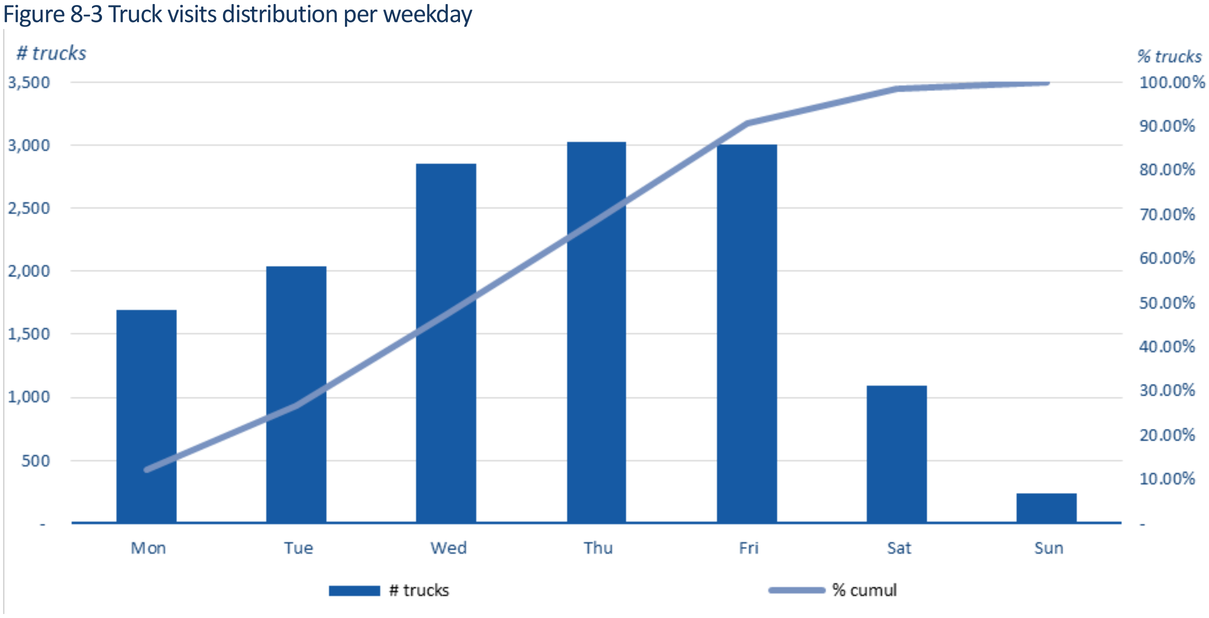
In case the JCT truck volume would be equally distributed over the 24 available hours, on average 38 trucks per hour would pass the JCT gates. Taking into account a gate processing time of 3 minutes at the in-gate and a truck loading factor of 1 container per truck, 2 in-gates would be required at the JCT terminal. Assuming a shorter processing time of 1 minute at the gate out, corresponding calculations show that 1 out-gate would be sufficient to handle the expected truck flow.

Unfortunately, as shown above in figure 11-1, the total number of truck visits is almost compressed into 12 hours per day. Hence, 4 in-gates and 2 out-gates would be required to provide sufficient gate capacity and to avoid queueing. Currently, JCT is using only 2 in-gates and 2 out-gates for the gateway traffic of import and export containers. Hence, truck queues will accumulate in the afternoon peak hours at the in-gates of JCT.

Truck visits per working day

Port and terminal gates are open 7 days per week, 24 hours per day. The information available in the gate database allows for a more detailed analysis of the use of the port and terminal gates. The figure below shows a more in-depth analysis of the distribution of the gate operations per day of the week.

Figure 8-3 Truck visits distribution per weekday



Source: MTBS, based on SLPA gate registration data

Wednesday, Thursday and Friday are the busiest days at the port of Colombo. On these days, more than 20% of the weekly volume is handled. The beginning of the week shows a bit less activity. On Monday and Tuesday, approximately 12% and 14% of the weekly number of trucks are handled, respectively. As one could expect, there is much less activity on weekend days compared to weekdays. On Saturday, around 8% of the total weekly volume is handled; on Sunday, only 1.7% of the weekly amount of trucks is handled.

In general, ports offer 24/7 gate services because of an existing market demand. If all stakeholders organise their activities accordingly, the workload distribution per weekday can be distributed more equally. Hence, congestion on the roads can be reduced through better spreading the operations over the 24-hour daily cycles and the days of the week. The current imbalance in the activity workload distribution results in inefficient use of the available resources and gate infrastructure installed at the main gate(s) of the port and at the terminal facilities.

At the main gate, a combination of administrative and physical checks is executed by various customs officers. For example, the following activities will be launched when a truck has picked up an import container at a container terminal and drives on the inner Port Road towards the main gate to leave the port area:

- One Customs Officer will execute a physical check of the container: container number, truck license plate, etc.
- One Customs Officer will put a Custom's seal onto the container.
- One Customs Officer will handle the administrative work: check original gate pass, loading pass and sometimes custom's declaration before issuing a new gate pass (printed document at central gate office) including the new seal number.

Depending on the examination profile of the cargo, the truck will receive an examination instruction:

- Green: no further examination required.
- Amber: truck needs to drive to Rank Area where a quick examination will take place.
- Red: full examination required.
- High risk cargo: truck needs to drive to a dedicated area for a special examination.

The table below presents the key observations concerning the current gate infrastructure and operational setup.

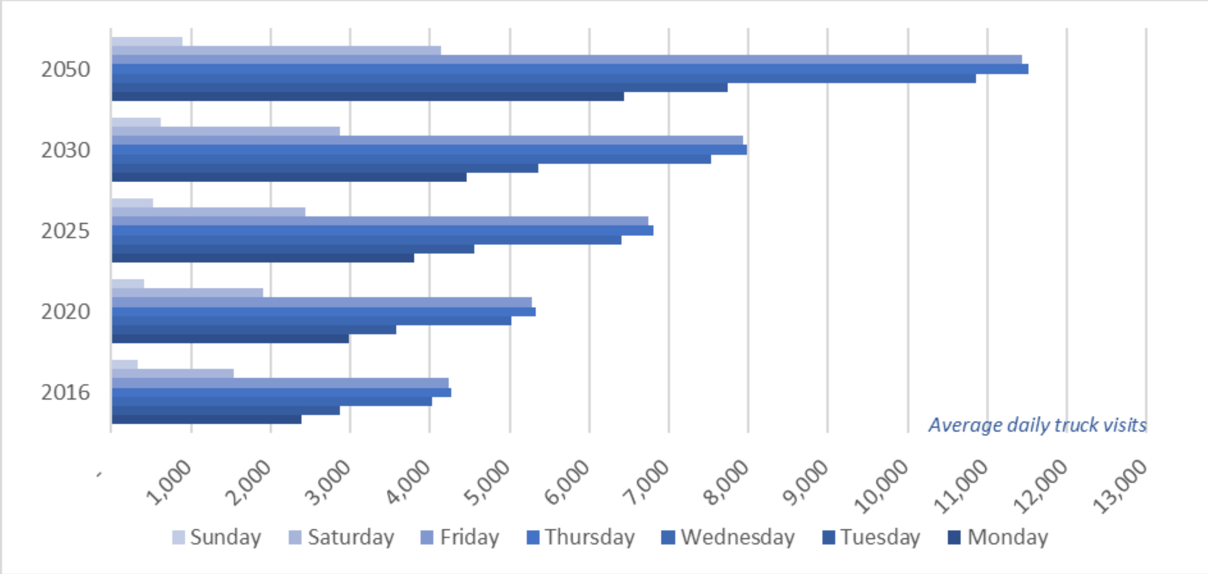
Table 8-2: Colombo Port Gates and Internal Roads - Observations

Category	Issue	Severity
Logistics	Inefficient use of gate infrastructure, due to substantial amount of manual handlings and lack of automation.	High
Logistics	The complete logistic chain need to adapt a 24-hour operational scheme to better distribute truck arrivals	High

8.2.3 Traffic demand and gates

The figure below presents the expected number of truck visits at the port in the long term, taking into account the traffic forecast for each of the main commodities that will be handled in the port of Colombo in the short term, mid-term and long term future.

Figure 8-4 Truck traffic forecast per weekday



Source: MTBS, based on SLPA gate registration data

Compared to the current situation, the traffic volume entering and leaving the port will almost triple between 2016 and 2050. In order to handle the increasing numbers of truck volumes, major upgrades will be required, both from a civil infrastructure point of view, and from a system point of view.

8.2.4 International best practices

In most ports in the world, the gate administration process and corresponding Customs activities are organised at the terminal level. In the case of Colombo, gate N°6 is currently used as the main port access gate, providing access to the 'inner' dedicated port area.

In the future, both the gate and the Custom processes can be (partially) automated, allowing for a more fluid traffic flow into and out of the port. On top of that, the gate process at each of the terminals within the inner port boundary can be optimised if the information obtained at the main gate is shared with the terminals.

Upgrade terminal gates

Currently, the gate processes at each of the terminals are still carried out manually. In the future, it is recommended to switch to more automated gate systems by using OCR technology (optical character recognition systems), capable of reading truck license plates and container numbers. Automated systems improve the gate performance and eliminate manual errors.

Gate Operating Systems (GOSs) manage and steer the diverse and localised gate processes and sub-processes used in modern terminal operations. Three main sub-processes can be identified:

- Truck driver ID cards used for identification and tracking of people and equipment.
- Optical Character Recognition (OCR) camera portals for fast and accurate registration of trucks and containers.
- Gate kiosks used as self-service terminals where truck drivers perform identification and registration tasks.

Truck driver ID card

Many terminals use Radio Frequency Identification (RFID) for the identification and tracking of people and vehicles entering the terminals. RFID tags are located on trucks and other assets or are integrated on access/ID cards, and are automatically read by RFID readers at the terminals. The data collected through RFID can be transmitted to the Terminal Operating System (TOS) and the Gate Operating System (GOS). RFID applications on terminals enable driver and vehicle identification as well as vehicle tracking, as the RFID card system can be used to automatically track all trucks and drivers present on the terminal. As such, RFID can serve as an access control system within the port and/or the terminal.

The two different types of identification have different purposes:

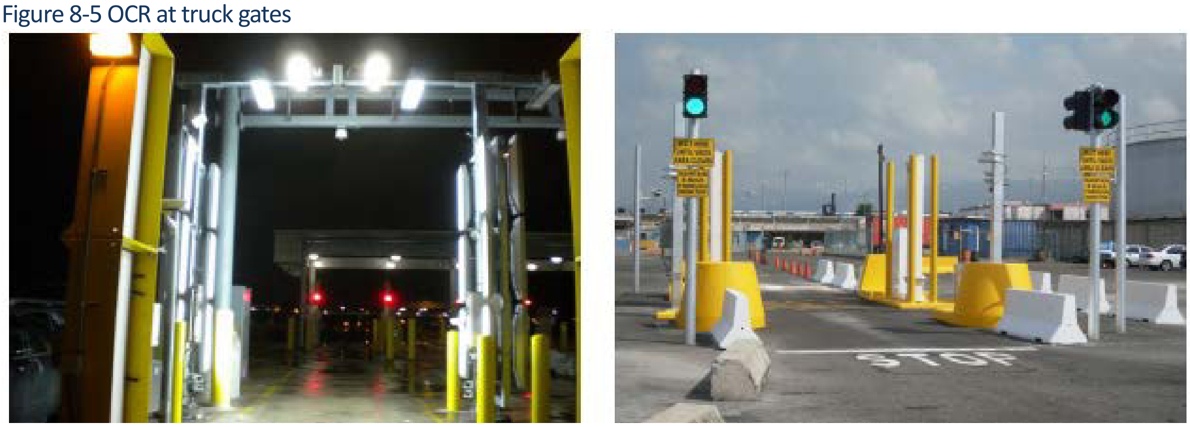
- **Truck Driver RFID card**
  This type of RFID access card is used for security and access control purposes. Usually, *passive* RFID cards are used, with photo ID and personal information printed and embedded on the card, optionally including biometrics.
- **RFID vehicle identification**
  - At the *gates*, it is used for lane matching between OCR portal and gate lane, linking the correct OCR data to the correct truck.
  - At the *out gates*, it is used to check if the correct truck combination is leaving the terminal: mandatory match between truck ID, container IDs and driver ID.
  - At the *interchange area*, it is used to ensure that the right container is (un)loaded on the right chassis.

Source: Camco Technologies

Optical Character Recognition camera portal

The OCR Camera portal enables terminals to automatically capture and process container data and obtain high-resolution images when recording trucks and cargo. The OCR camera portal accurately scans all incoming and outbound trucks, for automatic identification of trucks, containers, and trailers (see Figure 8-5). The system automatically detects and reads container numbers (ISO and non-ISO), ISO codes, trailer numbers, truck license plates, chassis numbers, IMDG dangerous goods labels, door direction, exact position of container on chassis, and container state (full or empty). Furthermore, the generated pictures are stored for damage claims management.

Figure 8-5 OCR at truck gates



Source: Port Equipment Manufacturers Association (PEMA)

Gate kiosks

Gate kiosks, as visualized in Figure 8-6, serve as self-service terminals where truck drivers perform identification and registration tasks while remaining seated in their truck cabin. All data is instantly checked with the Terminal Operating System (TOS) to optimise planning. This self-service concept significantly reduces operational costs and intervention times and increases overall throughput capacity.

When a truck arrives at the gate, the driver identifies himself at the kiosk, upon which the Terminal Operating System (TOS) is automatically notified on the job and location. During the actual load transfer, the need for human intervention is reduced as well.

Figure 8-6 Gate kiosks

Source: Camco Technologies

License Plate Readers

Gate automation solutions require License Plate Reader (LPR) systems that can read license plates of vehicles coming from various countries and/or states with the highest accuracy and in the shortest time possible. A reader takes a picture of the truck front, detects the license plate, and reads it with the highest possible accuracy. A downside of this technology is that the accuracy is less predictable than the reading of container numbers, as (i) the license plate is in one spot only whereas container numbers are repeated, (ii) the quality of plates is highly variable, and (iii) the variation in types, formats, and colours is unlimited. This may result in an increase of exceptions and helpdesk interventions because of incorrect LPR readings, thus creating more complex and less efficient gate processes.

Installation of gate automation will require various infrastructure works:

- Installation of gate portals equipped with camera's and illumination system
- Installation of gate kiosks or pedestals (communication/interchange between truck driver and gate system)
- Queueing lanes for the trucks in front of the gate portals

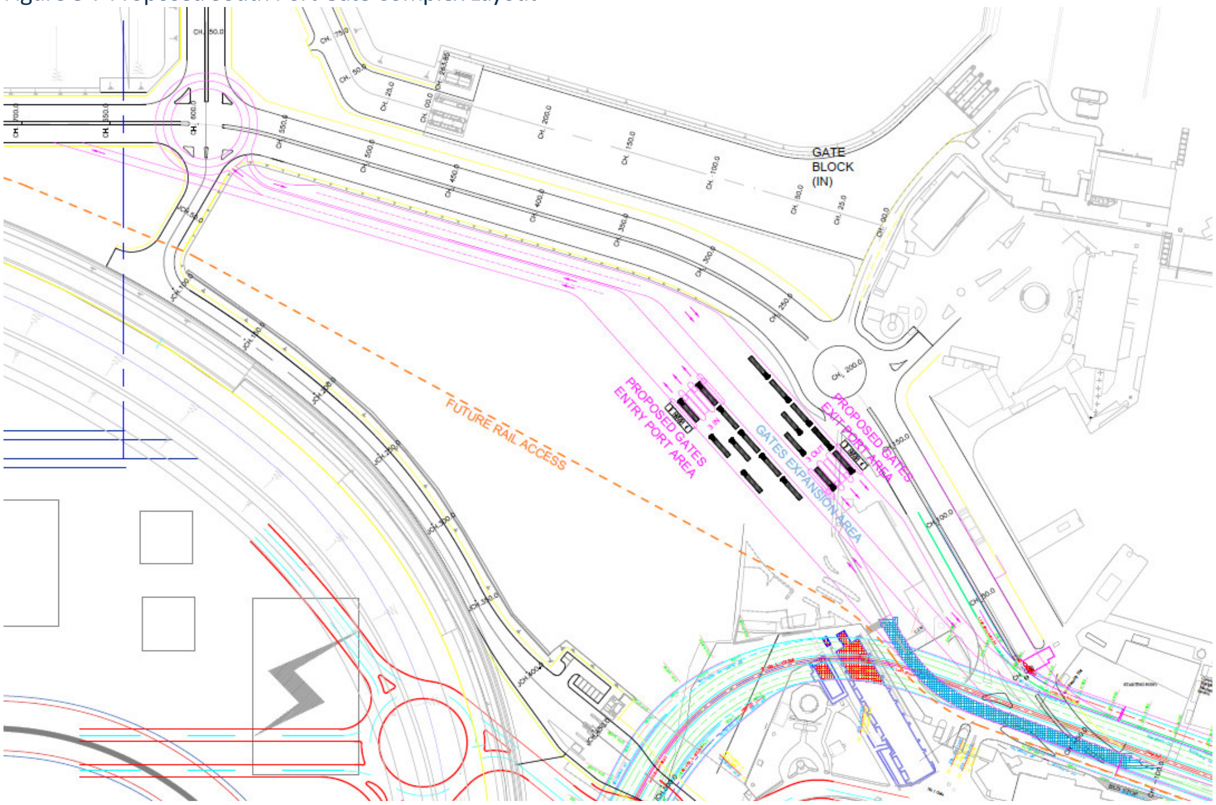
8.2.5 Recommendations and Short Term Priority Projects

At the Main Gate (Gate N° 6) – the north eastern access at South Port from the public road into the port area and currently the only access into the port for cargo traffic – upgrading and expansion works will be required to enable future traffic flows. At the moment, the gate complex consists of 3 in-gates and 3 out-gates. Both the in-lanes and the out-lanes need to be expanded from 3 lanes to 5 lanes. In the short term, the gate process itself also needs to be improved and automated to achieve shorter turnaround times at the gates.

At South Port, a dedicated gate complex will be constructed, enabling a direct connection between the Port Access Elevated Highway (PAEH) and the inner Port Road. Trucks entering the port will take the exit ramp from the PAEH and drive through the gate complex into the port. This port entry process needs to be highly automated. In order to cope with the future traffic forecast, a gate process cycle time of about 90 seconds is assumed for trucks entering the port area with an export container and a gate process cycle time of 30 seconds is assumed for trucks entering the port with an empty trailer to pick up an import container at one of the container terminals within the port.

Figure 8-7 shows a conceptual layout proposal of the entry and exit gate complex at South Port.

Figure 8-7 Proposed South Port Gate Complex Layout



In case the port exit gates reach full capacity due to peak hour arrivals in the late afternoon, trucks can always deviate to the Main Gate complex (Gate N° 6) at the north eastern side of the South Port to leave the port area.

The main recommendations are:

R10. **To expand the Main Gate** complex from 3 in-gates and 3 out-gates to 5 in-gates and 5 out-gates, and increase automation of the gate processes;

R11. **To construct a new gate complex at South Port**, enabling direct access from the inner Port Road to the Port Access Elevated Highway (PAEH); and

R12. **To cooperate with the port community** to better distribute the truck arrivals over the available working hours.

These recommendations lead to the following short-term priority project, which will be further discussed in section 15:

SP8. **Port Gate Upgrade Plan**, including an expansion of the current main gate from 3 in-lanes and 3 out-lanes to 5 in-lanes and 5 out-lanes, and a new gate complex that directly connects the South Harbour to the PAEH.

8.3 Warehousing

> SLPA needs to decide in what way it can and will compete as LCL handling operator with private parties. This decision will shape the requirement for new LCL handling facilities, as current facilities will be shut down due to construction of the PAEH and the new passenger terminal. For MCC cargo handling, a new 2 ha facility should be constructed within port limits, near the terminals and preferably in the corner of CICT and WCT.

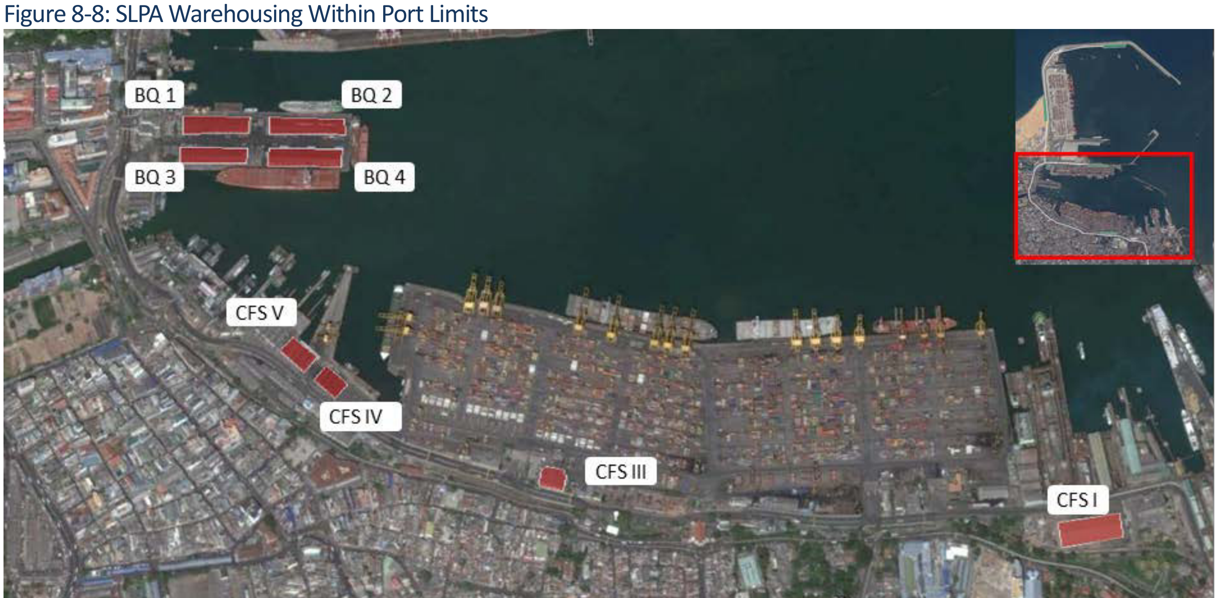
8.3.1 Introduction

This section provides the current overview of logistics infrastructure (operated by SLPA) within the Colombo Port area, and defines the development needs to cope with future demand in terms of warehousing activities.

8.3.2 Overview of Current Situation

The figure below displays SLPA warehouses within port limits, with CFS I recently being constructed.

Figure 8-8: SLPA Warehousing Within Port Limits



Description	Type of Cargo	Capacity (m^2)
BQ1	General non-dangerous cargo	5,000
BQ2	Local cargo/Transhipment/Dangerous cargo	5,000
BQ3	General non-dangerous cargo	5,000
BQ4	Transhipment/MCC cargo	5,000
CFS I	General /Dangerous Cargo	7,000
CFS III	Bonded Cargo	1,300
CFS IV	General Cargo	2,388
CFS V	Bonded Cargo	2,397

Description	Type of Cargo	Capacity (m^2)
CFS-Peliyagoda*	General Cargo	19,500
Total		**52,585**

*Not in figure

Currently, SLPA handles all LCL cargo at the CFS warehouses within the port limits and at its warehouse at Peliyagoda (outside the port limit). Recently, the LCL cargo handling has been liberalised, meaning that private parties can perform these activities as well. There is no operational constraint for private parties to deliver the same service at an equal or lower price. SLPA should decide if, and at which scale, it wants to continue its LCL handling activities in competition with private parties. SLPA could also act as a landlord for a new warehouse tenant that operates the areas it is assigned to by SLPA.

The following short term developments will take place regarding these facilities:

- The construction of the passenger terminal at BQ will lead to the closure of the warehousing facilities per 2019. The dangerous cargo handling will shift to CFS I. For MCC cargoes, a new warehouse is required. If SLPA wants to continue its LCL operations on the same scale, warehousing adjacent to the new MCC location is possible. In this regard, a warehouse is planned at UCT.
- CFS III, IV and V are to be removed due to the construction of the elevated highway as per 2018. If SLPA wants to continue its LCL operations on the same scale, warehousing adjacent to the new MCC location is possible.
- CFS I has started operations in the course of 2017, as a replacement of the previous warehouse that burnt down.
- Peliyagoda will remain operational for LCL/FCL cargoes.

Peliyagoda

The Peliyagoda facility was originally a UDA facility; hence, it was not designed and built for the task it is used for today. As such, the Peliyagoda facility has several (solvable) bottlenecks:

- Space constraints inside and outside facility.
- Higher roof is needed.
- No high racks with fork lifts to optimize pelletized cargo operations.
- Stuffing is taking place next to warehouse in a smalls strip causing congestion at the section.
- Several employees on the floor are not involved in operations.
- Cargo is stalled inefficiently.
- Safety procedures are not adhered to by staff (e.g. helmets and such).

There are gains to be made by investing in equipment and warehouse tools for the facility to make efficient use of the space available. For the facility to compete with private parties it should adhere to industry standards.

Figure 8-9: Log ventures Facility (left)* - Peliyagoda Facility (Right)

*The picture is used for marketing purposes and might not reflect reality on the floor, but it does show the added value of racks

The table below presents the key observations and recommendations regarding the Warehousing and Logistics activities.

Table 8-3 Warehousing & Logistics - Key Observations

Category	Issue	Severity
Infrastructure	Transit sheds are used as warehouses, but are not adequately equipped to handle the MCC and LCL cargoes. Additionally, layout / spacing of the transit sheds is not suited for the current operations.	High
Operations	Operations are carried out through manual documentation.	Medium
Equipment	Equipment is outdated and in poor state.	Medium
Systems	There is a lack of an efficient automated warehousing system.	Medium

8.3.3 Warehouse Demand

The table below summarizes the key assumptions that have been applied in order to calculate the future needs of warehousing capacity.

Table 8-4: Assumptions on MCC and LCL development requirements

Item	Unit	MCC	LCL
MCC Share of Transhipment Cargo	%	0.3%	-
LCL Share of Gateway Cargo	%	-	2.1%
Operational Days	# days	365	365
Dwell time (average)	# days	6	6
Occupancy rate of facility	%	70.0%	70.0%
Free stacking height (warehouse)	m	7	7

It is assumed that both the MCC share of transhipment and the LCL share of gateway cargo will remain constant throughout the projection period. The table below presents the results of the capacity calculations.

Table 8-5 Capacity Requirement CFS area MCC/LCL

Item	Unit	2016	2025	2030	2050
TEU Forecast MCC	TEU	8,047	21,614	27,113	67,186
CFS Area Requirement MCC	ha	0,25	0,29	0,37	0,92
TEU Forecast LCL	TEU	27,297	46,350	56,966	84,059
CFS Area Requirement LCL	ha	0,37	0,63	0,78	1,15

Currently, MCC of transhipment boxes mainly takes place at the BQ2 and BQ4 warehouses. These activities are an important service to the transhipment business, as transhipment boxes can be reshuffled to optimise logistics. With the transformation of BQ into a passenger terminal, a new facility should be developed; the new location should be close to the container terminals to limit trucking distance to and from the warehouse.

Two hectares (20,000 m^2) should be reserved immediately to ensure expansion options. The first phase should be a shed of approximately 8,000 m^2. The warehouse should be designed as high as possible to make best use of the land, although it is noted that dimensions of a substantial share of cargo from the stripped containers prohibits efficient storage in racks. However, in the area requirement calculations, a free stacking height of 7m is assumed, in order to optimize storage logistics of cargoes that can be pelletized. Possible locations for the new warehouse are discussed in the pre-feasibility for the BQ warehousing relocation in section 19.2.1.

8.3.4 International Best Practices

Apart from the CFS I warehouse that was recently constructed, all other SLPA warehouses currently in use are very old and in a poor state. Future design and development of additional warehouses should be based on modern standards.

Design characteristics

In terms of design, the following typical dimensions are used in state-of-the-art warehouses:

- Length between 100m and 250m (depending on the type and size of products).
- Width between 80m and 120m.
- Height between 7m and 15m (free stacking height).

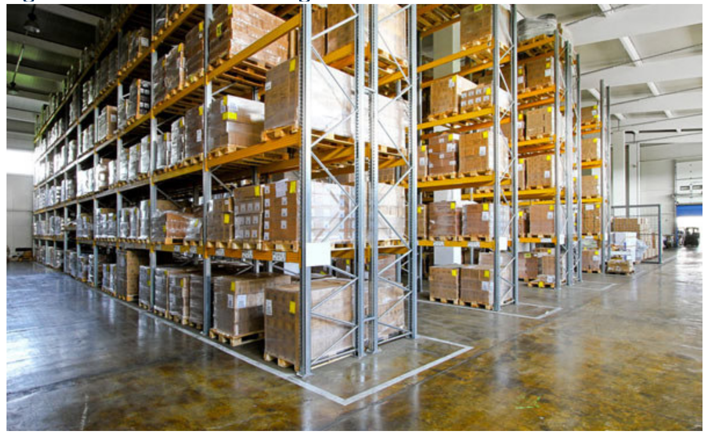
To facilitate a high performing truck loading and unloading process, the warehouses need to be equipped with truck loading bays or docks.

The docking platforms can be levelled to enable accessibility for various types of trucks and trailers. The (un)loading area

Figure 8-10 Warehouse Truck Loading Bays

is fully covered or sheltered, allowing for efficient all-time and all-weather operations, also for weather sensitive cargo.

Figure 8-11 Warehouse Storage Racks



To minimise the required land area, the use of high stacking infrastructure and equipment is required. Modern logistic warehouses are designed for a free stacking height varying between 7m and 15m, depending on the type and size of the products.

The installation of storage racks will allow for multi-level stacking of the palletised goods and products. Depending on the configuration of the storage racks and the assumed maximum stacking height of a standardised pallet with corresponding maximum pallet weight, stacking will be allowed at 4 to 7 levels (including ground level).

Equipment

For each of the activities at the warehouse and logistics centre, specific types of equipment will be required:

Figure 8-12 Forklift

<u>Stuffing and stripping of containers: forklift 1.0-2.0 ton</u>

A container with palletised cargo can be unloaded (stripping) or loaded (stuffing) with specifically designed small forklifts with a loading capacity between 1.0 and 2.0 ton.

Due to its limited dimensions, this type of forklift is able to drive in and out the container and requires limited manoeuvring spaces. Depending on the type of products or commodities, the engine of the forklift can be either diesel-driven, gas-driven or even electric driven.

Figure 8-13 Electric Pallet Truck

<u>Loading and unloading trucks: electric pallet truck</u>

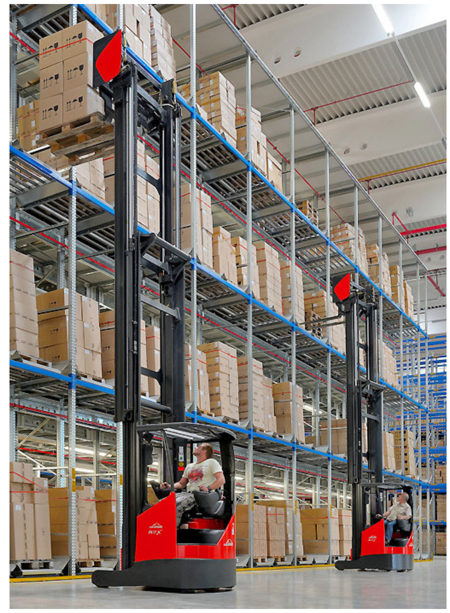
This type of equipment is specifically designed to unload a truck or container filled with palletised cargo. Due to the availability of loading bays, the electric pallet truck can easily drive into and out of the truck, trailer or container chassis.

This type of equipment is electrically driven, powered by a battery system. Current capacity of the battery system allows for an 8-hour shift of normal operations before (re)charging is necessary. Proper equipment fleet management and follow-up will be required.

Warehousing and storage area: reach truck

A reach truck is a typical type of forklift that is used in warehouses to stack pallets up to 10 to 15 m high. Based on the specific technical design, a reach truck only needs very limited manoeuvring space, hence narrow aisles can be designed in order to optimise the stacking capacity of the warehouse.

Figure 8-14 Reach Truck



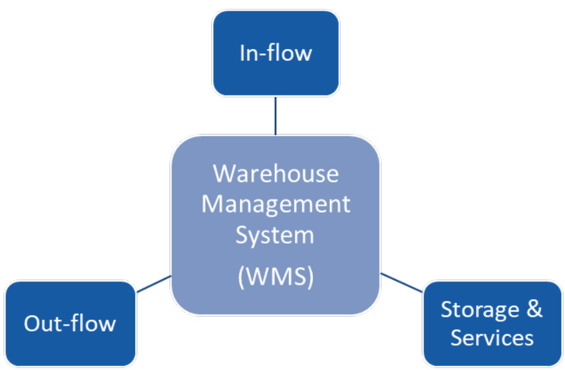
Similar to the electric pallet truck, a reach truck is electrically driven, with battery capacity allowing for an 8-hour operations shift without the need to recharge. This enables flexible planning and organisation of the available resources within the logistics warehouse.

Operational setup and organisation

Similar to a container terminal, a logistics warehouse is managed by a warehouse management system (WMS). The WMS system records every activity or process and manages all the individual (pallet) stacking positions within the warehouse. Additionally, the WMS system can be used to manage stock or inventory levels.

A basic overview of a warehouse management system setup is shown in the figure below.

Figure 8-15 Warehouse Management System



Subsequently, Figure 8-16 provides a high-level visualisation of the operational processes within a logistics warehouse.

ADB

Technical Assistance Consultant's Report

Project Number: 50184-001
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Democratic Socialist Republic of Sri Lanka: National Port Master Plan

(Financed by the Japan Fund for Poverty Reduction)

The Colombo Port Development Plan – Volume 2 (Part 3)

Prepared by

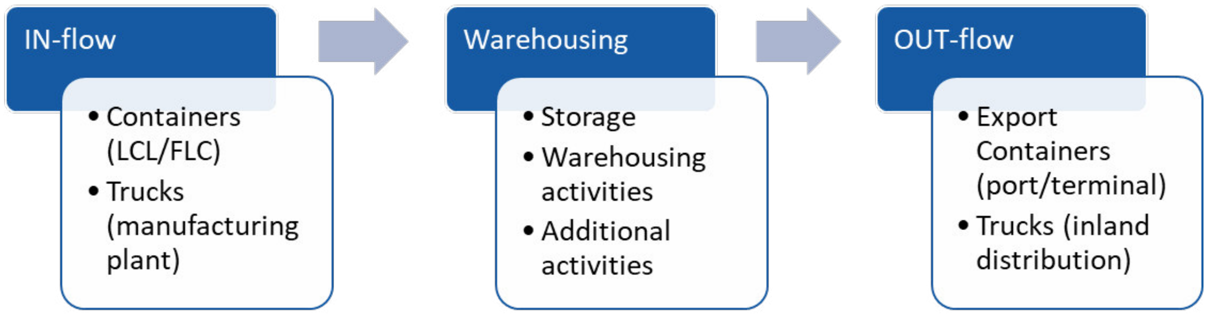
Maritime & Transport Business Solutions B.V. (MTBS)

Rotterdam, The Netherlands

For Sri Lanka Ports Authority

Asian Development Bank

Figure 8-16 Warehouse Logistics Process



Three main flows can be identified:

- Incoming flow: products or goods discharged from a truck or unloaded from a container.
- Warehousing cargo flow: storage of the palletised goods within the warehouse and – if applicable – registration/follow-up of additional value added activities like re-packing, labelling, price-marking, etc.
- Outgoing flow: products or goods leaving the warehouse via truck or loaded into a container.

The use of pallets is one of the basic and most fundamental requirements of modern warehousing activities and operations. All incoming cargo or products that are not yet palletised need to be stacked on (standardised) pallets during or directly after unloading a truck or un-stuffing a container. A dedicated follow-up of pallet stock management is of paramount importance to carry on the logistics activities.

After palletising the goods, the content of each pallet needs to be inventoried and this data needs to flow into the warehouse management system. This can be done either manually, with barcode readers or with mobile data terminals, or automatically. Subsequently, the warehouse management system will determine a suitable stacking location for each of the pallets, depending on the stacking dimensions and the corresponding weight.

8.3.5 Recommendations and Short Term Priority Projects

Compared to the modern way of operating a logistics warehouse, the current SLPA infrastructure and corresponding operations are lacking efficiency. In order to increase the stacking density and upgrade the performance of the logistics services, palletising of the incoming and outgoing flows of goods is considered an absolute requirement. This service can be offered (and charged for) in case the incoming goods arrive at the SLPA CFS area in a non-palletised form.

The following recommendations can be made regarding SLPA's warehousing design and development:

R13. Design and construction of a **new warehouse to cover the MCC** operational requirements in the future.
R14. Investment in new equipment (pallet trucks, reach stackers) to **operate the logistics warehouse.**
R15. Procurement of a modern, state-of-the-art **Warehouse Management System (WMS).**

These recommendations lead to the following short term priority projects related to warehousing at the port:

SP9. **BQ Warehousing Relocation Plan –** Current Warehouses on BQ need to be relocated to ensure continuation of operations. Additionally, new equipment needs to be procured and a modern Warehouse Management System needs to be adopted.

8.4 Demolishment and Relocation

8.4.1 Demolishment

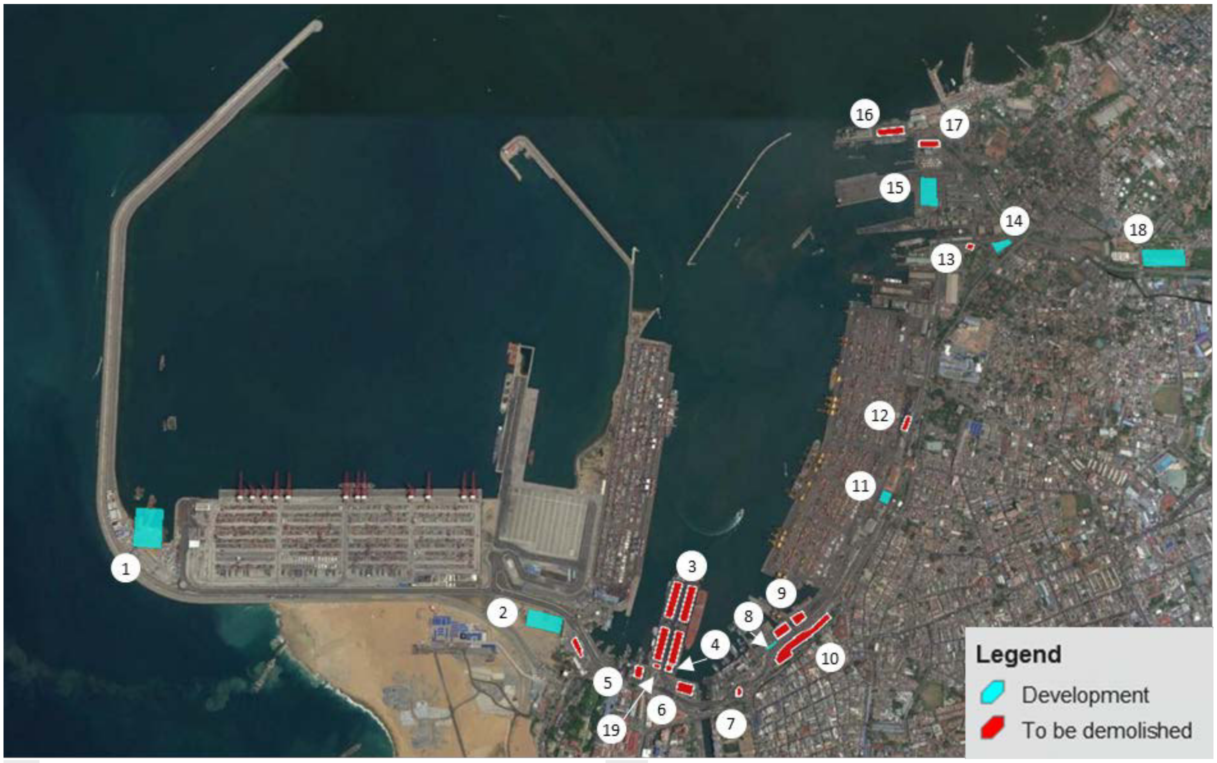
The port has several buildings and warehouses that are subject for demolishment due to their end-of structural life and or to be disposed because of new developments like the PAEH. Some of the buildings are still in function and it remains questionable whether safety of goods and personnel can be assured. Further, subject to the port to become a modern, clean and safe port, some the structures should be demolished and replaced.

The following picture shows the buildings that need to be demolished in red and relocation issues in blue.

Figure 8-17 presents the envisioned demolishment of buildings in the port.

- **BQ warehouses –** (nr. 3) In order to free the BQ area for the new passenger terminal the warehouses/transit sheds need to be relocated. Options are the Bloemandhal hill, the Corner of South port and the triangle.
- **BQ Welfare building –** (nr. 4) same as above.
- **Equipment workshop –** (nr 5.) this building has reached economic life.
- **Japanese workshop –** (nr. 6) this building has reached economic life.
- **Building near gatehouse –** (nr. 7) this building is need to be moved due to the PAEH developments.
- **Warehouse CFS IV and V –** (nr.9) these buildings need to be improved for efficient handlings. Due to a policy to have warehousing centred these buildings would become obsolete once.
- **Workshops electrical and mechanical –** (nr.10) this building is need to be moved due to the PAEH developments.
- **Workshop JCT –** (nr.12) this building is need to be moved due to the PAEH developments and JCT gate improvements.
- **Fuel station –** (nr.10) this facility is positioned wrongly in terms of logistics in the port and is preferably relocated.
- **Warehouse on PVQ –** (nr.16) this facility is used by detained cargoes by customs and has reached economic life. The goods should not be stored in the port area near a quay.
- **Warehouse near cement factories –** (nr.17) this facility has reached economic lifetime and needs to be removed.

Figure 8-18: Development & Demolishment Port Building



1	Optional Development – BQ Relocation	10	Workshops Electrical and Mechanical – to be demolished
2	Optional Development – BQ Relocation	11	Workshop JCT to be established
3	BQ Warehouses – to be demolished to create passenger terminal	12	Workshop JCT to be demolished
4	BQ Welfare Building – to be demolished to create passenger terminal	13	Fuel Station – to be relocated (see point 8)
5	Equipment workshop forklift trucks – to be demolished	14	Workshop electrical and mechanical to be created
6	Japanese warehouse – to be demolished	15	Optional Development – UCT new Warehouse
7	Building near Gate house – to be demolished	16	Warehouse on PVQ pier to be demolished
8	Optional location for fuel station in future	17	Warehouse near cement factories to be demolished
9	Warehouse CFS IV and V – to be demolished once new warehouses are offered	18	Optional Development – New warehouse location (BQ Relocation)
		19	New administration building – a new SLPA office is planned at the Beira canal

8.4.2 Relocations

Due to the PAEH developments several buildings are affected. SLPA have made a detailed plan for the relocation of affected buildings.

The main observation is that mechanical and electrical workshops have to be relocated. These are relocated to an area near Aluthmawatha underpass as explained in the picture below. The new workshops shall have multi-level stores to ensure that the floor spaces are sufficient while the ground spaces will become less compared to the old situation.

Figure 8-19 presents the envisioned buildings for relocations in the port.

- **Optional location BQ warehouses –** (nr. 1) is an optional location for the BQ warehouses.
- **Optional location BQ warehouses –** (nr. 2) is an optional location for the BQ warehouses.
- **Optional location for fuel station –** (nr. 8) this area is centrally located and, after PAEH has been created and warehouses are relocated it would become a good location for the fuel station.
- **Workshop JCT to be established –** (nr. 11) A new workshop for JCT is required as existing ones are replaced for PAEH and Gate activities.
- **Workshop electrical and mechanical –** (nr. 14) these facilities can be located in this area subject to a multi store buildings and provided that the area receives with clear access and sufficient equipment parking.
- **Optional development warehouse UCT–** (nr. 15) As the passenger activities may actually already start at BQ, one of the warehouses of BQ needs to be emptied. To provide for additional space a warehouse can be created near UCT.
- **Optional development BQ warehouse–** (nr. 18) this area is the preferred location for LCL handling in the port and can replace the BQ warehousing areas
- **New administration building –** (nr. 19) the offices located in the old administration building will be consolidated in a new multi store level building to be created at the Beira canal (opposite point 7 on the map). The new office will have a bypass into the port so that personnel can easy access the port area from the building. The building will also hold a coordination centre of the PAEH as well as road traffic management systems.

8.4.3 Short Term Priority Projects

SP10. **Mechanical and electric workshops. –** Due to the PAEH project, a number of buildings need to be relocated.

SP11. **The resettlement of underutilised buildings**

9 Connectivity and Hinterland

9.1 Introduction

This chapter aims to describe the accessibility of the port both from a nautical perspective as well from a hinterland perspective.

- This chapter starts in section 9.2 with an overview of the current nautical access and the major recommendations: Automation of harbour master operations can greatly increase safety.
- Section 9.3 presents connectivity by roads including a section on the PAEH, the effects on the current port connectivity and the major recommendations: Port roads and port gates are of great concern to the connectivity. With the construction of PAEH opportunities and threats (if not properly executed) arise for modernisation.
- Section 9.4 describes the connectivity by rail and the multimodal options including the recommendations and short term priority projects: Transport by rail is currently not feasible in Colombo port, but SLPA should strive for securing a rail path for future flexibility in this regards.

9.2 Nautical access and navigation

Accessibility is the most important feature for the port to facilitate trade. This relates both to waterside accessibility (access channel, navigational constraints, water depth at berths), and to landside accessibility (connectivity to highways, gate capacities, and rail connections). The port of Colombo is characterised by a single entrance channel that leads to two main port basins. The land connectivity is provided by one main road connection towards the Northeast.

9.2.1 Current situation

Port limits - The limits of the port of Colombo are defined by a rectangular area that extends 9nm into the sea, starting from the entrance to the port.

Approaches - The port is approached from the NW and entered through one of three entrances. The main entrance leads to South port and to one of the entrances to the old basin. The two entrances to the old basin lie on either side of a detached breakwater named the Dolphin, situated between Galbokka Point and Mutwal Point (1.75nm NE).

Main entrance - The main buoyed channel that connects to the South Harbour (about 3.8nm long, with a width of 630m) has a dredged depth of CD -20.0m towards the harbour, and CD -18.0m within the basin. The basin has a turning circle with a diameter of 1,300m.

West entrance to old basin - The inner part of the approach to the old basin has a dredged depth of CD -16.0m into the harbour, with a 450m wide turning circle between SAGT and JCT. The width of the entrance is approximately 123m.

North entrance - The buoyed channel, which was re-opened in Sept 2009 following a 10-year closure for security reasons, has a dredged depth of 13.0m. A shoal depth of 8.6m lies 0.1nm North of the head of the North East breakwater. Within the breakwaters, the central part of the harbour has a large dredged area; the North part is dredged to 14.0m, while the South part is dredged to 15.0m. Several sections of the area surrounding the central part are dredged to lesser depths. The South end of the harbour is connected to Colombo Lake by a canal with locks. Fixed low bridges make the canal non-navigable.

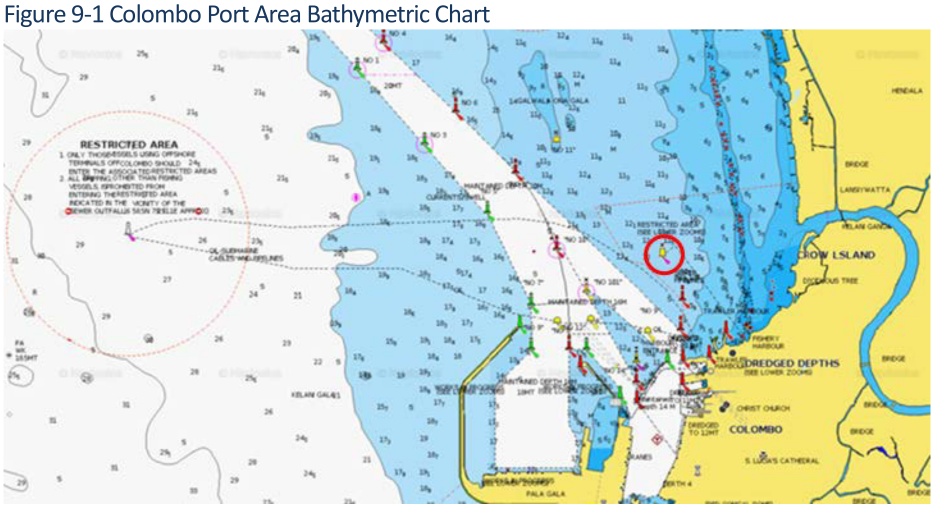
Remarks - A scend of up to 1.0m can be experienced within the harbour, thereby reducing depths accordingly. Additionally, water depths in parts of the harbour have been reported to be up to 3.0m shallower than charted. Furthermore, two pipelines cross the entrance channel, of which only the northern pipeline is used to connect to the offshore SBM. Additionally, a sewer pipeline (marked red) is located off the shore, close to the north entrance.

There was a large accident in 1990s: a large vessel hit a smaller berthed vessel, which consequently capsized. Since then, an escort tug service was introduced. The escort tug is secured to larger vessels upon entering the port area (within the breakwaters).

Port navigational operations stop when:

- Swell is > 3 m
- Wind is > 30 knots
- Roll is > 5 – 10 degrees

Figure 9-1 Colombo Port Area Bathymetric Chart



The table below provides a more detailed overview of navigational data and restrictions in and around the port of Colombo.

Figure 9-2 Colombo Port Nautical Information

Nautical information	Description
Tidal range and flow:	Range: Springs 0.6m, Neaps 0.2m.
Dock density:	1025
Weather	Prevailing winds: SW'ly and NE'ly monsoon.
Swell	During the SW monsoon a disturbed swell, combined with an E'ly set, may be experienced across the W entrance of the harbour.
Current	During the NE monsoon a current, setting North along the coast with a rate of up to 1.5kts may be experienced off the harbour; this results in an East set across the West entrance of the harbour.
Visibility:	During the SW monsoon visibility is often poor.

Nautical information	Description
Principal navigation aids:	Colombo Lighthouse "Galbokka". Monument (82m high) (06°56.3'N 079°50.5'E) Ratmalana RDF beacons.
Restrictions	• Restrictions: Vessels under sail may only enter between 0600-1800hrs. Other vessels, no such restriction. • Restricted areas: A restricted area is established, radius 1.2nm centred on the SBM in position 06°58.7'N 079°46.5'E. • A restricted area is also established, radius 0.4nm, centred on the SBM in position 07°01.7'N 079°48.8'E. • A restricted area, radius 1,000m, is established around the CBM, centred on the pipeline end manifold (07°00.9'N 079°49.9'E). • Restrictions of between 300m and 500m also apply on either side of the pipelines extending SE then E from the above installations. • Caution: Entry into the above restricted areas is only for vessels using the terminals, and vessels should neither anchor nor trawl in the vicinity of the pipelines. • Restricted area (outfall): All vessels other than fishing vessels are prohibited from entering the restricted area in the vicinity of the sewer outfall (06°58.5'N 079°50.9'E). • LPG CBM: If berthing is not scheduled for arrival the LPG vessel must anchor at least 20nm from Colombo, for security reasons. When berthing is ready the vessel must be 2nm W of • CBM at 0600hrs ready for pre arrival inspections. Berthing will be performed during daylight (0600-1600hrs) only, unberthing at any time.

9.2.2 Development requirements on port access and turning basins

The navigational channel towards the port has a width of 630m, which is sufficient for two-way traffic. According to PIANC guidelines, the following formula should be applied to calculate the required channel width:

- One-lane channel: $W = W_{BM} + \Sigma W_i + 2W_B$
- Two-lane channel: $W = 2 * (W_{BM} + W_B + \Sigma W_i) + W_P$
- in which: W_{BM} = basic width (1.5-1.7 * ship's beam)
  W_i = width additions (depending on winds, currents, waves, etc.)
  W_B = bank clearance
  W_P = distance between two lanes
- In the case of Ultra large container vessels with a beam of 60m, $W_{BM} = 102m$

For turning basins the following formula is used:

- Rule of thumb: D = 2 * Length of design vessel (normal tug assistance)
- In case of high freeboard and wind/current: more
- In case of calm waters and extra tug assistance: less
- Limited space available: less, subject to simulations
- In the case of Ultra large container vessels with the LOA of 400m the D = between 650m and 800m

9.2.3 Recommendations and short term priority projects

The following recommendations are made:

R16. **Vessel traffic guidelines and vessel traffic management should be further implemented**. Due to increased traffic to the South Port in the future, vessel traffic management will become more important. The traffic management guidelines need to be reviewed and sharpened in relation to vessel traffic and risks involved. For example, vessels moving from the old basin and from the South port should not coincide. A safe time buffer between moves could be simulated in order to identify suitable traffic guidelines.

R17. The existing **cruise berth needs maintenance** dredging and a new mooring dolphin to receive vessels of up to 260m.

R18. For **future port basins, a 700m wide turning basin is recommended**.

R19. For **future port basins, a width of approximately 600m is recommended.**

R20. **Maintain the water depths** in the two port basins at design drafts (South Port basin 18m, Old port basin 13-15m)

The short term priority project related to the nautical access is mainly focussed on the deepening of the port basin towards PVQ and is part of the PVQ upgrade plan, further discussed in section 15.

9.3 Roads

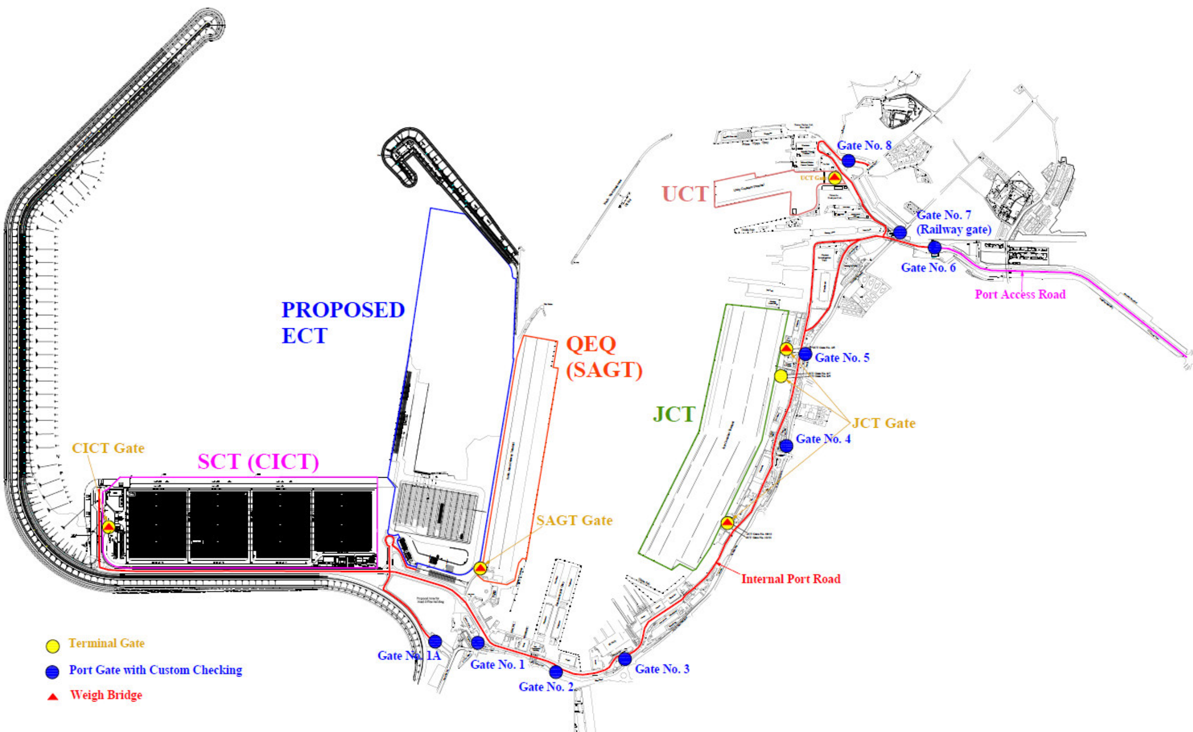
9.3.1 Current situation

Existing gates

Port of Colombo has nine gates, including a railway gate. At these gates, Sri Lanka Customs controls the movement of goods and personnel. The map below shows the gates of the Port of Colombo.

From the port's exit gates, trucks can enter Colombo's city road network towards the A01 highway to the East, which subsequently connects to the E01 expressway towards the South and the E03 expressway to the North.

Figure 9-3 Colombo Port Gates



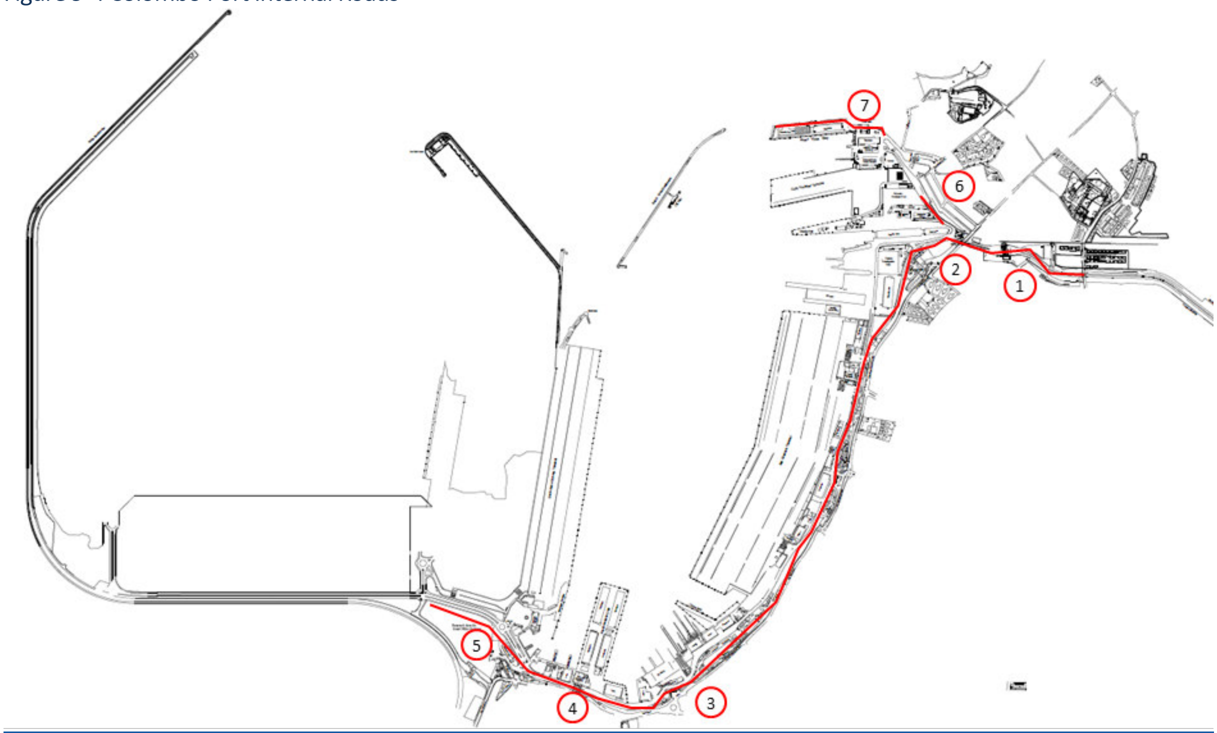
Gates	Name	Approximate Location	Purpose Description
Gate 1A	Gate No 01 A	Galle Face	Small vehicles and personnel (In & Out)
Gate 1	Main Gate	SLPA Office	Small vehicles and personnel (In & Out)
Gate 2	Leydan Bastian Gate	Bastian Road	Exit gate for small vehicles and vans (for BQ)
Gate 3	Export Gate	Main Street	Main gate for small vehicles and personnel (In & Out)
Gate 4	St. Anthony's Gate	St. Anthonys Church	Closed but occasionally used for trucks
Gate 5	J.C.T. Gate	Jaya Container Terminal	Closed but occasionally used for trucks
Gate 6	New Port Access Road Gate	Port Access Road	Main gate for trucks (containers & bulk) (3 In & 3 Out)
Gate 7	Railway Access Gate	Colombo Dockyard PLC	Railway gate (one track)
Gate 8	De Saram Gate	St. Andrew's Road	Dry bulk and Empty truck gates (2 In & 2 Out)

All gates in the Port of Colombo have height constraints, due to roofing above the gates; the minimum height is 5.2m. Trucks with heights exceeding 5.2m have to pass through a temporary gate near gate 2. These trucks also have to pass the administration building on the northern side because the bridge in front of the building only allows trucks of up to 4.5m.

The picture below shows the main internal port roads. Several sections that require attention during the first 5 years of the Master Plan are marked red and further elaborated on in the table below.

Marks 1 to 5 indicate sections of the port access road, which is the current backbone for all truck traffic in and out of the port. The road is in reasonable state, but will be affected by the construction of the Port Evaluated Highway (PAEH), which is to be constructed above the port access road. Several sections of the port access road shall be upgraded to arrive at 6 lanes; the 2 middle lanes will be reserved for PAEH construction activities. As such, 4 lanes will remain available during PAEH construction.

Figure 9-4 Colombo Port Internal Roads



#	Location	Description
1	Main gate	The main gate currently has six gates. Most of the time 2 are used for exports, 3 for imports and one service lane.
2	Underpass of Aluthmawatha road	The under pass has four lanes in width. In order to have six lanes this bridge needs to be upgraded. Next to the underpass a high voltage cable is located. This has been incorporated into the road works for the PAEH.
3	Gate 3	This is the main gate for personnel and services towards the warehouses at BQ, the terminals of BQ and JCT as well as towards South Port (CICT/SAGT). The gate has the main function to connect the city with the port. Other gates also provided access such as gat 1 and gate 0, however the main gate 3 is best located access from the city.

#	Location	Description
4	Bridge at Admin building	The bridge in front of the admin building is providing a height obstacle as current allowance is 4.5m. Under the PAEH project the road is expected to be lowered by 0.5m and the bridge (after demolishing) will be erected newly with 0.3m creating and new underpass height of at least 5.2m
5	Ramp up and ramp down	The bare land near gate 1 and gate 0 ("The triangle land") will be used in future for locating the ramp down and ramp up for the Evaluated Highway. By careful planning the section of land will also has a reservation for a railway track which can be erected once rail cargo is lifted into the country. (see also dry ports)
6	Connection to PVQ and guide pier	The road connection to PVQ is currently in poor conditions. The road needs rehabilitation.
7	Road access to/from Flourmill	The road at the back of the flour mill at PVQ is in a deteriorated state and needs to be rehabilitated to ensure trucks with flour can pass safely at the northern side and not across the quay, which is today's practise.

9.3.2 Port Access Elevated Highway

Overview

The Port Access Evaluated Highway (PAEH) is a project launched by the RDA to reduce traffic congestion to and from the city. The figure on the right shows the envisioned route of the PAEH.

Figure 9-5 Port Access Elevated Highway

The elevated highway runs from the New Kelani Bridge Project (NWB) (northern part) to the Fort at the southern part of the port. The path of the PAEH follows a similar path as the existing internal port road and is elevated 10m above ground level.

The PAEH project is currently in the detailed design phase, and comprises the following key features:

- Total length of 5.2 km.
- 2 city ramps and 1 port ramp.
- Dual lane in both directions.
- 80 km per hour speed limit.

Port Sector Impact

- The PAEH may substantially reduce congestion in Colombo, thus enabling more efficient truck transport between the port and the cargo destinations/origins.
- As the PAEH will run directly above the port access road, the development may impede subsequent development of the port access road.

9.3.3 Development requirements concerning port roads

Despite the considerable amount of road projects regarding the improvement of Sri Lanka's key transport corridors that are underway, projects that adequately address the direct connectivity of the port of Colombo are lacking – with the exception of the PAEH. To alleviate the current port road congestion, the following development projects have been identified:

- Optimization of the gate process – automation of the gate process could substantially reduce the truck waiting times. Additionally, a flexible gate system, which enables most gates to function as entry (exit) gates when substantial truck inflows (outflows) occur, could further decrease truck waiting times.
- Widening of the port access road – irrespective of the PAEH development, the port access road should be widened from 4 to 6 lanes, in order to increase the capacity. The section underneath the Aluthmawatha road cross-over, shown in the figure below, should also be widened to a 6-lane road.
- Signalling should improve the use of the six lanes, for example two lanes for the gates and one lane for interterminal traffic.
- Ramps near Fort end should have gates with sufficient space to align trucks.
- Ramps near Ingurukade junction should not have cross-over traffic. This can be realised by an under-pass or an over-pass.
- The slope of the ramps-up should not be greater than 4%.
- In the port, a railway path should be assigned under the PAEH to retain the possibility to develop a rail connection to the South Port in future. Additionally, sufficient space and height (5.2m) should be planned at the PAEH off-ramp near fort-end to develop a rail track in the future.

Figure 9-6 Aluthmawatha Road Cross-Over

9.3.4 Recommendations and short term priority projects

Following the analyses in the preceding sections, the following recommendations related to roads are made:

R21. **Optimization of the gate process** – automation of the gate process could substantially reduce the truck waiting times. Additionally, a flexible gate system, which enables most gates to function as entry (exit) gates when substantial truck inflows (outflows) occur, could further decrease truck waiting times.

R22. **Widening of the port access road** – irrespective of the PAEH development, the port access road should be widened from 4 to 6 lanes, in order to increase the capacity. The section underneath the Aluthmawatha road cross-over, shown in the figure below, should also be widened to a 6-lane road. By having a six lane road the terminal traffic generated in South port and the old port basin can be accommodated till congestion may re-occur due to South port max development. This can be countered by increasing utilisation of the PAEH, separate lanes for inter terminal traffic and improved flow guidance through automatic gates. Finally the rail connection to South port basin may reduce some of the traffic. The six lanes are basically two dual carriage ways (2+1) utilising the additional lane for port internal traffic. Commonly a national dedicated dual-carriage way has the capacity of 11,000 to 14,000 annual daily vehicles flow. Due to the gates and small distances in the port area the dual carriage way would feature 30% to 40% less capacity indicating around 8,000 vehicles per day. Towards 2050 daily truck traffic may feature 11,500 units per day, according to the logistics study, indicating the need for PAEH and rail connections and traffic guidance systems with smooth gates.

R23. **Signalling should improve the use of the six lanes**, for example traffic guidance with two lanes for the gates and one lane for port / interterminal traffic.

R24. **Ramps near Fort end should have gates with sufficient space to align trucks.**

R25. **Ramps near Ingurukade junction should not have cross-over traffic**. This can be realised by an under-pass or an over-pass.

R26. **The slope of the ramps-up should not be more than 4%**

R27. In the port, a railway path should be assigned under the PAEH to **have the possibility to reach South Port by rail in future.**

R28. **The ramps-down from the PAEH near fort-end should give sufficient area and height space** (5.2m) for the development of a possible rail track.

R29. **Gates near fort-end of the ramp should be minimal 3 gate In and three gates out** with options to expand with one gate each in future.

Based on these recommendations the following short term priority projects have been selected:

SP12. **Widening of the port access road -** Port road should be widened to a 6-lane road. In case the PAEH, which will run above the port road, hampers widening of the port road at a later stage, the widening should be carried out before the PAEH is completed.

SP13. **Port Gate Automation –** Automation of the gate process is an absolute necessity when dealing to achieve port efficiency and alleviation of congestion.

SP14. **PAEH Simulations –** Traffic simulations are required to help shape the design characteristics of the PAEH.

SP15. **PAEH Development -** Development should proceed as planned by RDA, with SLPA input on construction issues, ramp locations, and gates locations.

SP16. **Automation Customs & Cargo Clearance –** Customs operations need to be automated.

9.4 Rail and Multimodality

9.4.1 Current situation

The Port of Colombo has one rail track, which connects BQ to the national rail network. Figure 9-7 shows the rail placement in the port, and highlights several points along the route. Point 1 indicates the rail gate, where the rail enters the port; point 2 indicates the dedicated underpass where the rail crosses the Aluthmawatha road; point 3 indicates a ground-level crossing of the rail track and the port access road; point 4 indicates a rail workshop; and point 5 refers to a future rail path that should be reserved to connect to South Port in the future.

The main function of the railway is to load cargo directly from vessels onto rail wagons for direct transport on Sri Lanka's rail network; Colombo port has the only direct port-rail connection in the country. The rail is currently in a poor condition and, due to the road works in preparation of the Elevated Highway, rail tracks are removed and replaced. It is noted that SLR is planning to buy new equipment; requiring the existing rail track to be maintained.

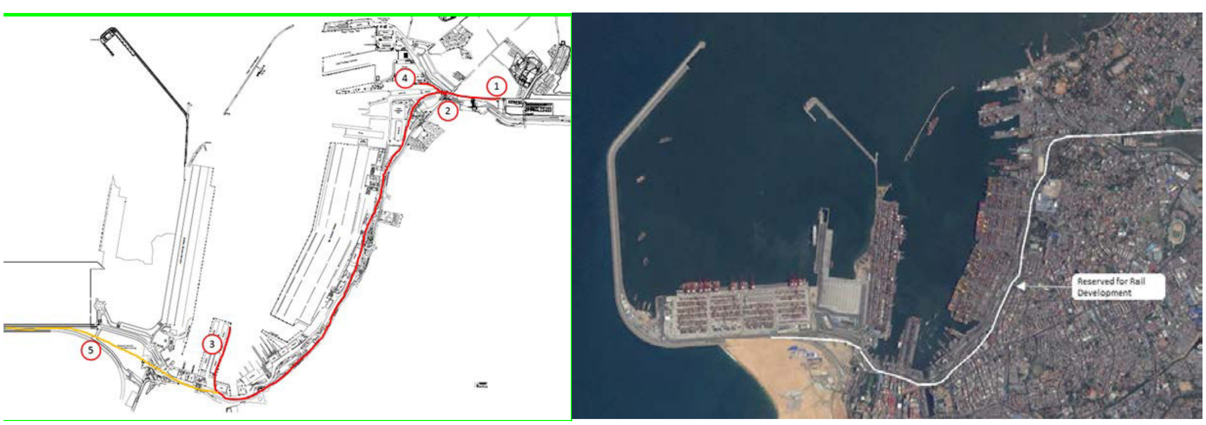
9.4.2 Development Requirements to support Multimodality

In order to enable rail connections in the future, potential rail tracks need to be considered in current connectivity plans. The Base Case for rail in Colombo is visualised in the figure below. A future rail path (number 5 in yellow) is reserved towards South Port and connects to the existing line in front of BQ. It is important to make the rail path reservation now that the Elevated Highway is being planned.

Especially the location at the Elevated Highway ramp near gate 1 results in challenges for the PAEH design, due to the limited space available to plan for both the highway ramp and potential rail track; this has been discussed with the PAEH design team. It is important that the railway line runs south of the PAEH ramps in order to avoid excessive road crossings in the future.

Whether the rail path is actually used in the future depends on the SLR's strategy regarding rail cargo transport. Inter alia, this decision will depend on the connectivity to dry ports in the future; this is further discussed in the following sections.

Figure 9-7 Rail track in Colombo Port



9.4.3 Multimodal Transport Options

This section examines four options for hinterland transport between the Port of Colombo and dry port locations. Three rail options are derived from the Multimodal Transport Project, which was carried out by a British consultants' consortium; this project is shortly introduced in the text box below. A trucking option has been added as the fourth option.

Sri Lanka: Multimodal Transport Project

This study was sponsored by the Japan fund for Poverty Reduction, presented in June 2012. The consultants described their objective as follows:

"The principal objective is to alleviate congestion in the area around Colombo Port by constructing one or two Inland Container Depots (ICDs} in the vicinity of Colombo, connected to the port by environmentally friendly and economical rail transport with the financial viability under public finance or Public Private Partnership (PPP}. Our study has shown that the project will yield substantial decongestion benefits, dependent on the site chosen."

The consultants established the feasibility of an ICD at Enderamulla, considering the then proposed development of Peliyagoda ICD operated by SLPA:

"Our provisional conclusion, therefore, is that construction of a truncated Enderamulla ICD in 2020, together with the necessary complementary upgrades to the port railhead, the container control system and within the Peliyagoda ICD site, would be a financially viable project."

The following figure summarises the sites that have been examined in the Multimodal Traffic Study.

Figure 9-8 ICD Location Examination in the Multimodal Traffic Study (2012)

A multi-criteria analysis will be used to identify the preferred mode of transport. The underlying assumption is that the rail is connected to a Peliyagoda ICD and a truncated Enderamulla ICD. The analysis of the different options primarily focuses on the sea port side.

Introduction

A Peliyagoda and a truncated ICD with a rail connection to the port faces the decision of the location of the rail head on the port. This is important for container handling operations, as rail heads take space. The different rail head placements also cause different routes of traffic within and outside the port area.

Figure 9-9: Overview of Rail and Potential ICD Locations

Four options are considered for placing the rail heads:

1. Railheads on all terminals
2. Central railhead for all terminals just south of CICT
3. Railhead outside of existing port area
4. Trucking (no railheads are placed)

A multi-criteria analysis will form a tool for decision making and analysing the strengths and weaknesses of a proposed options. In this case for every criterion 10 points will be divided between the four options. The options with the most points from the six criteria will be indicated as most preferable. The multicriteria analysis focusses on the following criteria:

Table 9-1: Overview Criteria[4]

	Criterion	Explanation
A	Challenge of Implementation	Some design might interfere with current development plans or lack funds for development
B	Estimated CAPEX	High costs of infra- and superstructure are naturally more challenging for a development plan, especially when it concerns possible sunk costs.
C	Design hindrance to other traffic	The crossing with other traffic is considered.
D	Congestion alleviation	Less trucks on the road means less congestion.

[4] Please note that no weight has been attributed per criterion. It is possible to attribute a higher weight to an important criterion.

	Criterion	Explanation
E	Social / Environmental Issues	Displacement might be necessary for some strips along the rail line or citizens might have hinder from traffic.
F	Operational costs (extra handling)	Extra handling of boxes will complicate the financial feasibility of a plan.

Option 1 - Railheads on all Terminals

Four rail heads on the 5 terminals accommodate the transfer of boxes to and from the port in this design. This option is the preferred option from the terminal operators' perspective, as the number of moves is minimised. The junction crossing indicated with a red circle on the map does form a potential problem for traffic, as traffic needs to be stopped when the train crosses the junction.

Figure 9-10: Visualisation & Assessment Option 1

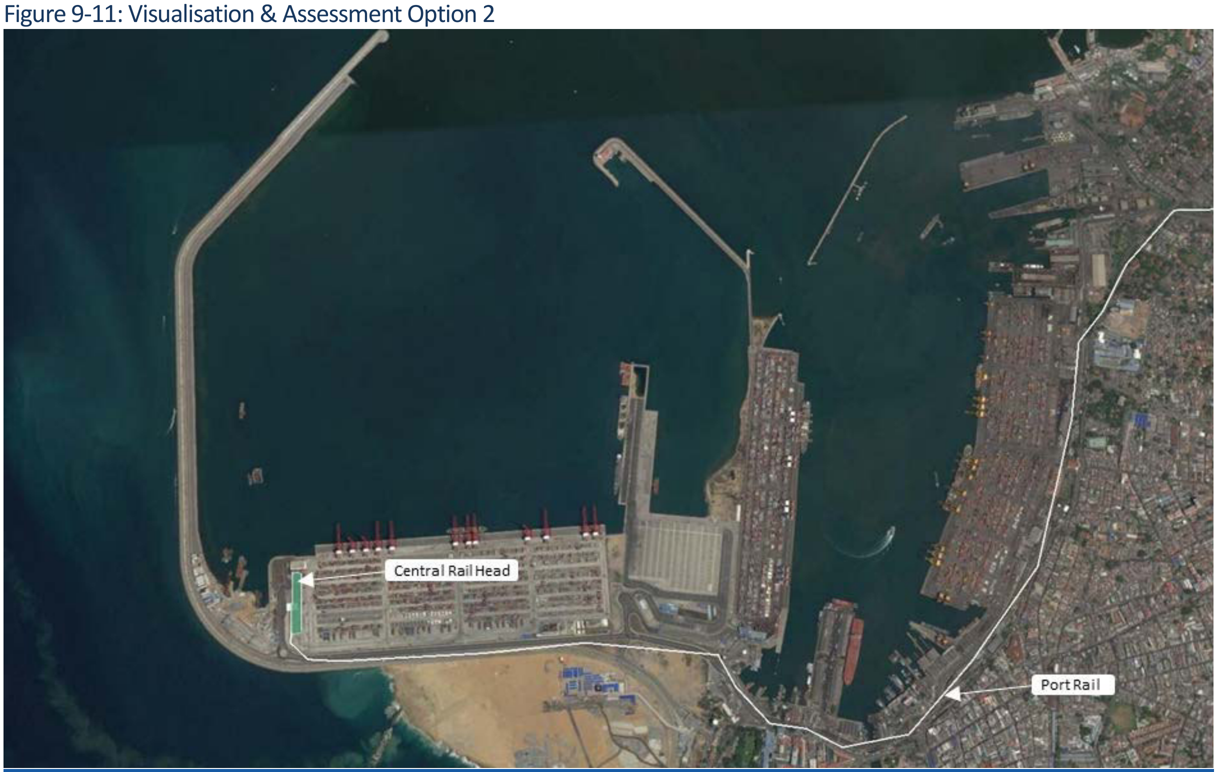
	Criterion	Assessment
A	Challenge of implementation	Rail line needs to cross PAEH and the more railheads, the more challenge of implementation and interference of regular operations.
B	Estimated CAPEX	High CAPEX for all four railheads compared to other designs.
C	Design hindrance to other traffic	The blocking of junction indicated red on map is serious problem.

	Criterion	Assessment
D	Congestion alleviation	Rail options alleviates congestion.
E	Social / Environmental Issues	Possible hinder along rail line.
F	Operational costs (extra handling)	No additional handling compared to trucking as stack – rail move is same as stack to – truck move.

Option 2 - Central railhead for all terminals just south of CICT

This option is not invasive on the terminal area, as it requires no additional room for the rail heads on the terminals themselves; however, there extra movement of boxes is required, which results in additional handling costs and traffic. This option requires crossing underneath the PAEH.

Figure 9-11: Visualisation & Assessment Option 2

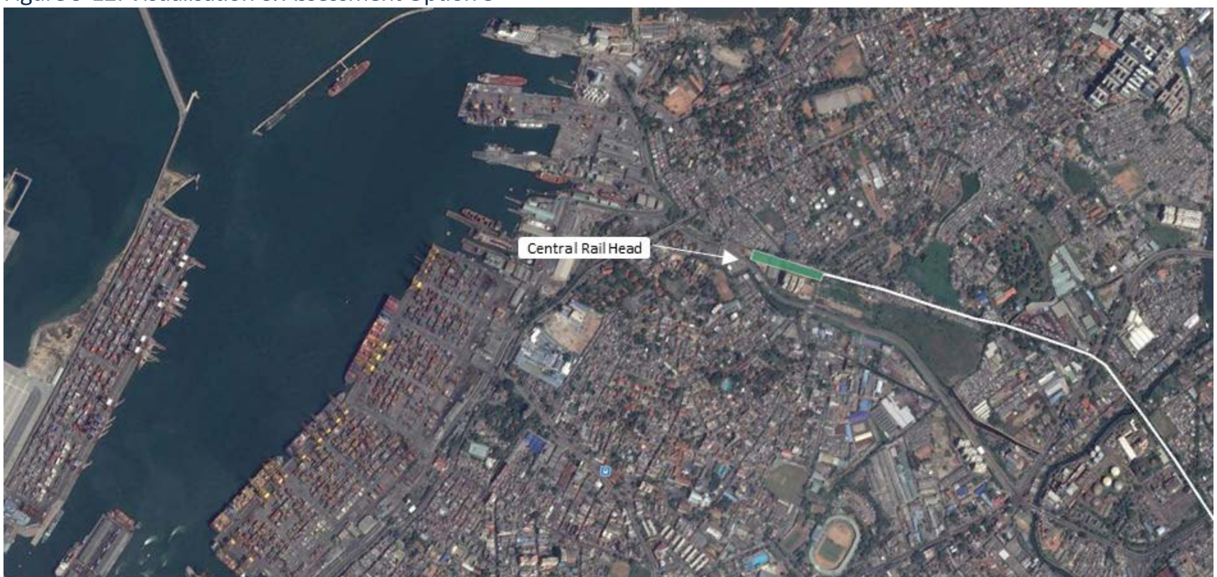


	Criterion	Assessment
A	Challenge of Implementation	Rai line will need to cross underneath the PAEH.
B	Estimated CAPEX	Cheaper options than 4 rail heads.
C	Design hindrance to other traffic	Design follows reserved path.
D	Congestion alleviation	Rail options alleviates congestion. But inter terminal traffic arises from central issuing.
E	Social / Environmental Issues	Possible hinder along rail line.
F	Operational costs (extra handling)	Additional moves to rail head from terminal

Option 3 - Railhead outside of port area

The railway head outside of the port is the least invasive option for the terminals and port area. However, the costs and traffic caused by the required additional moves are most substantial in this option.

Figure 9-12: Visualisation & Assessment Option 3



	Criterion	Assessment
A	Challenge of Implementation	Rail head land available and rail line reserved.
B	Estimated CAPEX	CAPEX for rail line and rail head construction.
C	Design hindrance to other traffic	No hindrance, except for trucks moving to rail head.
D	Congestion alleviation	Rail options alleviates congestion, but trucks still need to travel out gate
E	Social / Environmental Issues	Trucking from terminal to rail head.
F	Operational costs (extra handling)	Additional moves to rail head from terminal, very high additional costs.

Option 4 - Trucking

For the trucking option, no additional investments are required, except for the usual capacity expansions. Of course, trucking boxes can cause congestion if not well managed, especially in a port with a city interface like Colombo.

Figure 9-13: Visualisation & Assessment Option 4

	Criterion	Assessment
A	Challenge of Implementation	None
B	Estimated CAPEX	No additional CAPEX
C	Design hindrance to other traffic	Congestion may lead to severe hindrance in the future to city traffic.
D	Congestion alleviation	None
E	Social / Environmental Issues	Emissions from trucks are substantial compared to rail.
F	Operational costs (extra handling)	No extra handling charges compared to rail.

Picture source: Vanderlinden Transport Company

Conclusion Analysis

The table below presents the scores for each of the options on each of the identified criteria; for each criterion, 10 points are divided over the 4 transport options. It can be observed that trucking is the preferred option. Among the rail options, no conclusion should be drawn from this analysis, but the analysis does show the main strengths and weaknesses of each design.

The main reason for trucking as preferred option is that the rail options are not fully integrated in the port design. This is especially the case when considering the construction of the PAEH. Also, the extra costs of handling with rail heads outside of terminals can be substantial.

However, it should be noted that this does not imply that no future rail development is possible. Changes in developments in the coming years or decade might enable or even necessitate the railway option. It is thus recommended to keep the possibility of using it in the future.

Table 9-2: Total Scores Multi-criteria analysis

	Criterion	1 Rail Heads All Terminals	2 Single Rail Head Inside Port	3. Single Rail Head Outside Port	4 Trucking	Total
A	Challenge of Implementation	0	1	2	7	10
B	Estimated CAPEX	0	1	2	7	10
C	Design hindrance to other traffic	2	3	3	2	10
D	Congestion alleviation	5	2	1	0	10
E	Social / Environmental Issues	6	2	2	0	10
F	Operational costs (extra handling)	3	0	0	7	10
	Total	**16**	**9**	**10**	**23**	**60**

9.4.4 Recommendations and Short Term Priority Projects

For rail and multimodality, the following recommendations are made:

R30. **A path for optional future rail development towards south port should be secured.**

R31. If rail is to function efficiently, **the rail head should be placed near the terminals** to avoid additional handlings.

The recommendation leads to the following short term priority project related to rail and multimodality:

SP17. **Securing Future Rail Development Path –** A path for optional future rail development towards south port should be secured.

10 Colombo Port Development Plan

10.1 Introduction

This chapter introduces the layout of the port i.e. Colombo Port Development Plan, based on the cargo forecasts and requirements discussed in the previous chapters. First, the layout in 2035 is discussed, considering cargo forecasts in 2050 as well, to secure flexibility and compatibility in further years of developments. The two layout options of 2050 are compared under multi-criteria analysis. Secondly, the phasing layouts in 2025 and 2030 are proposed to reach the layout of 2035 mentioned above.

The recommended port lay-outs assume the base demand forecast. Specifically, containers are estimated at total throughput of 15.9 M TEU in 2050. As a result, South Port Development is recommended as it is able to satisfy this demand, through concentrated activities around one basin South of the river and keeps development flexibility open in the North for unforeseen or High Case demands. For the latter, North Port development options are preliminary discussed should development needs go beyond the Base Case scenario.

The following approach has been used for this chapter:

- Paragraph 10.2 details the two layout options in 2035, named the South Port Max and the North Port Large.
- Paragraph 10.3 exhibits the multi-criteria analysis with the South Port Max as the preferred layout.
- Paragraph 10.4 exhibits the phasing layout for 2025 and 2030.
- Paragraph 10.5 details the South Port Max 2050 layout.
- Paragraph 10.6 discusses the North Port options in case demand is beyond the Base Case scenario.

10.2 Port Development Options

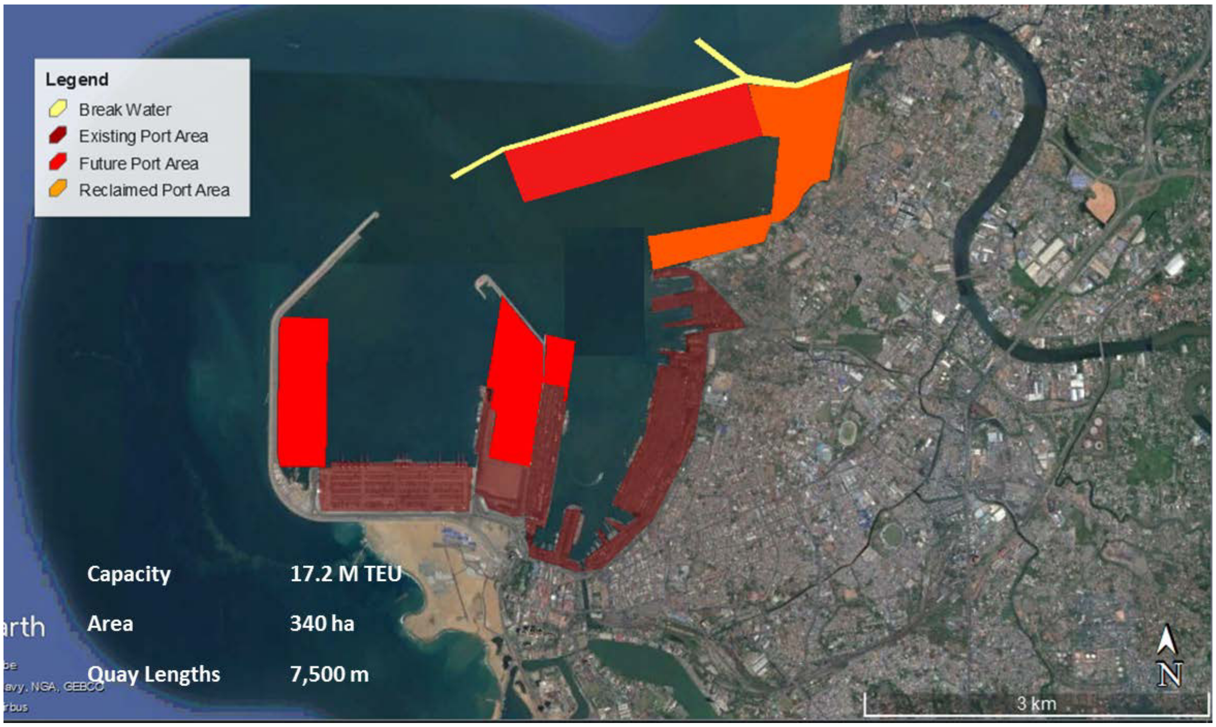
The port development options consist of two options for the Base Case forecast. Both these options cater to the 2050 Colombo port demand. Based on the multi-criteria analysis, the South Port Max option is selected as preferred choice.

Option 1 "South Port Max" is based on the SLPA concept of the current South harbour basin development. The "South Port Max" concept incorporates this design with a wave protection on the north side of the port. This wave protection can be expanded to a break water if expansion of port area is needed, in line with the North Port large design option. This concept includes the extension of the current south port break water. The river outlet flow should be redirected by an underwater revetment to keep siltation out of the port. In contrast to the SLPA concepts, the envisaged West Container Terminal I and West Container Terminal II should have a quay length of 1,400 m each. In this way 3 mega vessels can berth at these terminals at once.

Figure 10-1 Visualisation Option 1 – South Port Max

Option 2 "North Port Large "creates the necessary space with a development of adjusted version of the SLPA North Port concept. The development option titled "North Port Large" will have sufficient room for logistics development near the quay side. The western break water is not extended, lowering the angle of the north break water. An underwater guide pier should guide sedimentation from the river mouth further to the north.

Table 10-1: Visualisation Option 2 – North Port Large



10.3 Multi-criteria Analysis

Methodology

For the purposes of this investigation, the MCA method was selected to assess each of the two development options, considering the scoring criteria elaborated on in Table 10-2. Multi-criteria analyses (MCA) are commonly employed to evaluate a set of alternatives with the purpose of identifying a preferred option for more detailed analysis.

Table 10-2 Colombo Port Development Options - Assessment Criteria

Category	Criteria	Description
Capacity Creation (Weight: 0.15)	Cost of Development (0.05)	Cost of development of option. Lower costs are awarded with higher scores.
	2050 Base Case Volumes (0.05)	Assessment of fulfilment of Base Case 2050 volumes.
	2050 End state excess capacity (0.05)	Assessment of excess (container) capacity in end-state design.
Development Flexibility (Weight: 0.25)	Phasing possibilities (0.1)	Assessment of phasing possibilities in design.
	End-state flexibility (0.15)	Assessment of development options after completion
Terminal & Ports Aspects (Weight: 0.20)	Shape of total terminal area (0.05)	Assessment
	Quay Lengths (0.05)	Length of quays
	Interference and bottlenecks (0.05)	Assessment of traffic concentration
	Logistics area creation (0.05)	Land availability for logistics development near quay.
Manoeuvrability (Weight: 0.20) *	Nautical safety at approach route (0.1)	Assessment of nautical safety
	Mooring conditions (0.1)	Assessment of room for mooring
Social & Environmental Impact (Weight: 0.20)	Hindrance nearby population (0.1)	Assessment of distance and magnitude of disturbance
	Ecological impact (0.1)	Impact on environment in and outside the port

MCA Weighting

In a two-step process, each criterion and sub-criterion has been assigned a weight, indicating the importance of a specific criterion in relation to the other criteria. The first step comprises the comparison and weighting of the overarching criteria; the second step concerns the weighting of the sub-criteria, within the respective overarching criteria. The scoring weights for the criteria / sub-criteria have been included in Table 10-2 between brackets. SLPA management stated development flexibility as the most important aspect of any option.

MCA Scoring

The expected performance of each of the investigated options is scored against the identified criteria. Options with better performance on a criterion are assigned a higher numerical score, based on the estimated magnitude of the performance difference between options. For the purposes of evaluating the terminal zoning options, a scale ranging between 0 and 10 was used, where 0 represents the worst possible performance and 10 represents the best possible performance on a criterion.

The 10 points per criterium need to be divided over the two options. So, a score of 5 and 5 means both options score comparably.

Computation & Evaluation

The score and weight components are subsequently combined to provide an overall assessment of each of the options considered. The final score for each option is evaluated by applying the following formula:

$$Final\ Score_i = \sum_{j=1}^{n} \sum_{k=1}^{p} w_j * w_k^j * s_k^i$$

Table 10-3 MCA Formula - Legend

Item	Description
$Final\ Score_i$	Final score for option *i*
w_j	Weight for criterion *j*
w_k^j	Weight for criterion *k*, which is a sub-criterion of criterion *j*
s_k^i	The score for option *i* (score between 0 and 10), when assessed on criterion *k*

Assessment of Zoning Options

The table below presents both zoning options with the weighted average scores. The South Port Max development option has the highest score.

Table 10-4 Colombo Port Development Options - Scores

Category	Criteria	Assessment	Score South Port Max (1)	Score North Port Large (2)	Total
Capacity Creation (Weight: 0.15)	Cost of Development (0.05)	The preliminary estimations of South Port Max costs are 690 M USD compared to 780 M USD for North Port Large.	7.0	3.0	10.0
	2050 Base Case Volumes (0.05)	Both options cater to the container forecast of 15.9 M TEU in 2050.	5.0	5.0	10.0
	2050 End state excess capacity (0.05)	Both options have excess demand for the	6.0	4.0	10.0
Development Flexibility (Weight: 0.25)	Phasing possibilities (0.1)	Both options have a set development path, though the North Port Large design allows for partial and phased development of the area under the northern break water.	5.0	5.0	10.0

	End-state flexibility (0.15)	After completion of North Port Large, there are no further development options within the basin. The South Port Max development leaves room for North Port Development Options.	10.0	0.0	10.0
Terminal & Ports Aspects (Weight: 0.20)	Shape of total terminal area (0.05)	310 ha for option 1 vs. 340 ha for option 2.	4.0	6.0	10.0
	Quay Lengths (0.05)	Same for both options.	5.0	5.0	10.0
	Interference and bottlenecks (0.05)	South Port Max would have concentrated traffic which is less in the North Port Large design.	3.0	7.0	10.0
	Logistics area creation (0.05)	No area for logistics created in South Port Max. North port lands can be attributed to logistics.	0.0	10.0	10.0
Manoeuvrability (Weight: 0.20) *	Nautical safety at approach route (0.1)	North Port basin is narrow creating challenges for vessels.	6.5	3.5	10.0
	Mooring conditions (0.1)	North Port basin is narrow creating challenges for vessels.	6.5	3.5	10.0
Social & Environmental Impact (Weight: 0.20)	Hindrance nearby population (0.1)	Development near land has more impact on population than development at sea.	7.0	3.0	10.0
	Ecological impact (0.1)	Ecological impact extended breakwater of the South Port has been studied. Impact north port still uncertain.	7.0	3.0	10.0
		Final Score (weighted average)	**6.4**	**3.7**	**10.0**

Conclusion

The South Port Development option has a score of 6.4 out of 10 versus a score of 3.7 out of 10 for the North Port Large development option. Table 10-5 indicates the weighted scores on category level. Due to the weight assigned on development flexibility of 0.25 this category score has the highest impact.

Table 10-5 Colombo Port Development Options – Category Scores

Category	Score South Port Max (1)	Score North Port Large (2)
Capacity creation	**0.9**	0.6
Development flexibility	**2.2**	0.4
Terminal & port aspects	0.6	**1.4**
Manoeuvrability	**1.3**	0.7
Social & environmental impact	**1.4**	0.6

Final Score (weighted average)	6.4	3.7

10.4 Phasing of Old Basin and South Port

10.4.1 Projected Lay-out 2025

Figure 10-2 presents the envisioned port lay-out for the year 2025 under the Base Case that Colombo retains transhipment. The following developments are envisioned to meet port demand:

- **Construction of East Container Terminal (ECT) –** ECT (nr. 2) can become fully operational per 2021 with construction starting in 2019 if a concession agreement is reached on time. The terminal with its deep-water access is able to service the largest container vessels in the fleet calling to the port of Colombo.
- **Smaller size of Jaya Container Terminal (JCT)** – Following the diminished demand for JCT (nr. 4) expected due to the opening of ECT, a re-purposing of berth 1 for multipurpose activities. This transition can happen naturally as soon as container volumes drop, but flexibility of general cargo operations need be ensured.
- **Establishment of Multipurpose Terminal** – At this terminal, (nr. 10) general cargo can be handled and the container yard of JCT offers space for the (short) storage of vehicles. General cargo is currently handled at many locations in the port, including the ECT phase 1 quay and BQ. This terminal design covers 8.5 ha with a 300 m quay. The facility should be built flexibly with a possible relocation in mind.
- **Dedicated Cement Handling** – To ensure smooth operations for the imports of cement the New North Pier and the main berth of *UCT* (nr. 16) can be used to handle vessels. The depth is somewhat improved to 11 m at UCT, but the desired depth of 13 m cannot be reached at this facility. Through development of cement pipelines at the UCT quay, it can contribute to an enlarged berthing capacity for cement carriers. The pipelines will then connect to the new silo's to be developed near the existing cement terminals.
- **Dedicated Grain Handling** – With the shift of cement handling to UCT, PVQ can remain a dedicated grain berth (nr. 17) with no interference of other vessels. Further studies should consider the fact whether the quay can be dredged allow for larger vessels.
- **Renewal of Dolphin Jetty** – The Dolphin Jetty (nr. 15) infrastructure should be renewed, but can remain at place until possible north port development includes new oil jetties.
- **Construction of Floating LNG Storage** – The Muthurajawela LNG fired power station will be serviced by a pipeline from the floating storage facility (nr. 20).
- **Construction of new warehouses** – The MCC warehouse (nr. 19) can be located outside the port area for easy access. The facility should be operated according to leading industry efficiency practices for the land to be utilised optimally.
- **A dedicated terminal for cruise vessels** – The BQ terminal is transformed to a new ultra-modern Cruise terminal facility including a passenger terminal building which connects with the old heritage administration building. Passengers arriving in Colombo will pass through this building like in the past but in an atmosphere of "Modern meets heritage" (nr. 7).
- **A new administration building** – The new SLPA administration building is planned at Lotus road. The building will have port access through a by-pass under the existing port access bridge crossing Beira channel. The new building will have 17 floors, and an office area of approx. 26,620 m2 (31,600m2 in total), for about 1600 employees. (The location is not on this map but illustrated in detail in Annex IV - Land-use plan).

Figure 10-3: Port Lay-out 2025 Base Case

1	CICT	11	CFS I
2	ECT (New)	12	Scan Facility Customs
3	SAGT	13	Palm Oil Tanks
4	JCT	14	Maintenance & Repair SLPA
5	Customs Facility (New)	15	Dolphin Jetty
6	Service Jetties	16	Cement (Dedicated Berth)
7	Passenger Terminal	17	Grains (Dedicated Berth)
8	Navy (Expanded)	18	Warehousing (New)
9	Multi-purpose Terminal	19	Customs Facility (New)
10	Ship Yards	20	Floating LNG

10.4.2 Projected Lay-out 2030

Figure 10-4 presents the projected port lay-out for 2030. The significant projected additions and changes are:

- **Development of West Container Terminal Phase I** - WCT Phase I (nr. 5) with a quay wall of 1400m will complete the old basin development.
- **Extension of the South Port Break Water** – The extension of the breakwater will create room for further development of a West Container Phase II.

Figure 10-5: Port Lay-out 2030 Base Case

1	CICT	11	Ship Yards
2	East Container Terminal Phase I	12	CFS I
3	SAGT	13	Scan Facility Customs
4	JCT	14	Palm Oil Tanks
5	West Container Terminal Phase I	15	Maintenance & Repair SLPA
6	Customs Facility	16	Dolphin Jetty
7	Service Jetties	17	Cement (Dedicated Berth)
8	Passenger Terminal	18	Grains (Dedicated Berth)
9	Navy	19	Warehousing (New)

10	Multi-purpose Terminal	20	Customs Facility (New)
		21	Floating LNG

It should be noted that for the development of WCT II, a new breakwater is required and the new terminal would be positioned on the foundations of the existing breakwaters.

The following considerations are made:

- Despite the fact that WCT-II breakwater is in deepwaters, the expansion of South basin is recommended above the situation where North Port is developed without South Basin expansion. The main reasoning is that the Port needs around 8 million TEU of capacity to be provided before 2036. And this is most effectively developed below river Kelani mouth, leaving development options for the future open. One basin dedicated for containers is very effective for transhipment as inter terminal traffic is reduced compared to two separate basins. The North port development would require considerable studies including the effects on the river flows.
- WCT-II breakwater needs to be developed in advance of the WCT-II terminal. This means bathymetric surveys, environmental surveys and sediment flow surveys need to be carried out well in advance.
- It would be logical to study in one go, the sedimentation flows of the breakwater also in relation to the mian channel and the possible options for North port development. As the three are likely to be interrelated.
- The new break water and the effect on the existing main channel is also subject for research, fortunately the main channel is already curving towards the North.
- Pipelines which are in the region need to replaced in advance of the developments. This would also have an effect on the LNG berth at the existing breakwater, in case it will be developed.
- When the new breakwater is established and before the land reclaimation can start, the existing breakwater should be removed where it interferes with the projected location of the new quays.
- Like for WCT-I a straight line quay at CD -18m with turning capabilities (diameters of 950m) is preferred and bended quay should be avoided.
- The breakdown of the existing breakwater (to surface level), the development of the new breakwater, and the new terminal development should not hamper existing traffic from and towards the port.

10.5 Recommended port lay-out

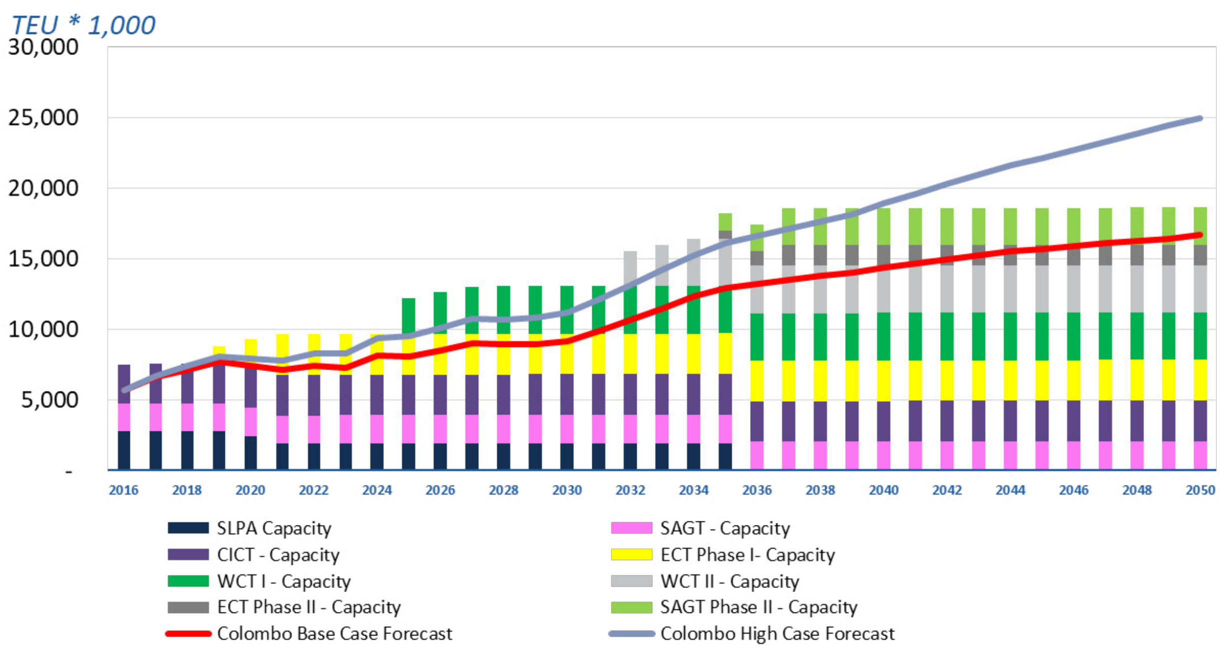
10.5.1 Phasing of container terminals

The figure below presents the phasing of the container terminals to reach South Port Max in line with expected demand. It presents the Base Case and High Case container forecast combined with the expected expansion path of terminals until 2050 under the Base Case.

The expansion path includes:

- 2019 start East Container Terminal Phase I operations
- 2025 start West Container Terminal Phase I operations
- 2032 start West Container Terminal Phase II operations
- 2035 start SAGT Phase II operations
- 2035 start East Container Terminal Phase II operations
- 2035 phase out Jaya Container Terminal operations

Figure 10-6: Phasing Container Terminals – Base Case



In the High Case the North Port development should provide for the capacity constraints towards 2050.

10.5.2 Base Case 2050 Lay-out

With the phasing of the container terminals as detailed above the most significant changes for the port are:

- **Development of WCT Phase II –** West Container Terminal Phase II (nr. 2) with a quay will of 1,400 m will provide an expansion of container handling capacity. The previously situated LNG terminal will be relocated to the Energy Hub (nr. 5)
- **Expansion and Combination of ECT and SAGT –** This new expanded terminal (nr.3) will have quays on three sides. Due to the expansion the old dolphin jetty will have to replaced.

- **Development of Wave Barrier –** The wave barrier (nr. 4) will provide both basins with protection as the expansion of SAGT necessitates the removal of the current dolphin jetty which functions also as a breakwater.
- **Development of the Energy Hub –** The Energy Hub north of PVQ could (nr. 5) be a permanent solution for LNG and refined oil imports.
- **Repurposing of JCT –** The terminal is expected to be repurposed around 2035 with sufficient investments in current operations. The possibilities include a multi-purpose terminal (nr. 6) and room for logistics (nr. 7)

Figure 10-7: Port Lay-out 2050 Base Case

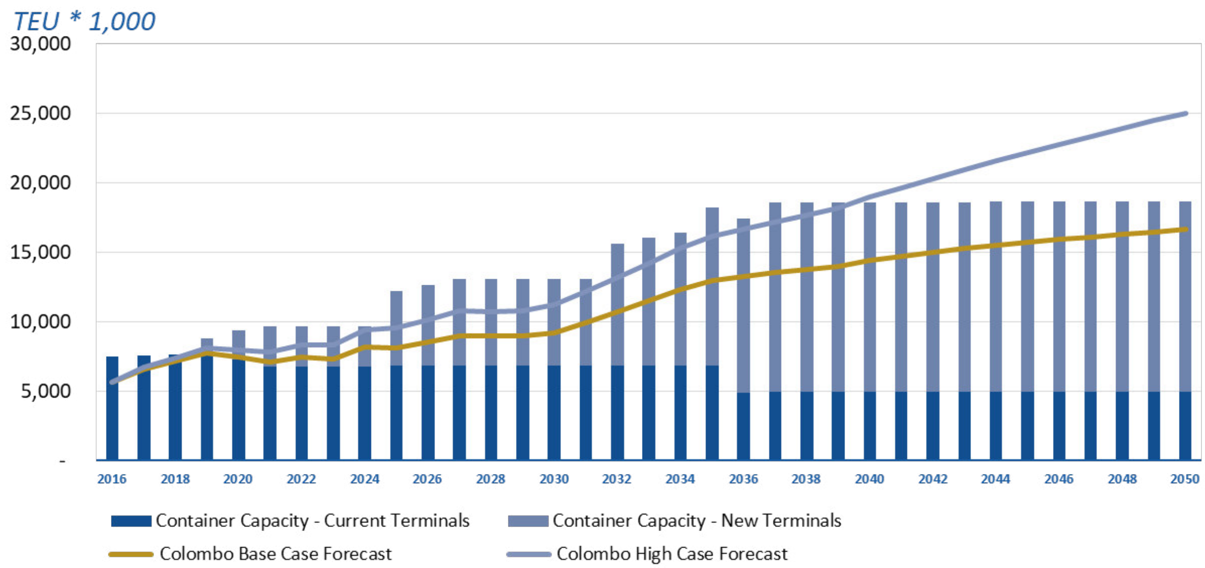
1	West Container Terminal Phase I	5	Energy Hub
2	West Container Terminal Phase II	6	Multi-purpose Terminal
3	Expansion and combination of ECT and SAGT	7	Logistics Area
4	Wave Barrier	8	LNG

10.6 North Port development – beyond the Base Case scenario

North Port development would be triggered by demand beyond the Base Case scenario. This may be unforeseen demands (or High Case) on containers but may also be triggered by other port sectors such as for example; Liquid Bulk, RoRo, general cargo or land required for logistics or any other unforeseen developments.

The High Case scenario shows that additional capacity by North Port development is required from 2040 onwards. Due to the complexity especially around the river outlet, planning should be considered at minimum 10-15 years in advance.

Figure 10-8: Port Development needs towards 2050



10.6.1 Discussion on North Port Development

North Port development is a key development for the Port of Colombo in the long term after satisfying demand needs at the South Port basin. Yet, as planning should look well into the future and planning and development will take considerable time, it is useful to discuss options for North Port development in a preliminary stage. This will be done on the basis of three identified preliminary options.

The following preliminary options have been identified:

- North Port Energy Hub
- JICA North port concept
- SLPA North port concept

Obviously several masterplan steps have to be concluded before detailed concepts are made, such as but not limited to; bathymetrical surveys, soil investigations, port sedimentation, river outlet and flooding, EIAs, entrance channel configuration, turning basins, navigational aids, vessel manoeuvrability, land space port activities and logistics and hinterland connectivity.

As such the details of each concept and the exact layout and or exact location are subject to additional detailed studies.

In this document only a brief overview of the three preliminary options is provided. The paragraph is focusses on the main characteristics of the option and some general points of attention.

All North Port concepts cater for liquid bulk facilities and have logistics areas next to container terminal capacities to handle 23 M TEU annually (including South Port development).

The North Port Energy Hub concept features the following:

- An approach which can be phased according to demand for the energy hub concept (liquid bulk demands).
- A main two sided wide pier, with parallel oriented berths for optimal container operations.
- Berths for RoRo and general cargoes.
- Space for logistics.
- Connectivity via a bridge (rail and road) towards the North and rail and road connectivity to the existing port.

Points of attention are:

- Navigational manoeuvrability, turning basins and access to the quays.
- River outlet flow and flooding
- Interference with the existing shoreline
- Development costs (reduced through less deep berths located at shallower waterdepths)

The JICA port concept consists of :

- An island approach which reduces the interference with existing coastline.
- A container terminal with perpendicular orientation.
- A multi purpose terminal.
- Berths for liquid bulks.
- Ample space for logistics.
- Connectivity via two bridges towards the North and towards the South.

Points of attention are:

- Navigational manoeuvrability, turning basins and access to the quays.
- River outlet flow and flooding
- Sedimentation into port basin
- Development costs (Breakwater is loacted at deep waters)

The SLPA North Port concept consists of

- A berths and breakwater constructed South of the river outlet
- A container terminal.
- A multi purpose terminal.
- Berths for liquid bulks.
- Some space for logistics.
- Connectivity via a bridge towards the North and roads towards the South.

Points of attention are:

- Navigational manoeuvrability, turning basins and access to the quays.
- Development of deep quays at limited water depths.
- River outlet flow and flooding.
- Development costs (Deep berths at shallow waters).
- Interference with the existing shoreline.

As can be noted for all north port development options it remains important to first research the impact of the port concepts on the river outlet. Impact and possible remediation on sedimentation flows, siltation, sand drifts, flood and water levels rises in the river delta should be clear before the options are chosen.

Table 10-6: North Port Concepts

Category	**Assessment & Discussion Design**		
	Energy Hub Concept	JICA Recommendation	SLPA Concept
			
Terminal & Ports Aspects	Aims at energy hub (liquid bulk) combined with containers, general cargo, RoRo and logistics	Aims at liquid bulk, containers, multi purpose and logistics through an island development	Aims at containers and liquid bulk with less space for logistics
Special feature	Energy hub can be developed as an standalone island in early phases. Bridge towards the North	Island with bridges towards North and South. Island can be developed with or without expanding south port	Bridge towards the North

Additional information about the preliminary options is further addressed in the Appendix XIV.

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11 Environmental Impact and Policy

11.1 Introduction

Environment management has become a cornerstone policy at Port Authorities worldwide. Every authority needs to tailor their environmental and social policy as to fit the local environment.

This chapter aims to define the environmental landscape in Colombo by identifying key issues in the port. Based on this identification recommendations regarding mitigation are proposed. These recommendations focus on the policy of the authority and specific measures it can and should take.

- Section 11.2 discusses the general legal framework for Sri Lankan environmental and social regulations: Sri Lanka has several legal acts regarding land acquisition and resettlement. Sri Lankan environmental regulations find their basis in the constitution.
- Section 11.3 presents the as-is situation and includes observations: The environmental risks identified concern air quality, water quality, traffic, noise, dust, lighting. These lead to specific measures and policy recommendations.
- Section 0 provides three long-term development projects for the port Colombo: The port access elevated highway, the railway line from port towards Kerawalapitya and the further marine side development of Colombo port.
- Section 11.5 concludes with future steps to implementing a Green Port with samples of other green port developments: SLPA can follow 8 recommendations towards implementing a Green Port policy. Related to this aspect is adhering international conventions like MARPOL Protocol.

11.2 Legal Framework in general

11.2.1 Social aspects and social safeguards

There are two important social issues associated with port development and port modernisation. The first issue is the acquisition of land, with involuntary relocation of people as possible consequence. The second issue is the potential retrenchment of staff.

In Sri Lanka, the subject of land acquisition is governed by the following policies, laws and regulations:

- Land Acquisition Act (LAA) No.09 of 1950 as amended and Regulations
- National Involuntary Resettlement Policy (NIRP).

Another document for the protection of women and children in relation to the consequence of land acquisition is the Women's Charter of Sri Lanka.

The potential lay-off of staff in circumstances of privatization of state-run enterprises and modernisation of operations come under the legislation of the Ministry of Labour and Trade Union Relations and are codified in the Labour Termination Act.

For projects with international funding, the relevant guidelines or directives of the financing institution are also to be followed in project implementation (for ADB-financed projects the Social Safeguard Statement of 2009).

0 presents an elaboration of the regulatory framework mentioned above.

11.2.2 Environmental management and Environmental assessment

Environmental protection has been given due consideration by the Constitution of the Democratic Socialist Republic of Sri Lanka. Article 27 (14) of the Constitution states that it is the duty of the state to protect, preserve and improve the environment for the benefit of the community. Also, Article 28 (f) of the Constitution states that it is a fundamental duty of every person to protect nature and conserve its riches.

The Sri Lankan Government has enacted several Acts that have a direct bearing on the environment. Of these, the acts, which have a direct bearing on the proposed Master Plan, are:

- National Environmental Act No. 47 of 1980
- Coast Conservation Act No. 57 of 1981
- Mines and Minerals Act No. 33 of 1992
- Marine Pollution Prevention Act No 59 of 1981
- Fauna and Flora Protection ordinance

0 presents a description of the relevant regulatory framework in force.

The EIA process is implemented through designated “Project Approving Agencies (PAA)” led by the Central Environmental Authority (CEA). The PAAs are EIA administrative agencies that are responsible for guiding the EIA for projects and for issuing EIA approval or rejection. A single PAA is appointed as the appropriate PAA for each EIA by the CEA

Any new (commercial) development project requires the permission (clearance) from the CEA. For project without major impacts no further steps may be needed, although the CEA may stipulate specific measures. Projects with intermediate impacts, may require performing an Initial Environmental Examination (IEE). Projects with major impacts require the highest level of safeguard, which would involve the preparation of a full Environmental (and Social) Impact Assessment (E(S)IA. Some projects require an EIA in any way. Those prescribed projects have been listed in the Gazette (Gazette No. 772/22 of 24.06.1993).

A project proponent needs to submit preliminary information about the project to the CEA, in order to initiate the EIA / IEE process. The project proponents are advised to submit preliminary information to the CEA at a very early stage in the project cycle. The project proponent could submit the preliminary information through a Basic Information Questionnaire which could be obtained from the CEA Head Office or Provincial / District Offices or downloaded from the CEA website.

The EIA / IEE process involves 6 major steps; (i) screening (ii) scoping (iii) preparation of the EIA / IEE report (iv) review of the report (by the public and the PAA) (v) approval with terms and conditions or rejection with reasons (vi) post approval monitoring. The step wise process has been defined in the EIA regulations which have been published in the Gazette No. 772/22 of 24.06.1993.

Within the framework of the current National Port Master Plan, preliminary ESIA reports need to be prepared for the priority projects in the ports of Colombo and Trincomalee, as identified in the Master

Plan. Such preliminary ESIA reports correspond to the screening and scoping exercises, mentioned in the previous paragraph.

The elements required to prepare the preliminary ESIA reports include:

- First identification and description of the proposed project
- Understanding of the environmental conditions at the proposed project site and its surroundings

Based on these two elements one can identify the most relevant environmental and social impacts. Depending on the nature and the severity of the impacts (and the provisions for prescribed projects) the need for subsequent E(S)IA or IE(S)E can be determined.

The preliminary ESIA reports issued under the current Master Plan, can serve as information for submission to the CEA, as a first step in the EA process.

11.3 As-Is Situation Environment

The port of Colombo, being situated in the centre of a large urban centre, affects to some extent its surrounding residential and commercial areas. In general, port operations engender emissions (noise, gaseous emissions, dust and particulate matter) from the use of equipment, machinery, vehicles and ships. Moreover, the use of such equipment and the storage and handling of liquid chemicals can result in accidental leaks or spills. The surrounding residential and commercial areas in Colombo will notice the emissions from the port although the city itself creates also such emissions as well, and because of the diluting/dispersing effect from prevailing winds effects, issues are less quickly noticed. Leaked or spilled oil, grease or lubricants do not end up in the neighbouring quarters, but rather in the port basin. However, all emissions from the port add up to the air pollution at large, and more specifically to the pollution in the city of Colombo in general.

With the construction of the Elevated Highway, connecting the port to the New Kelani Bridge the congestion due to port vehicles on the cities road network, will be reduced to some extent. The result would also depend on the availability of approach and exit roads between the port and the elevated highway.

It is also noted that it is not only the port which affects the town, also town life and town infrastructure affects the port. This is most noticeable with respect to waste water. All waste water for the town of Colombo enters the sea untreated. Most parts of the town are connected to a sewerage system, with two outfalls (of about 1.5 km length): one in Wellawatte (south) and one entering the sea near Mutwal. The second outfall at Mutwal is likely to interfere with the plans to develop a North Port. There are a number of town districts not linked to the sewerage system. Those districts discharge their waste water in surface water drains, or (like Mattakulia, Mahawatte and Bloemendahl) directly into the sea, via short outfalls. Some of those drains enter the port basin or the coastal stretch, possibly to be occupied by the North Port.

Beira Lake, a heavily polluted lake in the centre of Colombo is directly linked to the old Port Basin. The water from this lake discharges into the port, especially after rainfall.

In general, environmental issues can be summarized under the following headings:

- Environmental quality and monitoring
- Air quality
- Water quality
- Traffic
- Noise
- Dust
- Light
- Visual aspects
- Port-city interaction and commercial aspects
- Management of environmental issues

Air quality

Today no measurements on air quality are being taken. The measurements systems are not in place today and the carbon footprint of the port is unknown. The air quality can be measured by measuring the following aspects:

HC (hydrocarbons), CO (carbon oxide), NOx (nitrogen oxides), PM10 and PM5 (particulate matter) and SO2.

As a first step to improve air quality, diesel engines and vehicles should be required to run on fuel with a higher cetane number and a low sulphur content. In heavy-duty engines increasing the cetane number lowers HC, CO, and NOx emissions. Light-duty engines show a different fuel sensitivity than the heavy-duty engines. Sulphur increases PM in both classes of engines. Sulphur is also known to interfere with several diesel emission control strategies.

A subsequent step would be to preplace equipment and vehicles motored by fossil fuel, to the extent possible, with electrically driven equipment and vehicles. This would be in line with the Government's 2018 "Blue-Green" Budget, proposing that all vehicles in the country be powered by non-fossil fuel sources by 2040. To this end all Government vehicles are to be converted to (or replaced by) hybrid or electrical vehicles by 2025.

Water quality

This quality can be measured by measuring the following aspects:
DO (dissolved oxygen), BOD (biological oxygen demand), COD (chemical oxygen demand, N-total and Ptot, Oil, EC (electrical conductivity), pH, T, faecal-coliform and e-coliform count.

Traffic

The main impact from the port of Colombo on surrounding residential and commercial areas is the traffic, associated with the port's operations; transport of export goods (garments, tea, agricultural products) and import of goods. In view of the port's location, all traffic must cross sections of the town. The busiest route runs from the port to the bridge across the Kelani River at Kellanitissa.

The port is connected to highway AI at Nawagumpura via the main Port Access Road. From there, most port traffic continues along the A1 in the direction of Kandy or via the A3 direction Negombo. Residents and commercial establishments near the port are inconvenienced due to the movement of cargo trucks from port to other locations in the country and vice versa. At times the movement of public and private traffic is extremely slow because of the presence of convoy of cargo trucks on busy roads. Urugodawatta section of the Colombo –Avissawella Road is a good example. Cargo vehicles block the entrances to residences and commercial establishments much to the annoyance of the occupants. Parking of vehicles transporting cargo on the sides of the access roads to the port, creates traffic congestion and leads to slow movement of traffic. Residents find it difficult to enter public roads with their vehicles due to flow of long and large vehicles towards the port and back.

The traffic to and from the ports, combined with normal city traffic often creates congestion, and subsequently air pollution, waste of fuel, safety problems and a health hazard for residents.

Noise

Currently, there are no specific issues related to noise nuisance from the port. Most activities take place during daytime, during which the noise from traffic outside the port dominates. However, in case more activities would take place during the night (when general traffic in town is much less to virtually absent), noise might become a nuisance in areas as Colombo 1, 2 and 11).

Dust

The operations on PVQ (grain/flower and cement import) occasionally generate dust nuisance. Dust from cement is deemed a problem, especially for the workers in the port, employed near this quay. There are no residential or commercial areas in the direct vicinity. Dust is also generated by the shipyard and dust affects the nearby located residentials.

Light

Currently there are no policies or practices to limit or minimise lighting of the port premises. Commonly speaking the port should be able to operate 24/7 under safe conditions and light is one of them. This may cause some hinderance to nearby located residentials which is considered a natural fact generated by ports.

Visual aspects

Since its construction around 2000, the new Colombo South Harbour, presents a dominant element in Colombo's sky line, especially viewed from a popular site as Galle Face Green. However, with the current construction of Port City, on the south side of the Colombo South Harbour, the Port no longer will present a visual obstruction, since the buildings in Port City will take away the sights on the port.

Port-city interaction and Commercial aspects

To some extent, operations at the port generate commercial activities in the surrounding neighbourhoods. This will be especially true when more passenger ships would call at Colombo Port, and when the current SLPA building would serve again as passenger gate to the city. The port-city interactions become in this respect quite large and close cooperation between city planning and port planning is required to understand each other's wishes and concerns.

Management of environmental issues at SLPA

The environmental issues are dealt with in an ad-hoc manner as and when required. When new projects are carried out the required ESIA is fulfilled according to respective legislation. There is no department which deals with environmental issues as such it is mostly triggered by port plans. This way of working may lead to unclear situations as sometime the technical department and sometime the operational departments launch new projects affecting the environment. Moreover, the status of ESIA and requirements are not always launched in sufficient time in advance leading to possible surprises in the timeframe of the planned development.

Safety aspects for workers at terminals of SLPA is observed as poor. Workers do not wear the required clothing, there are no signs and people by foot are interfering with heavy traffic within the terminals.

Table 11-1: Environment - Observations

Category	Issue	Severity
Environment		
Organisation	The organisation has no department which coordinates, monitors and controls environmental issues	High
Emission Measurements	SLPA has no emission measurement system installed, hence the actual emissions cannot be measured	High

Category	Issue	Severity
Health and Safety	Occupational Health & Workers safety is very important but, safety guidelines are not adequately implemented, monitored and enforced. At the terminals no specific hats, jackets and shoes are being used. Several terminals can be regarded as unsafe as movement of personnel and heavy traffic often coincide.	High
Port equipment	The majority of SLPA equipment is diesel based. Hence the emissions from the organisation is subject to improvement.	High

11.3.1 Recommendations

R32. In view of SLPA's intention to adopt the 'Green Port Concept' in its mode of operations, **it is recommended to start routine monitoring of environmental quality parameters as soon as possible**. In this way, a reference level (existing baseline) of environmental quality can be established. This reference level can be used, in the future when greening concepts have been implemented, to assess the effect and success of the new strategy. Air measurement at two or three points in Colombo Port are recommended to be installed. Media and parameters to be monitored are:

Air quality: HC (hydrocarbons), CO (carbon oxide), NOx (nitrogen oxides), PM10 and PM5 (particulate matter) and SO2. Additional information on measurement and boundary limits of air pollution, noise, biodiversity and CO2 emission measurement is covered in Appendix XVI and Appendix XVII.

R33. **It is recommended to measure water quality at 5 locations in the port basin, including the outflow from Beira Lake.**

The following parameters to be measured: DO (dissolved oxygen), BOD (biological oxygen demand), COD (chemical oxygen demand, N-total and Ptot, Oil, EC (electrical conductivity), pH, T, faecal-coliform and e-coliform count.

The unloading facility at PVQ, a conveyor belt, should be better isolated to reduce issues with windblown dust.

R34. **Clear guidelines to be established for port concessionaires to contribute to a greener port**, including existing companies like Colombo Dockyard

R35. **Lighting on the port premises should be limited** to the essential (operational) areas only. For lighting, energy efficient led systems should be installed.

11.4 Long-term Development Projects

11.4.1 Listing of long-term development project

- Further extension of port (extension of Breakwater South Port Basin and construction of North Port)
- Construction of Elevated Highway
- Railway line from port towards Kerawalapitya

11.4.2 Extension of Breakwater South Port Basin and construction of North Port

There are various alternatives how to further increase the capacity of the Port of Colombo. In this Master Plan the two most likely options have been retained: the so-called South-Port Max and the Mega-Port North and South as seen in Figure 11-1 . A common element in both options is the further extension of the breakwater of South Port, likely to accommodate container terminals. Both option also have a structure on the North side to protect the port basin against wave action. In the 'South Port Max' option this structure will not be attached to the coast, and not be equipped or constructed as a port terminal. In the 'Mega Port North and South' option the breakwater structure will accommodate the North Port. In this option the breakwater will end just South of the Kelani mouth, while the stretch of coast between the mouth of the Kelani River and the existing harbour will be reclaimed for additional port activities.

Social aspects

The 'South-Port Max' option is not expected to pose any major social problems. In the 'Mega Port North and South' option however, the fishery port at Mutwal needs to be relocated (area reclaimed to cater for port activities). In that case, the fishermen having their operational base at this port have to be compensated.

Environmental aspects

The extension of the South Port Breakwater is likely to have morphological impacts further to the North. In combination with the breakwater for the North Port, the new structure may affect the sediment inflow into the port basins (need for dredging) but also the water exchange between the port basins and the sea (dilution). Furthermore, the area affected by erosion North of the Kelani Mouth is likely to shift further North. Currently, erosion is attacking the coast of Thimbirigasaya and Dikkowita. With the proposed extended South Port Breakwater, the erosion is likely to progress to Uswetakeyawa, while the erosion along the Thimbrigasaya coast will probable diminish.

In the 'Mega Port North and South' option, during low flow conditions, sediment may build-up in front of the Kelani river mouth. This may affect water levels in the Kelani River, causing flooding in the low-lying zones along the lower stretch of the river. Regular dredging would be required to alleviate or prevent this problem.

Figure 11-2: Visualisation Potential Colombo Port Development

The configuration of the two options may influence the amount of sediment that will enter the port basin, and also the exchange of water in the port basins and the sea. It is probable that the proposed lay-outs will reduce the exchange of water in the old port basin, thereby further deteriorating its water quality.

11.4.3 Construction of the Elevated Highway

The impacts associated with the construction and operation of the Elevated Highway are multiple:
During construction:

- Demolition of warehouses in the port premises in the alignment of the highway. Need to construct new warehouses at alternative locations.
- Possible restructuring of warehouse operations, with lay-offs of redundant staff as possible consequence.
- Major hindrance to normal traffic during the construction works and nuisance (noise, dust, vibrations, impeded access) to people living and businesses situated along the highway's alignment.

During operation:

- Reduced traffic congestion in the Northern part of town, assuming most port traffic will utilise the new elevated highway
- Extra noise for people living and businesses situated along the alignment of the highway and wider zone affected due to elevated position.

11.4.4 Railway line from port towards Kerawalapitiya

The construction of a railway line from the port to Kerawalapitya is likely to reduce the need for road transport through town, especially for containers. Especially the construction will not be without impacts:

- Need to acquire land for the new rail alignment
- Possible involuntary relocation of persons along the proposed alignment
- Nuisance and inconvenience associated with construction work

11.5 Towards the Green Port

SLPA is considering options to gear its operations towards the requirements in accordance with the 'Green Port Concept'. The adaptation in the operational procedures of the port will need to be a stepwise process. First, a firm commitment will be required at the management level of the SLPA, with support at ministry level.

The green transition is not yet a focus policy of SLPA as of today. However, some port users have already moved into this direction. For example, CICT has changed its diesel fuelled RTGS to Electric RTG's and has won the 2017 award for Best Container terminal (under 4 million TEU) of the Asian Freight, Logistics and Supply Chain Awards, organised by Asia Cargo News.

Green port focus and environmental concerns have become major topics at Port Authorities. The focus on a Green port concept is promoted by institutions such as ESPO and EcoPorts and have gained considerable attention by Port Authorities from various ports all over the world. Within the port industry, environmental awareness has resulted in pro-active management to create a "Green" thinking attitude for the port authorities and port operators. The Port Authorities have leading role in promoting and facilitation the attitudinal change towards creating and environmental sustainable port business.

11.5.1 Examples Green Port Concept Internationally

There are no clear-cut recipes to become a "Green Port". Different ports follow different courses in their desire to green their operations. Each port develops its own green policy depending on its own specific situation (physical, geographical, historical, trade types). Different organisation and ports use different description for defining the "Green Port" Concept. Examples of how different ports approach this concept can be found on the internet and here shortly examples in the EU are presented and one in the United States.

Under the Green port concept several features can however be noted such as:

- Promote green shipping through tariff incentives
- Implementation and certification of port environmental review system (PERS)
- Implementation of a certified Environmental Management System in line with ISO 14001 certification
- Promote green shipping and the supply of "green" fuels such as LNG
- Promote clean hinterland transport
- Introduction of cold ironing (often not suited for cruise)

European Union

Directives of the European Union are directed to the "green" development of seaports, which implies a special attention to the energy efficiency and environmental protection.

Promote the use of clean ships through tariff incentives.

This method is to promote the use of green shipping though giving incentives on reduced port dues once a shipping line calls at the port frequently. Incentive schemes are already common practice in Dutch ports for more than a decade. The port authorities are encouraging ships to work as safe and environmentally friendly as possible. Ships that are meeting the Green Award's demands set to ship, management and crew, will be granted a certificate and the Green Award flag. Under certain conditions, ship-owners are entitled to a Green Award discount on the harbour dues. The system is applied to deep-sea coastal and inland vessels. For example, vessels receive a discount when the vessels have a Green Award Certificate or a comparable Green Certificate.

Green Award Certification at Dutch ports

Green Award certifies ships that are extra clean and extra safe. Ships with a Green Award certificate reap various financial and non-financial benefits.

By rewarding high safety and environmental standards in shipping, Green Award makes above standard ship operation economically more attractive. The Green Award certification scheme is open to oil tankers, chemical tankers and dry bulk carriers from 20,000 DWT and upwards, LNG and container carriers and inland navigation vessels.

The Green Award procedure is carried out by the Bureau Green Award, the executive body of the independent non-profit Green Award Foundation. The certification procedure consists of an office audit and an audit of each individual ship applying for certification. Amongst many others, the assessment focuses on crew, operational, environmental and managerial elements.

At ports in Belgium, Canada, Latvia, Lithuania, the Netherlands, Oman, New Zealand, Portugal and South Africa, the Green Award vessels receive a considerable reduction on port dues. Private companies also appreciate the extra quality which Green Award guarantees. Several incentive providers, government institutions as well as private companies, grant savings to a vessel with a Green Award certificate, which subject to annual verification, is valid for three years.

Ports in Croatia

The concept of Green Port Development is the integration of the environmental friendly methods for port activities, operations and management. There are several ways to define measures for the establishment of ecological/green seaports. Examples of measures are: the implementation of policies, relevant for the reduction of the emissions of harmful substances into the atmosphere, the landscape design of an appropriate seaport which includes trees that absorb noise and pollution. Moreover, measures that include the use of renewable energy port operations and activities, recycling and reuse of materials. One of the main measures for the application of the concept of "Green Port" development is the inclusion of the term "green" growth in the further development of the port system and the establishment of environmental planning

Research has been conducted into the environmental priorities of the European Port Sector over the period 1996-2013 (see Table 2 from Scientific Journal of Maritime Research 31 (2017) 10-17 © Faculty of Maritime Studies Rijeka, 2017). It is clear that priorities have changed in this period, but there are a number of persistent concerns; in recent years the issues of energy conservation and relations with local communities have been added to the main concerns.

Table 11-2: Assessment of Environmental Priorities in the European Port Sector in the period 1996-2013

	1996	2004	2009	2013
1	Port development (water)	Port wastes	Noise	Air quality
2	Quality of water	Dredging operations	Air quality	Port waste
3	Dredging	Dredging operations	Seaport wastes	Energy conservation
4	Dredging operations	Dust	Dredging operations	Noise

	1996	2004	2009	2013
5	Dust	Noise	Dredging operations	Waste from ships
6	Port development (land)	Air quality	Relations with local communities	Relations with local communities
7	Land side pollution	Dangerous cargo	Energy use	Dredging operations
8	Habitat degradation	Storage	Dust	Dust
9	Amount of traffic	Port development land	Port development (water)	Port development (land)
10	Industrial waste water	Discharge of ships' bilges	Port development (land)	Quality water

Source : http://www.ecoports.com/publications (10.05.2016)

The Port of Long Beach

The Port of Long Beach is committed to improving the environment, Its Green Port Policy is an aggressive, comprehensive and coordinated approach to reduce the negative impacts of Port operations. The Green Port Policy, which the Board adopted in January 2005, serves as a guide for decision making and established a framework for environmentally friendly Port operations. The policy's five guiding principles are:

- Protect the community from harmful environmental impacts of Port operations.
- Distinguish the Port as a leader in environmental stewardship and compliance.
- Promote sustainability.
- Employ best available technology to avoid or reduce environmental impacts.
- Engage and educate the community.

In American studies, the following environmental problems have been most frequently mentioned:

- air pollution from port operations, including smog and particle pollution,
- the loss or degradation of habitat,
- destruction of fisheries and endangered species,
- wastewater and rain water discharges,
- traffic congestion,
- noise and light pollution,
- loss of cultural resources,
- contamination of soil and water from leaks from different tanks,
- air pollution from chemical storages,
- solid and hazardous waste pollution,
- runoff and soil erosion.

The Long Beach Harbour has formulated a framework to implement a greening policy, including: Specific environmental principles, which, once adopted, will govern all Port activities

- A series of goals – for each element of the policy
- Specific metrics [parameters] to measure progress toward meeting the goals
- Some new aggressive environmental programs designed to achieve progress toward the goals
- Specific incentives to promote program participation among tenants
- Specific legislative proposals that would support the program

11.5.2 Elements of the Green Port Policy

SLPA formulates a green policy for the transition towards a green port. The policy should also formulate how the green policy can be implemented with the port-users. A green port policy and policy framework need to address the issues related to:

- Operations within the port;
- Port related traffic on land
- Vessel operations towards and in the port

Steps involved in developing the SLPA ports in a "Green Port" direction would include:

- Establish base line conditions
  - Inventory of current operations, with corresponding equipment, emissions, energy consumption, procedures, waste streams
  - Assess current environmental quality (air, water, noise, light)
  - Identify possible measures to reduce emissions, reduce energy consumption, reduce and handle waste, using best available technologies
- Formulate a greening policy; the policy would need to address
  - Air quality
  - Port wastes
  - Energy conservation
  - Noise
  - Relations with local community
  - Quality of water
- Set a series of goals – for each element of the policy
- Set up monitoring programme to assess impacts of implementing the greening policy
- Embark on a number of environmental programs designed to achieve progress toward the goals
- Specific incentives to promote program participation among tenants / make participation for new tenants compulsory.

11.5.3 HSSE Department

A further 'greening' of the ports operations will require considerable efforts in terms of management, procedures, equipment and facilities. An essential element that should be included in this 'greening process' would be the Establishment of a Health, Safety and Environment (HSE) management department within the port organization structure (see Appendix X).

The task of such a department include:

1) Establishment of health and safety plans for all operations, which covers

- Preparation of HSE plans for workers, and for projects during the entire project cycle (planning, designs, construction, operation, decommissioning) – ADB safeguard policies and principles
- Preparation of HSE plans for departments/buildings (this includes permanent and temporary work) in accordance with the Factory ordinance of Sri Lanka and OSHA
- Conducting training
- Preparation of manuals
- Development of protocols for HSE
- Auditing on regular intervals

- Prepare and maintain Emergency Preparedness Plan, Emergency Response Plans and Disaster Management Plans

2) Establishment of Environmental monitoring unit, which is responsible for

- Establish a new state of art environmental laboratory for monitoring environmental elements/ parameters related to port activities
- Monitor gaseous and watery emissions, as well as ambient quality of air, water and sound levels on a routine basis
- Monitor emergency situations with on call readiness/availability
- Preparing environmental safeguard compliance reports

3) Maintaining environmental quality standards, which includes

- Obtaining accreditation for services and goods (this has now been made mandatory by the Sri Lanka Accreditation Board)
- Obtaining ISO quality certification
- Carrying out quality control / quality assurance
- Carrying out internal audits
- Application of cleaner production measures, 3R principles, 5S system
- Conducting training
- Preparation of manuals, guidelines etc.
- Adoption of green jobs

4) Undertaking greening port activities, which includes

- Promoting green shipping for reduction of $CO2$ and $SO2$ as per IMO conventions
- Promoting green port program with the reduction of idling time, improving productivity, introducing green technologies (improved fuel quality, change from diesel to electrical engines where feasible)
- Introducing electrically driven public vehicles within the port for (mass) transport
- Improving the lighting with proper lumens levels with LED technology
- Maintaining energy footprints as low as possible with more renewable energy
- Promoting clean and green environment and green fuels
- Minimise the air pollutants from ships as practically possible
- Preparation of manuals, guidelines etc. on greening activities

5) Maintaining maritime waters devoid of pollution (in accordance with international conventions and protocols) which includes

- Instituting proper dredging plans and dredged material disposal
- Managing ballast and bilge waters as per international/ or MEPA regulations and guidelines (e.g. the 2017 International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM)
- Controlling the ambient water quality degradation, in particular the areas connected with Beira Lake
- Developing water and sediment quality analyses periodically to understand evolution of the quality
- Maintaining proper storm water management plan
- Maintaining oil spill preparedness and response plan with recovery equipment

6) **Handling waste being generated due to port activities, which comprises of**
- Bringing in environmentally acceptable reception facilities for ship wastes
- Introducing proper waste management techniques such as wastewater treatment plants, hazardous waste management plants (incinerator), air quality control measures
- Bringing in 3R principle with waste reduction, recycle and reuse programs
- Developing demolition plans for CEA approval
- Developing proper solid waste management plans
- Developing protocols to handle dangerous and radioactive cargo
- Developing procedures for emergencies with all safety measures in place

7) **Achieving environmental safeguard compliances, which comprises**
- Maintaining environmental protection licenses with CEA
- Maintaining dumping licenses with MEPA and comply with all rules and regulations
- Maintaining the EPL terms and conditions with monitoring activities
- Liaising with the CEA and CC&CRMD for EIAs and IEEs
- Preparing and maintain EMPs
- Preparing basic information questionnaire (BIQ) for new projects for environmental clearance from CEA and CC&CRM

8) **Combating climate change issues and achieving SDG goals, which includes**
- Studying and prepare actions on possible climate change impacts, their mitigation and adaptation
- Liaising with Disaster Management Centre for preparation of disaster management plans
- Achieving Sustainable Development Goals 13–2030 agenda on gender equality, clean water and sanitation, affordable and clean energy, decent work and economic growth, reduced inequality, climate action, peace and justice strong institutions and partnerships to achieve the goal. In the Appendix XVIII additional examples are provided.

As indicated above HSE manuals need to be prepared. This could be undertaken by the proposed HSE department. Also, a comprehensive plan in respect of all operations and construction works should be worked out. Once the plan is ready, it must be operationalized by the SLPA and corrected for shortcomings, if any. As per the Factory Ordinance of Sri Lanka, it should be implemented, and annual audits have to be organized with the Labour Department. This plan has to be enforced for all divisions of SLPA and feedback needs to be received for further improvement. At least every five year this plan must be updated and then implemented fully.

The system once prepared needs to be implemented with the assistance of SLPA. As mentioned earlier, one Chief Engineer should be responsible and under his guidance this plan should be implemented in every division or department of the SLPA. Board of Management approval is therefore obtained in order to carry out all instructions in the HSE plan. In addition, necessary stakeholder institutions such as Labour Department, ILO, CEA, IMO, MEPA, CCD etc. should be informed of the plan to get their support. Every five years, this plan should be updated, in collaboration with the assistance of all stakeholders.

11.5.4 International conventions

Another step would be integrating the requirements of a number of internationals conventions and protocols into the operating procedures of the SLPA. Sri Lanka is signatory to a considerable number of conventions and protocols, but several international conventions have not yet been adopted.

Sri Lanka is signatory of quite a number of maritime conventions and protocols. However, it is not always clear to what extent the conventions and protocol are adhered to. To qualify as a green port, full compliance with international conventions and protocols is mandatory. SLPA should review which new conventions should be ratified (like the recent Convention on Ballast Water or the MARPOL Protocol Appendix X).

In this context it would be wise to look for cooperation with other ports in the region, which have already taken steps in the greening process (Singapore). Such contacts would assist in focussing on priorities and promote collaboration on environmental implementation issues such as compliance with ballast water management and waste treatment. (BWM convention).

11.5.5 Security

The SLPA should fully implement the International Ship and Port Facility Security Code (ISPS Code). The ISPS Code was created by the International Maritime Organization to enhance ship and port facility security. The ISPS Code is an amendment to the Safety of Life at Sea (SOLAS) Convention (1974/1988) on minimum security arrangements for ships, ports and government agencies. Having come into force in 2004, it prescribes responsibilities to governments, shipping companies, shipboard personnel, and port/facility personnel to "detect security threats and take preventative measures against security incidents affecting ships or port facilities used in international trade."

The Code is a two-part document describing minimum requirements for security of ships and ports. Part A provides mandatory requirements. Part B provides guidance for implementation.
The ISPS Code applies to ships on international voyages (including passenger ships, cargo ships of 500 GT and upwards, and mobile offshore drilling units) and the port facilities serving such ships.

The main objectives of the ISPS Code are:

- To detect security threats and implement security measures
- To establish roles and responsibilities concerning maritime security for governments, local administrations, ship and port industries at the national and international level
- To collate and promulgate security-related information
- To provide a methodology for security assessments so as to have in place plans and procedures to react to changing security levels

11.5.6 Standards for gaseous emissions

The standards in force in Sri Lanka for gaseous emissions are not very strict, when compared with standards in other countries. Furthermore, the CEA has only defined standards for the parameters HC (hydrocarbons) and CO (carbon oxide). No standards have been formulated for NOX, a powerful global warming gas, PM10 / PM5 (particulate matter) of SO2 (sulphur dioxide).

When the SLPA would start regular monitoring of emissions, it would be appropriate to compare results with international standards instead of with national standards. For additional information reference is made to Appendix XVI, Appendix XVII, and Appendix XVIII.

11.5.7 Recommendations

The recommendations on environment is focused on:

R36. **Establishment of a green policy** and implementation framework including measurement systems, monitoring and controlling emissions, set targets for the emission controls.

R37. **Establishment of HSSE department**. Attention for environmental issues within the operation of the port would be greatly served by establishing a dedicated, relatively independent Health, Safety and Environment (HSE) department. Such a department should conduct its task from the perspective of assuring optimum conditions for health, safety and environment. It should not be subordinate to a section with merely economical and efficiency interests.

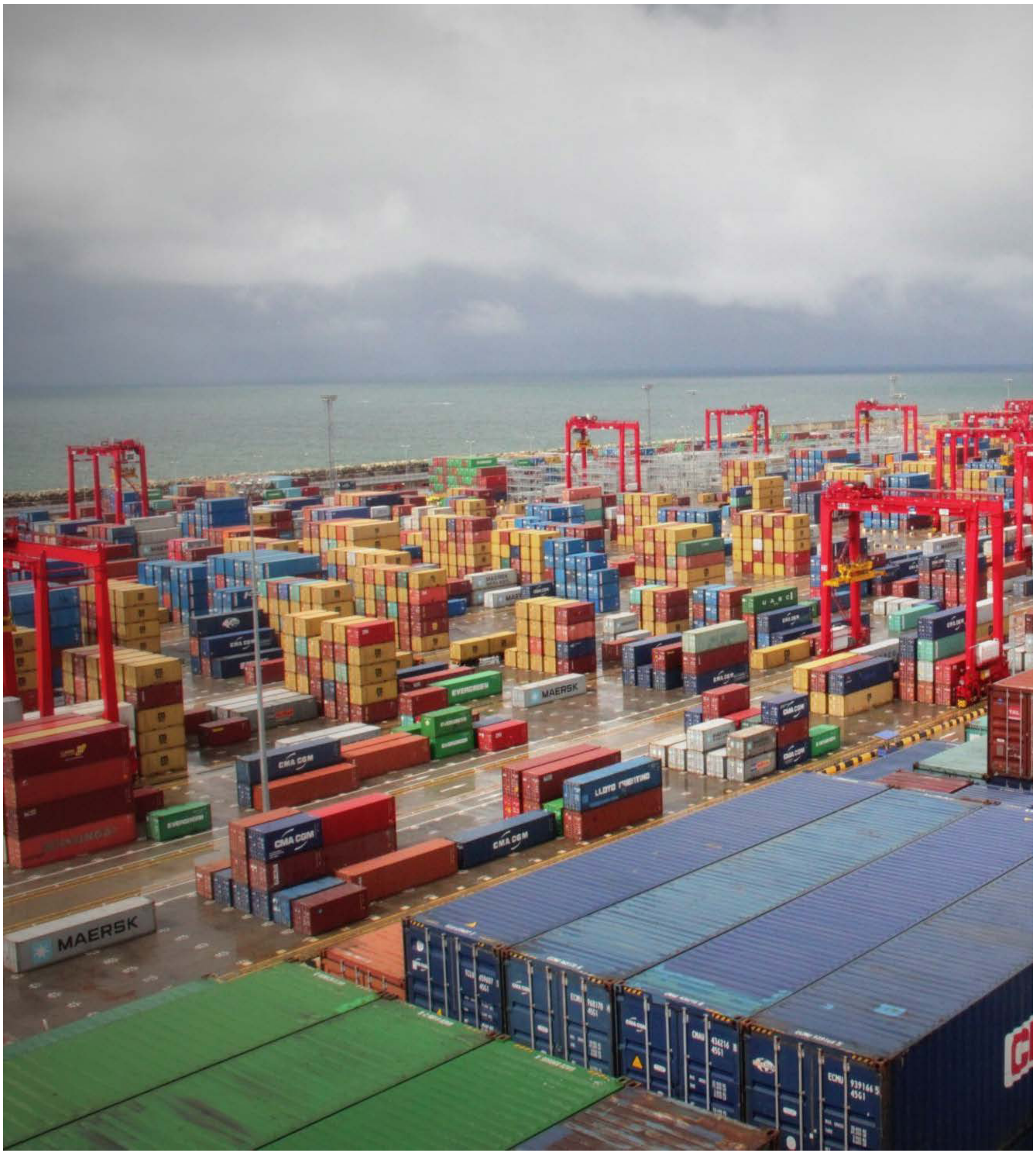
The role and tasks of such a HSE-department is elaborated in the section on the Green Port Concept.

R38. **Green the port organisation,** effective measurements to green port activities (own organisation and port users).

R39. **Complying to international relevant conventions.**

R40. Set up an **environmental Management System in line with ISO 14001** certification for the different parts of its operations.

Part C: IT, Customs and other Auxiliary Port Functions



12 IT in the Port Environment

12.1 Introduction

IT has become a backbone for many ports in the world. Especially container ports today require high levels of automation to stay competitive with other ports and to ensure that ship time in port is reduced. This chapter describes the IT landscape in the port of Colombo and provides international examples of IT developments in other ports such as Singapore, Rotterdam and Dubai.

The following approach has been used for this chapter:

- Paragraph 12.2 discusses in SLPA's IT issues in general and the mindset to become "paperless": Communication between private terminals and SLPA is mostly based on data file transfer in a non-automated fashion.
- Paragraph 12.3 describes the current situation including the key observations: Observations highlight systems lacking, which could be implemented to help safe and efficient operations.
- Paragraph 12.4 describes the way forward in IT: SLPA sees the importance of digitalisation and its benefits. International conventions will drive the trend towards digitalisation
- Paragraph 12.5 provides details on the port and the port community system: The functionality of a PCS is aimed at eliminating unnecessary paperwork which can clog up cargo handling.
- Paragraph 12.6 describes the terminals and IT and illustrates the recommendations for SLPA terminals.

12.2 SLPA and IT in general

SLPA over the years, automated many manually managed functions and all software introduced were constructed to fall in line with the legal rules of the land. Therefore, automation happened to convert the manual transactions and record storing to become computer based storage. The automaton efforts did not challenge the existing procedures and practices and take fullest advantage of automation, instead functions were captured as it is and fields and records of a transaction was transferred to a computer. Due to this approach, many functions that can automated, and become computer dependent continue to remain printed hardcopy based, signed, hardcopies retained for lengthy periods to be referred if needed and legally compliant.

Since multiple parties are involved in receiving or providing a service to the Port, until all parties are connected through a common Digital Infrastructure, retaining printed documents continue to be the most reliable answer. Hence information retaining as printed proof, with signatures, is viewed as mandatory. To alter this the state acceptance of modern digital practices, moving towards global digital transition and enacting new legislations need to be fast tracked. There is a national demand to go "Digital", and therefore, an effort to upgrade, introduce automation is seen easier than before, and will be accepted by business partners with grace. The Port of Colombo should take advantage of the National Digitalization and align automation to eliminate non-productive, tedious, and inefficient functions.

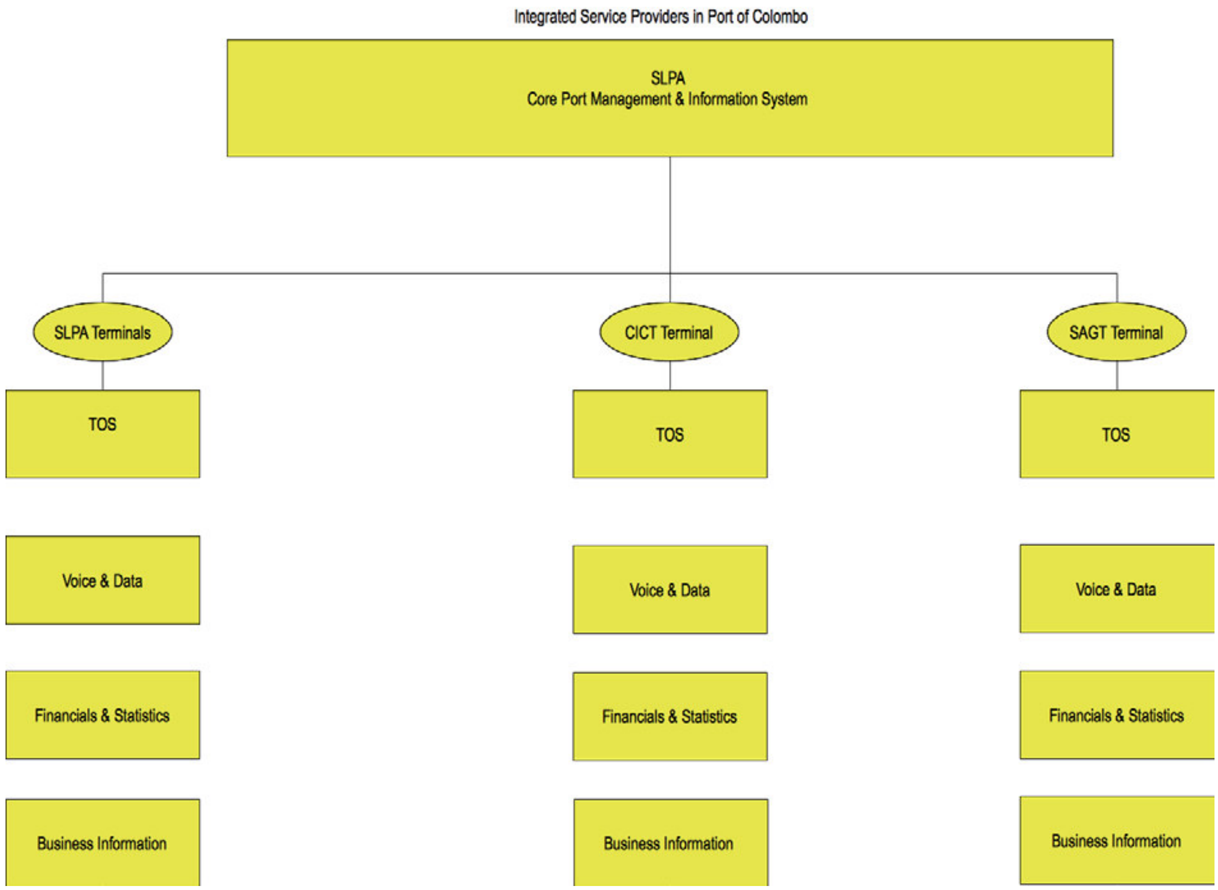
This study has provided ways, means and recommendations to overcome situations with methods, procedures to introduce in stages a process of digital automation and to become paperless. This introduction will bring value of modern automation leading to transparent, efficient, dependent, process driven practices that bringing large benefits of modern cloud computing through digital certification for authentication of transactions to speedup slow practices.

The introduction procedures recommend a "Paperless" working environment to seamless data sharing and integration, where bottlenecks become prominent and the systems will further provide suggestions as solutions to eliminate them. Hence the improvement leads to quick and better decision making. The recommendations encourage automation of practices through PPP (Private, Public Partnerships) to form through BOT (Build Operate and Transfer) under franchises with SLPA as a shareholder and SLPA continues to be the regulator.

SLPA and private terminals

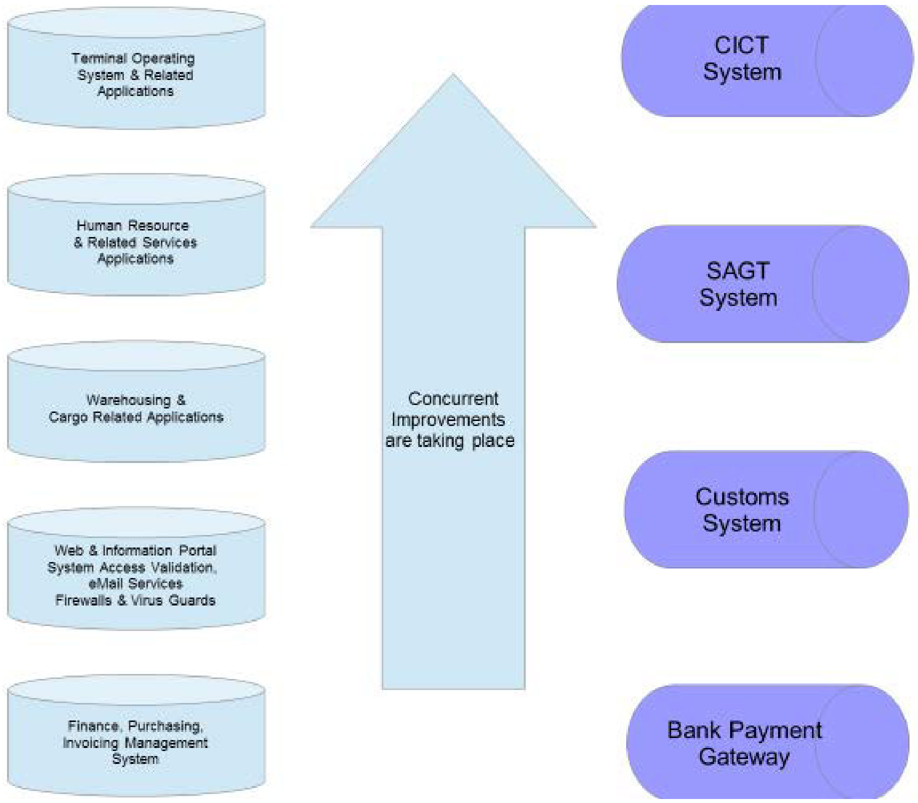
There are three Port Container Terminals serving clients of the Port of Colombo. JCT, CICT and SAGT as Terminal Service Providers, use their own independent Information capturing and record keeping information processing methods. They run Computer Applications on their own Hardware Systems. CICT and SAGT who came in to serving the clients had the benefits of introducing uninherited systems and enjoy efficient automation. Nevertheless, JCT has many inherited computing legacies, hence there are many functions and practices that continue to require printed forms to be filled by hand and shared with the respective service seekers, providers and other Terminals. This continue to force the information manually captured to be updated by data entry when CICT and SAGT could electronically submit digital data files that enables data interchange for efficient data transmission. The current data capturing, updating, sharing practices are very human dependent hence they rely on operational hours, holidays, leave days, shifts, human errors and so forth. It further requires special attention to ensure data validation and verification.

Figure 12-1: Overview Systems Terminals and SLPA



Communication between private terminals and SLPA is mostly based on data file transfer in a non-automated fashion, many voice, and fax communication is still used to guide and confirm the sending and receiving of the respective data files. SLPA TOS application of JCT and the central management system is also reprocessed by the staff of statistics department to produce standard daily management reports. In addition, for report generation statistics staff has to manually enter data to formats before management reports are produced, requiring data validation, error checking, confirmation, signing by respective official, subsequently emailing to the respective management team, who again recheck and then send to the senior management. Information from the harbour master office is based only on handwritten notes sent after an operation is completed through paper and re-entered to the billing and invoicing at the central finance system before invoices on tugs, pilotage and other service charges are invoiced to the respective parties. This applies to expenses of the Harbour Masters Division that are related to the respective ship operation.

Figure 12-2: Functions Demanding Quick Improvements



The above graphic shows functions that demand quick improvement. It is visible that the other service providing or partners too are improving their Data Processing Infrastructure and Digitalizing efforts in parallel and concurrent with each other. Private terminals like SAGT and CICT will have their own prioritization to comply with the industry and global partners. Hence SLPA to automate towards integration in this environment is however extremely challenging.

12.3 Current situation

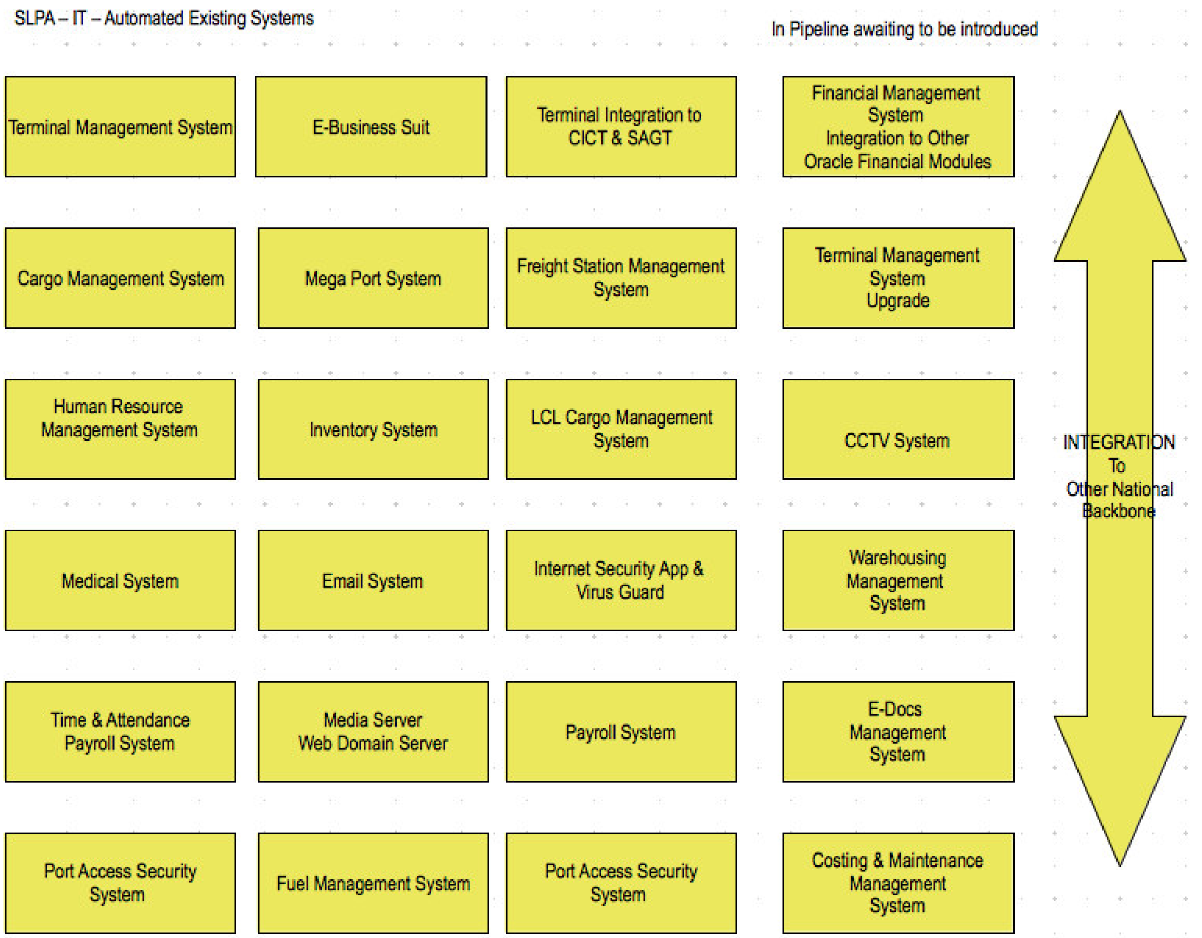
In this paragraph the following paragraphs are presented.

- Existing situation – systems in use
- Applications and systems lacking
- Key observations

In this chapter first the systems are displayed which are currently in place and their cost or revenue supporting functions. Thereafter it shows the systems available and the ones that are as of today still lacking. Finally, the way forward is discussed showing means and ways forward on how to implement new systems efficiently and effectively.

SLPA has an annual plan of upgrading the Information Management Infrastructure, hence, there is a process approved as a master plan on IT. Simultaneously CICT and SAGT continue to upgrade their information management systems to be able to provide quick and efficient services to their customers. Since the two private terminal operators are linked to international private terminal management companies, they continue to use state of the art terminal and ancillary management IT solutions to be able to link to their local and global clients. The approval for such upgrades are received within the group. In contrast SLPA needs to follow tender procurement procedures some of which are approved at the National Cabinet level.

Figure 12-3: Existing IT Systems in use SLPA

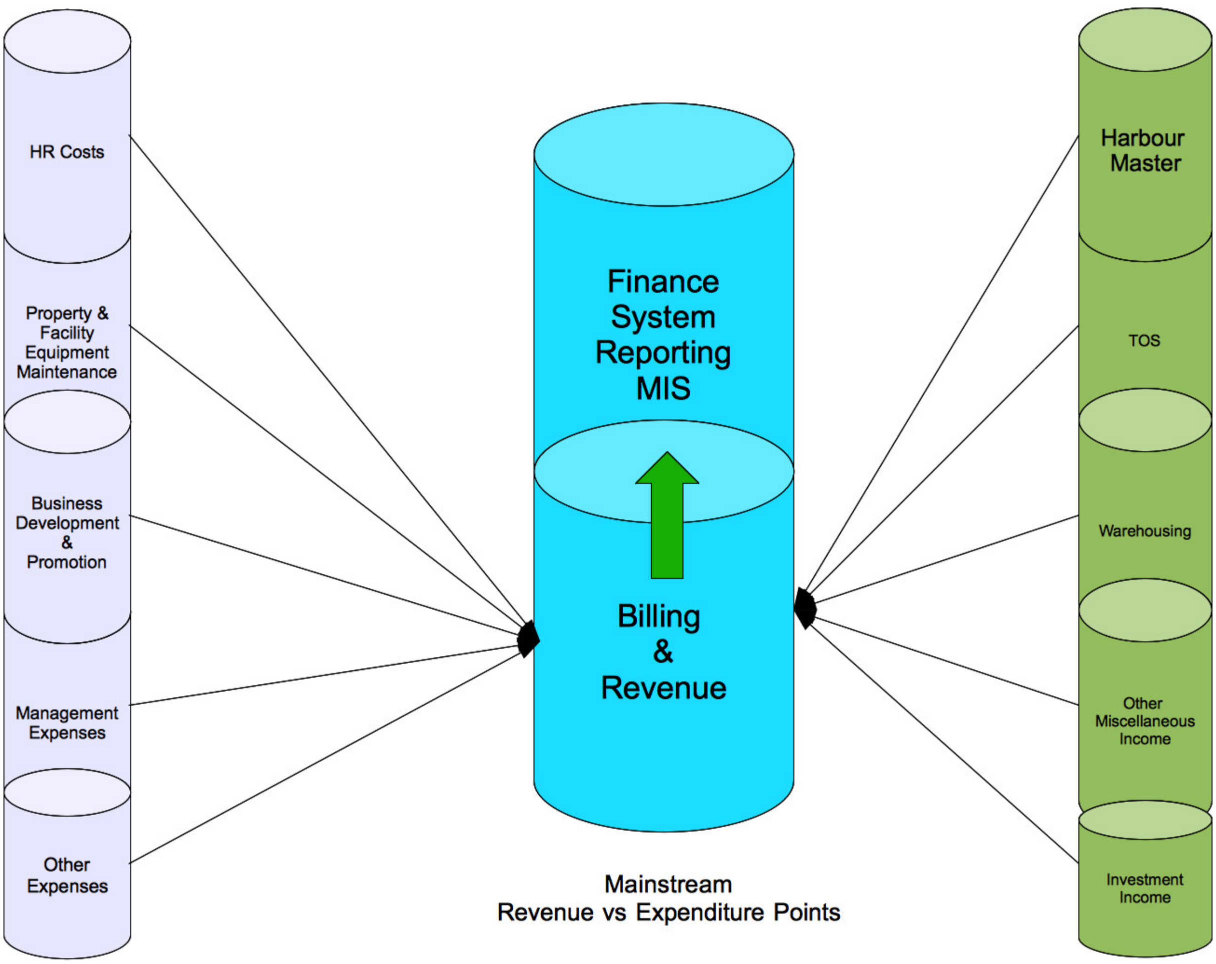


On the right-hand the systems in the pipeline waiting to be introduced are displayed. For long SLPA has focussed on an integrated system by making expensive amendments to link to the central oracle finance system. New requirements of automation resulted in new subsystems which preferably were required to be integrated to the existing main systems. This challenge was not satisfactorily fulfilled because existing systems were dated from various vintages and linking were too complex having to accommodate too many platforms. Today it has resulted in a mushroom of applications which have different levels of integration or no connection at all and requiring manual data feeding to complete tasks designated to these systems. While SLPA continues to introduce new applications and modernizing existing systems, SLPA embarks on expensive customization rather than change the business process by re-engineering to stop manual signing, dependence on paperwork to cease inefficient practices. This is to the dismay of the private terminals who uses technology, EDI supported digital data integration and management applications that are unable to use full potentials to let the port users receive the benefits.

It is evident that SLPA is seeking approval and finance to upgrade several existing IT systems. SLPA is challenged to maintain the existing applications designed & customized over many years where automation was a direct conversion of manual processes supporting paper based activities. To support these rules private terminal operators, retain print copies securely stored for several years. Latest and modern applications able to meet much larger traffic and quick in response by processing data can be introduced without linking to currently used applications. This reduces the risk of connecting to automated processes designed and developed at different times, using a range of operating systems, versions, databases, technology and design architecture, application design languages and versions, and need to have specialized maintenance support staff.

Schematic overview of the main systems at SLPA is divided between the revenue stream and the cost stream. The picture shows the revenue systems on the right side and the cost systems on the left side. In the middle the central finance system is positioned. One of the main problems is that several of the connecting lines involves manual steps and processes.

Figure 12-4: Main Systems SLPA



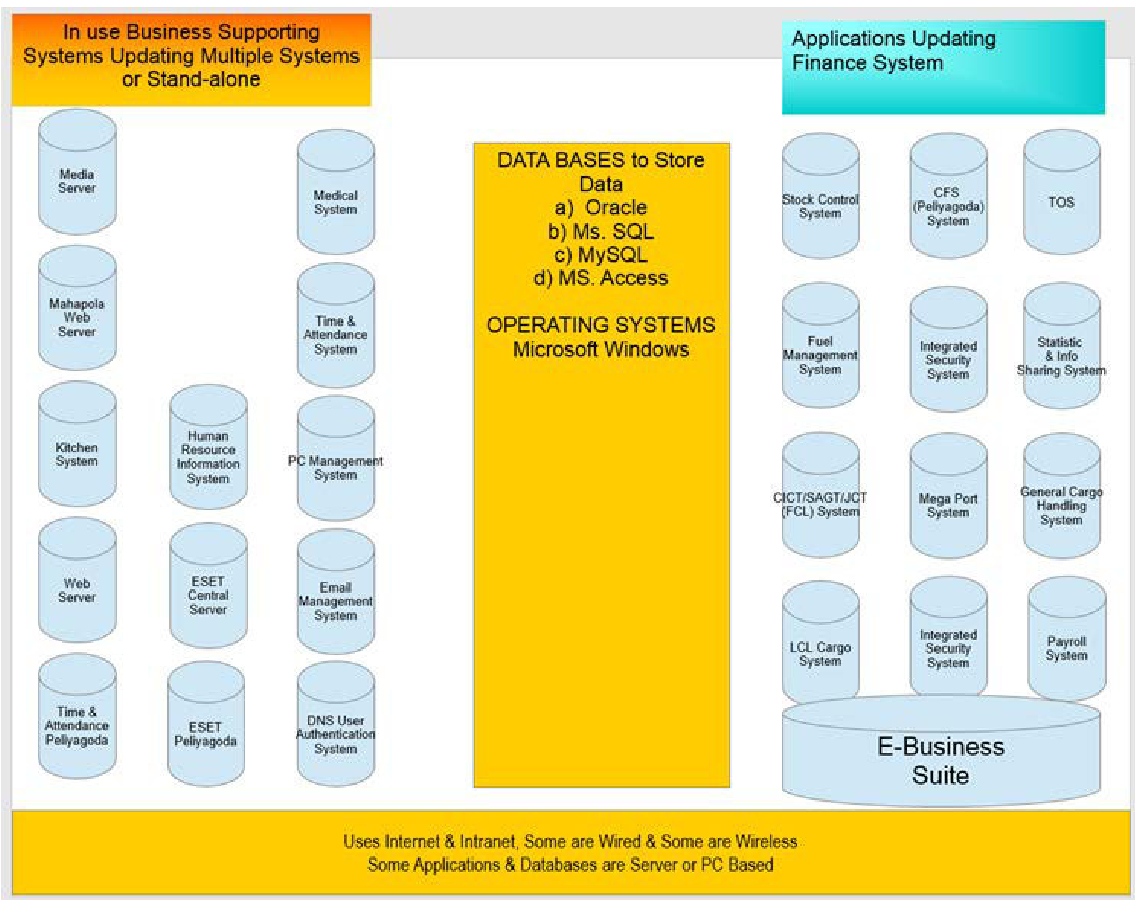
New technologies are available today with cloud based solutions and ease of sharing information. The emphasis amongst IT techniques therefor has shifted from trying to create a massive central system to one which is based on communication of the required information on a common web based interface or platform and to push or pull only the relevant transaction to complete the business cycle of a process.

12.3.1 Existing situation - systems in use

There are multiple software applications, used to support the business of the SLPA. These applications produce reports, and based on them, transactions are entered to the accounting and finance system to capture revenue. Simultaneously the expenses are updated to the accounting and finance system to reflect them in the financial reports. There is a heavy dependence on manual papers, and signatures for approval throughout the processes.

The next picture shows the systems in use. It is a schematic overview as listing all individual applications for the many functions which are applied within SLPA cannot be presented in one drawing. Systems are grouped by their functionalities and displayed herewith. On the right side the systems are involved in revenue generation and capturing whilst on the left the business supporting systems are displayed.

Figure 12-5: Listing of Applications

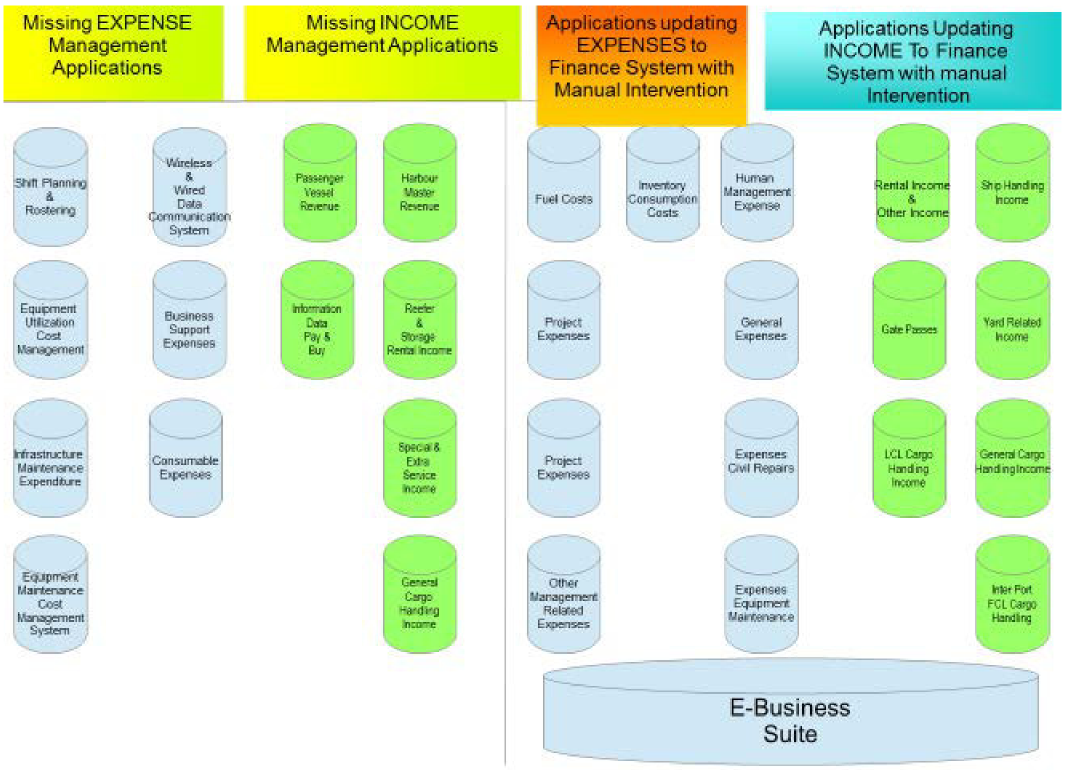


It should be noted that many systems from several disciplines (like for example container terminal system TOS, CFS Peliyagoda, stock control, payroll etc.) are delivering information which needs to be entered in the central “E-Business Suite”. Databases used are oracle (finance system), MS SQL server, MYSQL and MS access by the design of the application. The platforms used are wide spread some use internet and some use intranet, some are wired and some are wireless. Although the common operating platform is windows, many versions of the operating systems are present including non-supportive windows XP leading to concerns on sustainability and security.

12.3.1 Applications and systems lacking

The following diagram shows on the left applications which are missing for a modern and proper port systems. They are divided between applications supporting the revenue stream (green) and applications supporting the cost side (grey). On the righthand the systems in use are illustrated for those which have a high manual intervention. These systems are subject to improvements in order to create efficiencies and become paperless.

Figure 12-6: Applications Missing and In Need of Update



The following revenue generating activities remains hand written and subsequently entered to the billing system to generate the invoice to the respective party.

- Reefer & Storage Rental Income - Handwritten, paper based and sent to Statistics Department to update to the billing system.
- Detention Cargo – Containers or CFS Cargo that is detained by Customs or preventive officers.
- Special & Extra Services - Providing additional security and safety, health and fumigation, assigning yard space and remains unutilized, extra moves due to change of berth or terminal are a few to list that needs paper signing and later recording to the billing system for invoicing to the respective client.
- General Cargo - This remains paper driven and all services provided are captured by handwritten records. Subsequently the sales invoices are raised through the billing system to the respective party.
- Services for Passenger Vessel - This remains paper driven and all services provided are captured by handwritten records. Subsequently the sales invoices are raised through the billing system to the respective party.

- Request for Data & Information - The requirement for data for various purposes and by many organizations is handled by the Statistics Department. There is no cost allocation and revenue charge for such activity.
- Harbour Masters services management system - All handwritten paper based and sent to Finance Department to raise the sales invoice to the respective party. The harbour master services should be supported by a system in which berthing planning, pilot and tug times can be processed for billing. The system should be integrated with a vessel classification system.

Following Expenditures are captured by handwritten paper and later entered to the accounting system to be reflected in the ledgers.

- Wireless (Wi-Fi) & Wired - Maintenance expenses, apportioning to respective divisions, service charges, repairs, and related support services. Communication expenses, product development expenses, maintenance of computer hardware are all absorbed by the IT department, and not by business units.
- Public information portal, Interactive website, social media, business marketing and publicity drive. The corporate imaging of SLPA should be addressed including to boost of the public information portal and interactive website.
- Business Support Expenses - Voucher driven and entered to the accounting system once again manually apportioned. This mainly draw attention to expenses incurred by divisions for others or third parties where it is a reimbursable expenditure where it requires an invoice to be raised.
- Shift Planning & Roster System - it is manual, hence the costing and true picture for a vessel operation or any other operation cannot be traced in financial terms.
- Infrastructure Maintenance & Management Expenses or Civil engineering and property management system.
- This system is missing today. It would allow civil engineering to plan their maintenance and resources whilst, digitally keeping track of important drawings. Port development planning is an important element in the future of the port and process can be complex and time consuming. Hence such system would allow civil engineering to plan forward, understand the phase of a development project and the steps to be taken (procurement, tender, ESIA etc.). There are periodical and regular expenses that has to be monitored and not placed under a common expenditure heading. With manual or no computer system to trace, track and forecast this remains manually driven. This is linked to the Purchase Control System. However, there is no expenditure planning and projection system.
- Lump Sum approval for divisions and expenses under a heading is allocated instead of identified pre-planning and then charging to the respective cost heading. This would increase flexibility and accountability for the divisions.
- The engineering and technical workshops have only manual systems for planning and administration. There is no business software in place to set tasks and to monitor progress. Expenses recording of all machinery and ancillary items is manually maintained. This is paper driven and bin and job card based. Hence an expense report to compare productivity on a project needs to be manually done.
- Management Expenses - Expenses recording of Management is not assigned or allocated to projects.

Also existing systems which support the main revenue stream are depending a lot on manual intervention and is therefore subject to misinterpretations, human errors and failures.

The following main systems are highlighted which have manual interventions and are directly linked to revenues:

- Yard related income. The current TOS system (Sparcs and Navis Express) have no proper yard utilisation & optimisation module. File transfer to Oracle E-biz for billing, financial and statistical integration is often cumbersome. Real time invoicing is not available.
- LCL Warehouse related income or Warehouse logistics management system. The procedures on LCL cargo are very much manually driven including stamped payment forms. Currently registration of cargo in warehouses is recorded on a simple system. Warehouses run by SLPA require a proven business software solution for their warehouses. The pick & place order and delivery should ensure that the warehouse logistics is improved and secured. Bar-code scanning and labelling should become a feature in the new software. The systems should have a web interface and communication tool.
- Ship handling income. Tug and pilotage revenues are based on a manual process and paperwork needs to be completed before Oracle e-biz can be updated and the invoice can be made.
- Gatepass income. Gatepasses are not digitalized and linked customer relation module. There is no intelligent web based purchasing and payments module.
- General cargo income. The manifest of general cargoes need to be handed in manually. The complete shipfile is calculated manually and then entered into Oracle E-biz.

12.3.2 Manual documentation in the activity chain

In this paragraph two activity chains are explained:

1. LCL cargo clearance & delivery process
2. FCL import container: cargo clearance & container delivery process

The amount of manual documents applied in this chain are illustrated. In the same table the modern practises are detailed to understand the difference between systems applied. The results are quite obvious, the amount of administrative documents in the manual process are numerous, up to seven copy documents to get to a delivery order, involving a lot of process time and administrative checks and administrative burden and limited transparency. This compares to a semi-automated paperless solution in which approvals are made through the systems through status checks and status updates. In this way the administrative flow is reduced and paper is eliminated. Further the system becomes very transparent, each party involved knows the same status.

Table 12-1: LCL cargo clearance & delivery process

Process / Activity	Current situation Colombo	Benchmark International best practices
Cargo declaration	E-declaration or manual	E-declaration
Container arrival notification	Fax/Email from shipping line to agent	Automatic notification
Agent request for de-stuffing	From agent to terminal; advanced guarantee payment to SLPA	Online request from agent to terminal; based on existing guarantee running account
Cargo unloading/de-stuffing (out of container)	Manual check Consignee comes to BQ administration building to check (in cargo booklets) if the cargo has been de-stuffed from the	Online notification after de-stuffing

Process / Activity	Current situation Colombo	Benchmark International best practices
	container and moved to the SLPA warehouse	
Import dues (to Customs)	Payment (cash or transfer); payment slip stamped by Customs. If cargo has been submitted to the warehouse, the consignee goes to Customs office (outside port) to pay the customs fee	Online payment
Port dues (to Port Authority)	Payment (cash or transfer); payment slip stamped by Port Authority. Consignee pays port dues to Port Authority at SLPA office (outside port)	Online payment
Delivery order (request from Consignee to SLPA to deliver)	Manual (3 stamps required) Consignee returns to BQ administration office to obtain a stamp for the delivery order (after showing payment receipts of Customs dues and Port dues)	Online
Cargo delivery to Consignee	Manual Consignee goes to SLPA warehouse to pick up the cargo upon submission of • delivery order Customs • delivery order SLPA • customs declaration • copy bill of lading • gate pass • landing & delivery payment slip • storage payment slip Consignee waits outside warehouse until SLPA port employees bring (unpalletised) cargo to the entry of the warehouse; Consignee loads cargo into truck	Palletised Warehouse operator loads cargo with forklift into consignee’s truck

Table 12-2: FCL import container: cargo clearance & container delivery process

Process / Activity	Current situation Colombo	Benchmark International best practices
Ship arrival; ETA from shipping line to Port Authority	Email/Fax	EDI (Electronic Data Interchange)
Manifest	E-manifest (BAPLIE) 99% online – 1% manual	E-manifest (BAPLIE) Online
Cargo customs declaration by consignee	E-declaration	E-declaration
Import dues (Customs)	Payment (cash or transfer) If container has been discharged at the terminal, the consignee goes to Customs office (outside port) to pay the customs duty	E-payment
Port dues	Pro-forma disbursement account Advanced payment (online) Ship's agent pays port dues to Port Authority	E-payment
Container arrival notification	Shipping agent informs consignee on arrival container in stack	Automatic notification
Handling dues	Terminal charges shipping agent for the handling Monthly settlement Shipping agent charges to consignee: • Quay move • Stack move • Storage • Delivery move	
	Consignee settles payments (cash or online) before pick-up of the container; obtains landing a delivery payment slip	E-payment
Delivery order (request from Consignee to SLPA/terminal operator to deliver)	Consignee has to complete the delivery order by obtaining approval by: • Customs • Terminal operator • Ship agent	E-notification to Port Community System and/or Terminal Operating System
Port in-gate process: Truck sent for pick-up	Manual • Customs issues copy of gate pass (paper) to the agent/importer upon payment of custom declaration	Security check • Automatic identification truck driver • Truck license plate

ADB

Technical Assistance Consultant's Report

Project Number: 50184-001
February 2020

Democratic Socialist Republic of Sri Lanka: National Port Master Plan

(Financed by the Japan Fund for Poverty Reduction)

The Colombo Port Development Plan – Volume 2 (Part 4)

Prepared by

Maritime & Transport Business Solutions B.V. (MTBS)

Rotterdam, The Netherlands

For Sri Lanka Ports Authority

Asian Development Bank

Process / Activity	Current situation Colombo	Benchmark International best practices
	• Trucker needs port access pass from SLPA (sticker) • Wharf clerk provides copy of gate pass to truck driver (paper)	
Terminal in-gate process: Container delivery to Consignee	Manual Truck drives to terminal to pick up the container upon submittance of: • Delivery order Customs • Delivery order terminal operator • Dustoms declaration • Dopy bill of lading • Dustoms payment slip • Copy of gate pass • Landing & delivery payment slip	(semi-) Automated Truck driver is invited to pick-up the container after finalisation of the online container delivery order Security check • Automatic identification truck driver • Truck license plate • Connecting container number to truck license plate
Terminal out-gate process	Trucker receives Equipment Interchange Report (EIR) after collection of the container	Trucker receives Equipment Interchange Report (EIR) after collection of the container, including gate pictures of equipment
Port out-gate process	Truck drives to Main Gate at port boundary Customs checking procedures • Wharf clerk delivers original gate pass to Customs (including truck license plate number and seal number) • Truck driver delivers loading pass to Customs • Custom issues customs seal Customs issues new gate pass (to drive to Customs Inspection area)	Truck drives to port gate Security check • Automatic identification truck driver • Truck license plate
Customs Inspection	Three examination modes: • Green: no examination (5-7%) • Amber: quick examination (+90 %) • Red : full examination (3-5%)	Upon Custom request, truck driver needs to visit Custom scanning facility for examination

12.3.3 Key observations and bottlenecks

The following key observations and bottlenecks on system are mentioned in this table. The emphasis is been made on the guidance of the revenue generating support but also cost aspects the list has been made.

Table 12-3 IT systems on revenue stream - Key Observations

Category	Issue	Severity
IT systems on revenue stream		
General	Manual processes and paper based approvals cause high administration and time consumption	High
TOS	The TOS of JCT (Navis Sparcs 3.10 and Navis Express) are outdated and do not support modern yard utilisation, real time yard planning and web based applications, GPS and modern gate applications	High
TOS	TOS system to provide a dashboard management system with relevant management information (productivity and performances)	High
TOS	Ability to upload files and amend records within the permitted timeframe	High
TOS	System should be able for to bill activities directly on handlings and storage and share the invoice lines with the finance system.	High
TOS	Babplie files often have errors leading to communication, corrections by shipping agents	High
TOS/ harbourmaster	Berth planning system to be shared between container terminals and harbourmaster and linked to scheduling system of vessels on calendar planning	High
Gate automation	JCT has no gate automation, once TOS system is updated OCR gate systems become feasible (OCR and automated truck driver passes).	High
Damage control	Equipment Interchange Reports (EIR) are made manually. These reports lack photo's. Accident reports and claim handling is subject to become more efficient through OCR scanning.	Medium
Harbour master	Tug and pilotage recording and invoicing is subject to manual registration.	High
Harbour master	Ship registry, berth planning, mooring and de-mooring is not integrated with invoice recording. A Harbour Information Management System (HaMIS) is required integrating the ship registry file with actual ship history call records. The ship registry file is to be linked with the international ship file from IHS/Fairplay or Clarksons.	High
Harbour master	HaMis system is lacking and planning on tugs and pilots including statistical data should be provided from HaMis to a management web based dashboard. Turnaround times to be integrated into the dashboard with information provided by the TOS systems (productivity & performances)	High
Warehouse	The warehouse LCL system is a manual driven process, no automation available (no barcodes scanning, no receipt alerts, no damage control systems, no track and trace)	High
Single window	There is no single data window for port users. Approvals in the information chain are based on manual procedures and stamped documents. Communications on the process is based many circular round via phones and even by fax. System should share specific and allowed data between terminal operators and management information systems	High
Single window	Publications on procedures, rules and practices	High

Category	Issue	Severity
Legal	Contract management system with alerts should be linked with TOS to respond effectively on disputes	Medium
Payment control	Systems to be linked with unrestricted Payment Gateway and Pay online and submit digital receipts.	Medium

Table 12-4 IT systems on costs stream - Key Observations

Category	Issue	Severity
IT systems on costs stream		
CRM	A Customer Relation Management system is lacking.	High
Manual document management	The manual document management system should be digitalised to avoid business based on hard copies.	High
Shift planning & rostering	Shift planning and rostering is done on a manual basis whilst services have to offered 24/7 optimisation is required in this respect.	Medium
WIFI networks	WIFI networks are lacking at various locations	High
Cable internet	Cable internet is often not reliable causing file transfer to fail	High

12.4 IT Way Forward

The new applications will use a common interface to push or pull only the relevant transaction to complete the business cycle of a process. Hence, the new applications run as independent stand-alone software solutions. They meet the mandatory condition of being "cloud based, modular, made for the purpose, mobile and internet ready, arrives with common interfaces to share transactions with other computer databases and applications, available 365x24, stores only the relevant information to provide the absolute information to the seekers. All applications such selected will meet "365x24 hours, stores only the relevant information provides the absolute information to the seekers. The efficient planning processes and procedures follow a strict logic, triggers recommendations, apply best practices of professional projections. Through digital certification, it linked to electronic transaction identification, records are visible to authorized organizations or officials. The information is transparent, reliable and traceable & reusable to the originating source for further analytics to improve productivity and efficiency".

With this approach SLPA will not need to customize and alter the design architecture of the new applications to interface to the currently used applications. This saves huge investment and time and prevents data mismatch, failure and downtime.

By negotiation SLPA is able to obtain the most favourable terms that will expedite the selection process and make the project to be based on a cost effective PPP with revenue generation ability. The software will arrive with interoperability and digital data interchange hence will be able to push information per the directives of SLPA. These applications arrive with many built in extra features, language translators, multiple calendars, email, ability to send out sms, digital image storing, and many other built in functions. It also will continue to be enhanced as the owner cum operator will want to keep port users attracted to the application and make them becomes adoptive. Eg. (Current web based banking applications and internet banking software). These will simultaneously lead to applications able to provide national information for local and international trade through user friendly GUIs.

Though these applications can be replicated, if any other Port in Sri Lanka wishes to use the select the same application, it should be treated independently and should be altered to meet the requirements of that port.

The immediate benefit will be observed by JCT users. They will use the designated application for the purpose that is available real time, with no human intervention. For a service provided of the Port of Colombo, the provided service will be captured, measured, outcome recorded, invoiced, payment received through the automated payment gateway. There will be less disputes, no personal favours, alteration of levies or rates, and unauthorized intervention that brings disrepute or losses to SLPA. Since the private terminals have already automated, the service level improvement will be in par. Where there are inter-terminal charges, SLPA fees to collect for Harbour Master Services etc, this change will help to standardize and commonly improve professional service standards.

Mandatory Electronic Data Interchange by IMO - FAL convention
SLPA should take the offer that is in the horizon. The IMO will be promoting EDI as a mandatory requirement under the "FAL convention" for vessels to produce and shared with the Port of Call. This will be a Data Push Activity for the Port to update the TOS and also share with the other partners (Customs, Agent, Line, Harbour Master, etc). This promotion increases the efficiency of shipping and regulatory measures for safety, security and environmental protection contributing to clean oceans by

elimination of unnecessary, disproportionate or obsolete administrative requirements. FAL 40 adopted new mandatory requirements on Electronic Data Interchange. According to the new standard, Public Authorities have to establish systems for the electronic exchange of information by 8 April 2019. A period of no less than 12 months for transition to the mandatory use of the systems shall be provided from the date of the introduction of such systems. A new Recommended Practice encourages the use of the "single window" concept, to enable all the information required by public authorities in connection with the arrival, stay and departure of ships, persons and cargo, to be submitted via a single portal without duplication.

Figure 12-7: IMO FAL Convention

To facilitate the clearance of an inspection period for ships in ports, the FAL Committee has taken joint initiative together with other IMO bodies for the 'online access to certificates and documents required to be carried on board ships'. According to this new decision, electronic certificates should be treated as equivalent to traditional paper certificates, forms and the many local variants of these 'standard' documents around the world, and replace practices leading to bureaucratic overload and adding to the challenges that a master finds when the ship calls at a port.

The result of a possible future platform is illustrated here below. Note that the Single window or port community systems has been created on the left next to a new warehouse system, an new TOS system and a Management information system.

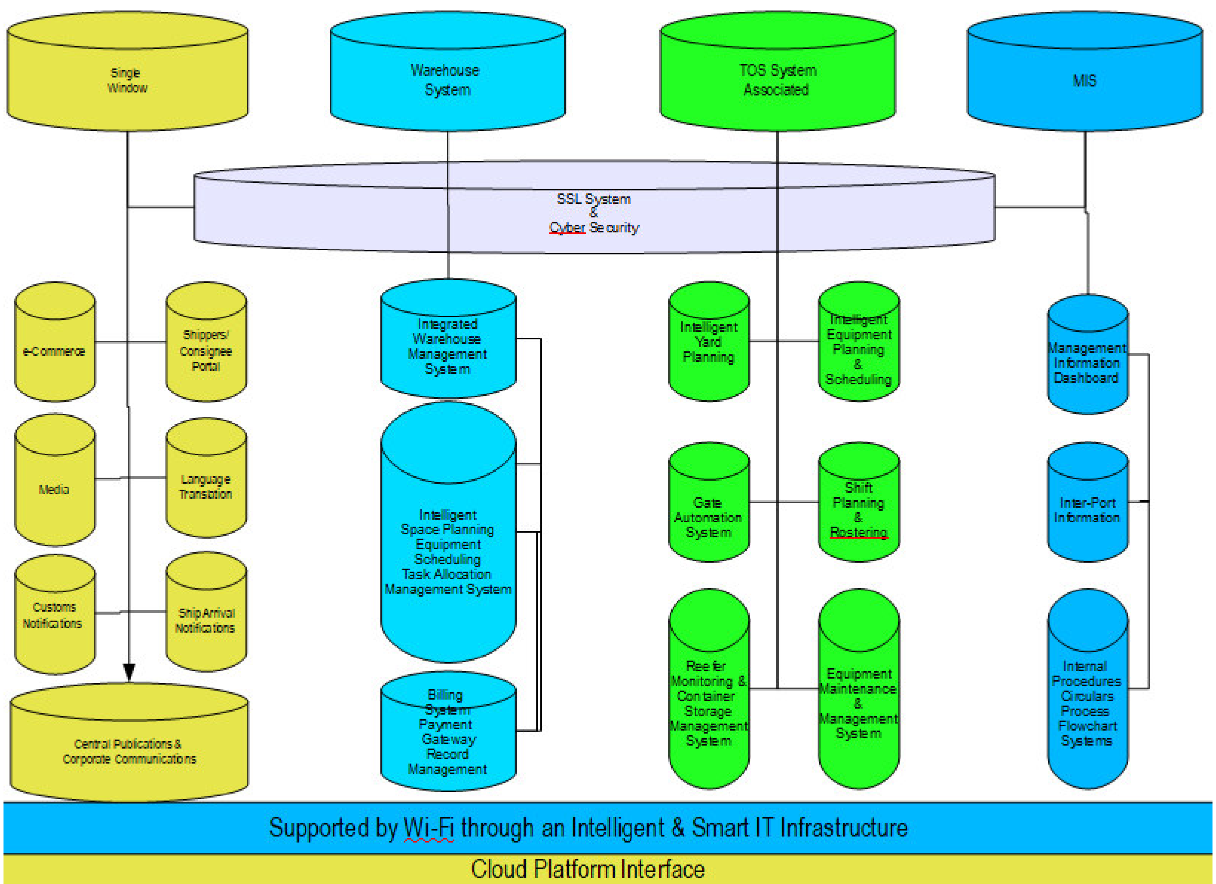
The systems are connected through web based cloud communication and has secured layers so that each data element has the right ownership whilst information can be shared and re-used by others.

It is recommended to introduce a proven technology regarding the single maritime window. In the section on port community systems references and samples are provided.

To implement the system the following steps are required:

1. Information flow from ship agents to Maritime Single Window
    a. Streamlining the FAL conventions and the ship documentations according to international formats
    b. Mapping the information flow between ship agent's and port authorities
    c. Mapping any relevant other data elements in accordance with national legislation and procedures applicable to port levels.
2. Mapping all relevant data elements in accordance to other organisations
3. Determine status changes and time in the chain and authority of the data elements to update data elements
4. Ensure all logic situations related to the status of container are covered
5. Prevent from Cyber security
6. Data exchange through EDI
7. Test runs with major clients
8. Revise according to test runs
9. Go-life and roll-out

Figure 12-8: Possible Future Platform



IT Recommendations

Following IT system introductions are recommended with reason and business benefit:

R41. **MIS – develop MIS information system linked to single window**

- Management Information Dashboard - With functions to drill down and compare projected vs actual. Provide warnings for action, emails and alerts for action, division specific for quick action.
- Inter Port Information - To provide statistics and utilization, demands, productivity and performances. Other technical and business information that needs only to be shared between terminals, will be resident here.
- Internal procedure manuals, circulars, process flow diagrams, handbooks, business information, notices boards are enabled.
- Rental & Lease Agreements
- Business Intelligence for management decision making

R42. **TOS – Upgrade Navis Sparcs to N4**

- Intelligent Yard, Equipment, Shifts Planning and Gate Automation
- Operation & Utilization - of the Quay, Yard, Equipment, Storage, Business Intelligence, his allows pre-planning of the yard, assigning of cranes, and other handling equipment, manpower planning for optimum throughput.
- For billing information to be generated without human interference, instead to run as a procedure, and process based.
- Reservation and Priority services

R43. **Warehouse Management System**

- Introduction of a fully automated warehouse system that will systematically receive the cargo, and store in the pre-defined space. Automatically calculate storage and demurrage charges, advise to shuffle cargo to optimize floor utilization. This system to automatically send out the cargo information to the single window system to advice consignee to follow instructions and to make arrangements, includes booking reservation to clear after the dues are paid to a bank.

R44. **Single Window – Including sub systems works to provide the essential information**. They can be gradually incorporated, and will be unrestricted for time of introduction and automation. The system and the demand will automatically drive the need. Always a proven system is recommended. Knowledgeable people have done this before.

- FAL convention – electronic data from ship to port
    - Mapping data elements with various organisations and institutions.

- Customs link with Portal
    - Customs procedures
    - Information required by the consignee to clear his cargo
    - Customs e-declaration
    - Customs e- payment
    - Customs clearance notifications

- Shippers & Consignees Portal
    - Organise export documentation
    - Organise import documentation

- Check status of the container
- Truck and cargo arrival notifications
- Vessel arrival/departure notifications
- Exchange notice of Readiness
- Container release notification

- e-Commerce - The list is unlimited and each subsystem can be selected from the master page. The business portal for all service providers and service seekers enabling a transparent fair playing ground customer service
  - Competitive and fair to all
  - Links approval granting organizations to speed up processes
  - National business Port information and data published for information sharing
  - Truck & Transport Services
  - CASA (Ceylon Association of Ships Agents)
  - Banks & Payment Gateways
  - Contract Labour
  - Private warehouses

- Media
  - Web Sites
  - Language Translation
  - Customs Notifications
  - Business Announcements
  - Financial Notifications
  - Contact page

- Central Publications & Corporate Communication
  - Port Legal Policies Procedures & Rules
  - Language Translator
  - Call Centre, Complaint Handling & Customer Services
  - Social Media & Library of References and Business Publications
  - Safety Rules, location maps & Calendar
  - Registration formats & online data input forms
  - Space Availability, public announcements, procurement & charts

Cost related recommendations

R45. **Shift Planning & Roster System** - it is manual, hence the costing and true picture for a vessel operation or any other operation cannot be traced in financial terms. Planning systems can be integrated with the TOS system.

R46. **Civil engineering and property management system**. This system is missing today. It would allow civil engineering to plan their maintenance and resources whilst, digitally keeping track of important drawings. Port development planning is an important element in the future of the port and process can be complex and time consuming. Hence such system would allow civil engineering to plan forward, understand the phase of a development project and the steps to be taken (procurement, tender, ESIA etc.). There are periodical and regular expenses that has to be monitored and not placed under a common expenditure heading. With manual or no computer system to trace, track and forecast this remains manually driven. This is linked to the Purchase Control System. However, there is no expenditure planning and projection system.

R47. **Accounting procedures**. **Lump Sum approval for divisions** and expenses under a heading is allocated instead of identified pre-planning and then charging to the respective cost heading. This would increase flexibility and accountability for the divisions. Management Expenses - Expenses recording of Management is not assigned or allocated to projects.

R48. **WIFI coverage and Fiber Optic backbone**. The hardware infrastructure in the port is poor including the fibre backbone which often is an issue during construction works. The WIFI coverage is poor at many sites within the port. (Port users like to obtain access as well)

R49. **Engineering and Technical workshop planning** and management system. The engineering and technical workshops have only manual systems for planning and administration. There is no business software in place to set tasks and to monitor progress.

R50. **Process flow & procedures manuals and audit system**. Generally speaking the port lacks a central point in which procedures are clearly addressed and explained by flow charts. This will help personnel to do their tasks (internal) and shall help port users (external) to understand the main Q&A for the port and will increase transparency.

R51. **CRM, Strategic marketing Modelling, Digital Document management system**. A customer relation management system is lacking at SLPA. This would enhance the marketing function of the port. Strategic marketing modelling would ensure that strategic clients are highlighted to support strategic decision making.

R52. Digital document system with **e-signatures and authorisation**. In order to become paperless a digital document system should be implemented supported by e-signatures and authorisations. This system would ensure that managers can approve the documents digitally and can authorize according to their responsibilities.

R53. Port security through **digital birds-eye view system**. Also drones can be used by authorized institutes and should be legally prohibited for non-authorised institutions and privates.

12.5 Port Authority & Port community systems

IT and digitalisation is a major topic in modern port authorities. Internet, cloud application, mobile phones and Wi-Fi networks have changed the way systems work and interact with each other.

For the port Authority, the digitalisation of the information flow is crucial to create a modern Port Authority. Paperless working should be the future and many ports around the world have been able to introduce paperless handling through automation of the document flow. Several port users and entities are crucial is this process such as the Port Authority, Customs, Terminal operators and consignees.

The following elements are described in this section:

- The port community system
- VTMS
- Berth planning
- Classification and ship type database
- Gate automation, Truck passes and traffic flow control

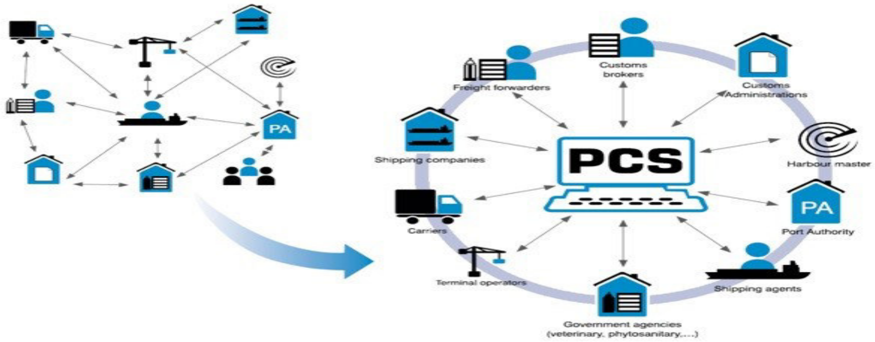
12.5.1 Port Community Systems

Across the world, the implementation of port community systems (PCS), either in individual ports or as national systems is widespread. A Port Community System is an electronic platform that connects the multiple systems operated by various organisations that operate in a seaport or inland port community. It is shared in the sense that it is set up, organised and used by firms in the same sector – in this case, a port community.

A PCS offers for the electronic exchange of information amongst all port and logistics sectors and is recognized as the most advanced method for the exchange of information within a single or national port community infrastructure. A PCS has the ability to serve as a National Single Window or to integrate into a National Single Window. A PCS is therefore pivotal in the Single Window concept and will reduce duplication of data input through efficient electronic exchange of information. Moreover it will cut communications and paper administration as information is enter once and re-used in multiple formats for users in the logistic chain.

The diagram on the left hand side shows the high level of communication and information exchange. The right hand picture shows the Port Community system where information is securely stored and shared between respective port stakeholders.

Figure 12-9: Schematic Overview PCS



In Singapore, South Korea and most of the European ports in which a PCS has been implemented, the port authorities in those ports played a key role in the creation and setting-up of the PCS or single window. The PCS in Rotterdam, Amsterdam, Antwerp, Barcelona, Hamburg, Le Havre and various other ports have been set up through involvement of the port authority.

Innovation drives automation and digitalisation

Today automation has come to a new era of development with the introduction of SMART applications mobile apps and the use of GPS data (the so-called "smart port" concept). The latter can bring advantages through for example:

- Tracking and tracing;
- Truck routing and avoidance of congestion;
- Truck on-demand (reduce waiting times at gate);

Information technologies also drive the modern information flows. Therefore, Port Authorities focus on digital information platforms such as port community systems to inform the port users.

Four main systems are mainly implemented by port authorities:

- Port community systems;
- Paperless custom;
- Digital bill of ladings (not only in container shipping but also in bulk shipping); and,
- Digital orders in the transport chain (container release orders, pick up orders etc.).

It should be noted that automation reduces unskilled labour employment, resulting in higher skilled labour requirements. This development changes the common labour setting in ports from low skilled to high skilled labour.

There is cultural resistance to change hence from an authoritative practice to system and procedure driven introduction takes time. For the Port Community System and related automation to reach the expected superior standards, there are requirements such as legal compliances, investment, approvals, customization and acceptances by parties involved. Introduction, implementation, alter course to provide an efficient process flow, investment on hardware, skill based training. These will therefore require, announcements and conferences to educate all stake holders.

A replacement of existing systems, methodology, computer hardware, operating systems, databases is therefore minimised if the missing but critical software is selected and introduced with a road-map.

Therefore, a gradual but a prioritized project has to be constructed with clear objectives and milestones and determined investment. This will let selectors to use Data on a platform free environment, Computer resident or Cloud Based, Mobile Technology supported, Push and Pull features for fast decision making. Information sharing, supervised payment gateways and meet legislations, please the regulators and supervisory bodies to receive alerts are a number of procedures that need to be changed in order to provide an excellent port community base solution.

A Port Community System has the advantage of linking other ancillary services using the benefits of "5G Wi-Fi connections set to be three times faster than 4G, starting with 450Mbps in single-stream, 900 Mbps (dual- stream) and 1.3G bps (three-stream). This huge growth in IoT and smart devices, 5G's speed and capacity will enable an even more rapid arrival of this connected future."

With the introduction of a Port Community System, parallel functions linking through automation to an electronic platform is achieved that connects the multiple systems operated by a variety of organisations that make up a seaport and extend to other business and national organizations engaged with national economic drive.
Port Community Systems can play a major role as Countries move towards the Single Window environment; adoption of new regulation and make valuable contribution to the harmonisation and coordination of reporting formalities, processes and procedures. Countries such as the Netherlands and Spain started their PCSs in the 1990s.

A Port Community Systems offers a standardised communication platform in order to improve the systems in terms of punctuality, reliability or costs and, on the other hand, the need to increase competitive position among ports. It lets good collaboration with the key authorities, as well as with stakeholders, potential customers and local trade associations. Users to the Port Community System will be trained through workshops with the end users allowing a fresh group of academics in modern logistics in supply chain.

Since the Port Community System (PCS) is ideally placed to form the foundation or backbone of the Single Window vision the number of ports connected to a PCS can integrate functions of Port of Colombo and extend to all national ports of Sri Lanka. Through this neutral and open electronic platform enabling intelligent and secure exchange of information between public and private stakeholders it lets improve the competitive position of the sea ports' communities leading to optimising, manages and automates port and logistics processes through a single submission of data and connecting transport and logistics chains.

Direct influence and immediate benefits of having a Port Community System

- Easy, fast and efficient EDI information exchange, re-use and centralisation, available 24/7/365
- Customs has "service level agreements" with PCS users to manage the electronic exchange of information between different parties on their behalf.
- The Single Window allows parties involved in trade and transport to lodge standardised information and documents tightly integrated with reduction of paperwork by electronic handling of all information relating to exports, imports, transhipment, consolidations, hazardous cargo and maritime statistics reporting and declarations.
- Status information maritime and other statistics, control, tracking and tracing through the whole logistics chain
- Transparency of Port procedures and processes and practices.
- Support the ambitions to meet global carbon reduction requirements.

The functionality of a PCS is aimed at eliminating unnecessary paperwork which can clog up cargo handling. Using electronic data exchange, the PCS is an effective real-time information system; fast, focused, flexible and multifaceted, it aims to improve efficiency at all stages of the process of manifesting, through vessel discharge and loading, Customs clearance, port health formalities and delivery in and out of the terminal. As well as the above, the PCS offers improved security, cost reduction and potentially more competitiveness for each user.

A Port Community System links the different actors of the logistic community and acts as a Risk Management platform for regulatory bodies like the Customs and the Ports Authority. It is an Inter-Organisation Information System, namely a Business-to-Government one that sits in between the key players of the Logistics Supply Chain to enforce the World Customs Organisation SAFE Framework around the world. The success of a Port Community System depends on factors ranging from its acquisition to the complete satisfaction of the different Stakeholders that form the Logistics Supply Chain. The success of such a system plays a fundamental role in positioning as a competitive regional trade hub in the region and providing at the same time, considerable benefits to the local business processes and the local logistics conglomerate.

The demands expressed can be facilitated with the use of advance information technology based programmes and equipment. Where it is possible, cloud based shared services and resources need to be considered. Proven products with the least modifications must be considered and where the manual practices were directly automated needs to be revisited and deeply analysed. With the findings introduction of simplified upgrades implementable at the shortest time can be considered. Where it allows, duplication work practices must be stopped. Drive for excellence and quality ISO and IMO objectives must be declared as goals and linked to the performance measuring matrix.

Reliance on handwritten notes, VHF messages, Voice Calls need to be regulated through data mapping and clearly entered to applications that are easy to use. Extra attention on mobile technology based apps will serve the customers in the foreseeable future.

Table 12-5: Proven Port Community Systems

Product Name	Origin	Modules	Remarks web site
PCS	Singapore	Multiple	https://www.portnet.com/WWWPublic/products.html
PORTBASE	Netherlands	Multiple	https://www.portbase.com/en/
Uni-Pass	South Korea	Multiple	https://www.customs.go.kr
Global Institute of Logistics	U S A	Multiple	www.globeinst.org
Actual I T	Slovenia	Multiple	http://www.actual.si/?main=2
Indra	Madrid, Spain	Multiple	http://www.indracompany.com/en

Two examples will be mentioned here:
Please also note that the single window is also addressed in the chapter on Customs. There the South Korean example on their single window "UNI-Pass" is discussed.

Example: Singapore Port Community System

A PSA flagship IT solution – PORTNET PCS is the world's first nationwide business to business (B2B) port community solution and a winning entry in the National Infocomm Awards (2006). It has provided the logistics industry with a single sign-on network portal. Through it, PSA has connected shipping lines, hauliers, freight forwarders and government agencies, helping them to manage information better and synchronise their complex operational processes. From managing complex transhipment processes of shipping lines (EZShip), supporting slot exchanges among alliance partners (ALLIES™), enabling companies to monitor performance and make critical business decisions (TRAVIS™), integrating port documentations seamlessly with the haulage processes and workflow (Haulier Community System™) to providing a documentation portal between shipping lines and shippers (CargoD2D™), PCS simplifies and synchronises millions of processes for customers moving their cargo through Singapore. Over 10,000 integrated users rely on the system's unparalleled capability to provide real-time, detailed information on all port, shipping, and logistics processes crucial to their businesses. PCS processes more than 220 million transactions a year. It save about S$ 1 billion (USD 667 million) annually for the trading community … together with Singapore Telecoms, Port of Singapore Authority, and Civil Aviation Authority of Singapore … shipping agents, and air cargo agents), financial institutions (eg, banks), and port and airport.

The efficiency of the Port is enhanced by IT and operational systems, and by the infrastructure Singapore provides in general. While one could develop parts of this system easily, it is their combination that makes it difficult for another Port to compete …

PORT OF SINGAPORE AUTHORITY's more complex plans can also be handled, by automating the communication between the port users and PSA as well as among port users themselves, PSA further extended the usefulness of PCS to the maritime community by linking it to various users and authorities.

The PCS supports features such as:

- Flow-Through gate
- CITOS (ship and yard planning)

Flow-Through Gate

The Flow-Through Gate, introduced in 1997, is a fully automated system that identifies container trucks and gives drivers instructions within 25 seconds. It handles an average traffic flow of 700 trucks per peak hour, and 9,000 trucks per day.

After a manifest is submitted through PCS, the fully automated and paperless process at the gate clears trucks entering the port within 25 seconds, with the following steps:

- The truck arrives at the in-gate. The driver taps his PSA pass on the Self Service Terminal (SST) and verifies his identity through a fingerprint biometric reader or keys in his Personal Identification Number (PIN).
- The truck is weighed at the weighbridge.
- The gate picks up the truck's identity from the In-vehicle Unit (IU) at the dashboard.
- The gate's Container Number Recognition System (CNRS) captures the container number via Closed-Circuit Television (CCTV) cameras.
- The system checks the driver's identity, truck's identity, weight and the container number against the manifest and clears the truck for entry.
- The system sends a message to the driver's mobile phone or Mobile Data Terminal (MDT) on the exact position in the yard where the container will be stacked.

CITOS

Few examples of how CITOS directs port operations:

- Berthing System
- Ship Planning System
- Yard Planning System
- Resource Allocation System
- Flow-through gate
- Reefer monitoring

On a typical day, 60 vessels of different sizes call at the port. Although a high number of them arrive out of schedule, berth planning system allows most of them to be berthed on arrival. Planning begins 72 hours before the ship arrives, when the shipping line applies for a berth and sends ship stowage and connection instructions to PSA Singapore through PCS. Once berthed, the quay cranes unload boxes destined for other ports and load boxes brought in by other vessels. The prime movers are tracked individually via the Global Positioning System (GPS) and distributed dynamically among the vessels. The prime mover moves off to a container holding area in the yard. There, the yard cranes lift containers from prime movers and stack them in the yard. The sequence is reversed for delivery out of the yard to a connecting vessel. Containers are not stacked in a random manner. When the information is keyed into the system through PCS, CITOS automatically generates ship stowage plans and yard layout plans based on factors, such as:

- Ship stability (for stowage planning)
- Weight
- Destination
- Size
- Special requirements (e.g. reefers, dangerous goods, out-of-gauge cargo, tight connections)

This allows PSA Singapore to:

- Maximise land use and optimise container retrieval
- Track the location of each container
- Maximise resource productivity by planning ahead

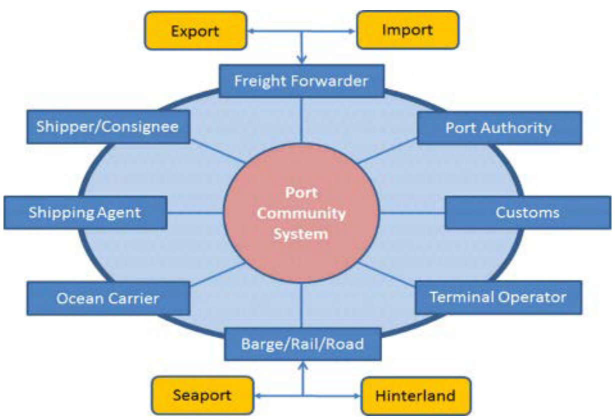
Example: Rotterdam Port Community System

Through the Rotterdam Port Community System, Portbase offers over 40 different services to approximately 3,200 customers in all sectors in the logistics chain. The system is the digital connection to all smart Dutch ports, has a national coverage and is available for all port sectors: containers, general cargo, dry bulk and liquid bulk. Everyone in the logistics chain can exchange information through PCS easily and efficiently.

Previously, companies had to organize matters such as pre-reporting a vessel, the status of a shipment, export documentation, loading/unloading papers or communication separately and by e-mail, fax or telephone. Thanks to the Port Community System, those days are over. Everything is now merged into a single system. This results in increased efficiency, lower planning costs, better and transparent planning, faster handling and fewer errors.

The services within the Port Community System focus on all port sectors: containers, break bulk, dry bulk and liquid bulk. All the links in the logistics chain can easily and efficiently exchange information through these services. The Port Community System offers each of these target groups its own package of tailor-made services. Through a service selector you can easily find the service you want.

Figure 12-10: Actors PCS



Source: Port of Rotterdam

The port base systems organize for example the flow of information to allow containers to swiftly move between terminals and modes of transport.

On Maasvlakte 2 for example, there are two new container terminals RWG and APM Terminals MVII and they request carriers, forwarders and shippers to electronically notify all relevant container information in advance. Portbase is the portal for this. The submission of all necessary information in advance applies equally to import and export cargo, as to trucks, trains and inland barges. Through correct pre-notification, the delivery and/or collection of containers becomes easier than ever. Every terminal visit by proceeds efficiently. Neither RWG nor APM Terminals MVII has a reception building or pneumatic dispatch; neither is set up to solve administrative issues or Customs matters at the gate.

The main features of Portbase in this case are:

- Organise export documentation
- Organise import documentation
- Truck and cargo arrival notifications
- Organize arrival and cargo to be delivered / collected by truck
- Organize arrival and cargo to be delivered / collected by train
- Organize arrival and cargo to be delivered / collected by barge

Other functions of Portbase are sharing information and send notifications between systems and between persons such as:

- Ship arrival/departure
- Barge arrival/departure
- Exchange notice of readiness
- Customs procedures
- Container Freight station notifications
- Container depots notifications
- Container and tank cleaning notifications
- Container arrival/departure notification
- Equipment interchange messages
- Container released for pick-up
- Finding information on auxiliary services such as agents and ship agents, bunkering, water supply, power supply, ship maintenance and repair, ship waste, supply industries, chandlery (spare part, provisions, nautical equipment, cleaning products etc.

How Portbase Works

Each service includes multiple service processes. These processes describe the required message exchange and interaction between the parties. This involves messages between systems (system messages) and messages between people (notifications). The platform ensures that the processes are in accordance with the established rules. Thanks to the central database is optimal reuse of data. Companies need to provide data, but only once.

Benefits

The Port Community System centralizes all information and the days in which companies had to develop and maintain a whole range of bilateral connections by telephone, fax and paper are over. All the information exchange in the ports now runs efficiently through a single hub. The services available in the Port Community System provide concrete savings in time and money from day one. The benefits:

- Greater efficiency;
- Lower costs;
- Better service provision;
- Better, more transparent planning;
- More rapid throughput times;
- Fewer mistakes;
- Optimal re-use of information;
- Available 24/7.

Security

Security is at very high standards with features such as: Information security manager, security audits, and the system is ISO-27000 (datacentre security) certified and the system has dual redundancy, so if one physical system fails the other takes over in real time.

Costs

Portbase is a non-profit organization. Companies only pay a fee for the use of services with demonstrable added value. These costs are minor compared to the advantages offered by the services. Financial support for services of strategic importance to the port is obtained from the general revenues of Port of Rotterdam and Port of Amsterdam shareholders. The service pages of this website in the services or a personal contribution.

Invoicing

Billing is monthly. Portbase makes prepay customer a realistic estimate of the number of anticipated transactions. Once a year off place (similar to the billing method of energy companies).

Recommendations for the Port of Colombo

A port community system is lacking although some terminals do have automatic data interchange with shipping lines.

The information across the maritime community would create a much smoother and more efficient cargo handling. Terminal operators can work more efficiently when berth planning is known in advance and no major changes are made at the last minute.

Shippers and consignees know exactly whether their goods have arrived and what the status is of customs clearance.

To introduce a port Community system in Port of Colombo it is recommended:

R54. **To set-up an port community wide task-force** with transport representatives and IT knowledge.
R55. **Representatives of the terminals should liaise with the taskforce of port community.**
R56. **To investigate which first steps to take to introduce such system in port of Colombo.**

The task-force should be headed by SLPA representatives knowing the various demands within the transport chain and the systems capabilities.

The aim of the task force will be to create:

- As first step: draft design to create a port community system/ single maritime window which is able to receive the FAL convention information electronically.
- As second step: design the data mapping which is required to share this information with main stakeholders like terminal operators, harbour master and port authority.

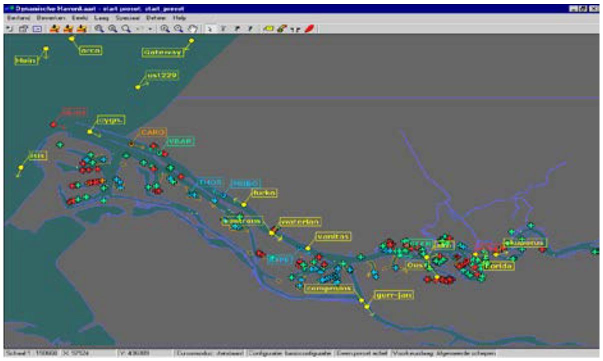
12.5.2 VTMS & berth planning

Port have often their own VTMS (vessel tracking management system). Today these systems are interconnected with the AIS vessel positioning which is mandatory at sea and coastal waters under the international SOLAS agreements. Professional applications from third parties are available which create an integrated image from both radar and AIS signals. In the example below the dynamic vessel movement port map of Port of Rotterdam is presented.

Examples Port of Rotterdam and Amsterdam

The ports of Rotterdam and Amsterdam have introduced a common system for the guidance of maritime traffic. The HaMis (Harbour Management information system) combines the AIS information with specific data on the vessel related to the port call. In this way, the vessel characteristics, location, destination in the port and information on dangerous cargoes is in a click available to the harbour master personnel.

Figure 12-11: HAMIS Interface Example



Source: Port of Rotterdam, Radar control post along the shoreline.

Next to this, the VHF is still dominantly used to communicate with the vessels. To have reliable and sound communications the waterways are divided into sectors and each sector has a VHF reporting channel. For each of the water section it is stipulated whether the vessel only needs to listing on the channel or that they have to report while entering and leaving the section.

Figure 12-12: Radar control post along the shoreline.

Source: Port of Rotterdam

Introduction of remote monitoring of the maritime signal system

Also, CCTV is used for vessel traffic monitoring. The CCTV control are installed at road and near waterways.

Source: Port of Amsterdam

Berth planning

The VTMS systems in Rotterdam are integrated with berth planning. For each vessel, it is known in advance to which berth it needs to go and whether the berth is available or not at arrival of the vessel. Due to the long distance between vessel arrival at pilot station and the berth in the port the VTMS supports harbour masters planning in the estimated time to reach the berth. In this way, the vessel can advance anticipating the availability of berths. Even so the tug planning and mooring lines personnel can be coordinated through this system.

Recommendations for the Port of Colombo

The harbour master at Colombo performs a crucial role in the safe manoeuvring of vessels and berth allocation.

However, the harbour master lacks systems to coordinate efficiently the nautical movements through the port. Especially as requirements of private terminal are changing the demand for berth allocations more and more.

R57. **The harbour master office should introduce VTMS and berth planning tool**

R58. **Harbour Masters services management system** - All handwritten paper based and sent to Finance Department to raise the sales invoice to the respective party. The harbour master services should be supported by a system in which berthing planning, pilot and tug times can be processed for billing. The system should be integrated with a vessel classification system.

12.5.3 Classification and ship type database

The VTMS system is using a global database of vessels with vessel particulars provided by international recognised sources such as IHS (Lloyds register/Fairplay) or Clarksons. These databases ensure that vessel profiles including classifications are available and that a vessel port call history is created as per unique IMO number identification.

Recommendation for the Port of Colombo

R59. **The harbour master office should introduce ship classification** database and link this to the VTMS & berthing system

12.5.4 Truck passes and traffic flow control

Port passes and Truck passes are provided by the Port Authority. Today trucks can obtain their passes at the gates and or through ship/cargo agents with application forms.

Traffic flow management

Today the port of Colombo has no traffic flow guidance systems. The gates face congestion due to various administrative procedures if the truck driver is not able to show correct documentation. However, the queuing is often done in one lane and the gates do not switch according the main traffic flow.

The future port will have two main gates, the equivalent to the current gate and the gates near Fort to/from the PAEH.

It shall be important to be able the guide trucks which gates are available for them. This can be done through lane indicators and notice signs. The truck should have disciplines to stay in-line and to take the right queues. Inter terminal traffic is as much as possible separated from the main flow and should be indicated as well.

Recommendations for the Port of Colombo

R60. **Introduce traffic flow management program** this would encompass truck plate recognition; electronic trucker pass; container number scanning; traffic flow signals and lane directions.

R61. In the future online port passes should be made available. Discounts could be provided to large port users applying for large quantities/frequent users. **Port passes should be made available** with discounts to agents applying for large quantities.

12.6 Terminals & IT

12.6.1 Terminal operating software (TOS)

CICT is the only terminal in the port of Colombo that can handle the 18,000 TEU plus vessels. CICT processes are steered by the corporate standard terminal system CTOS. It is a Chinese system. CICT is working continuously on improving its service levels. The next step is automating the truck gates by applying OCR technology.

The SAGT operations is driven by the NAVIS N4 Terminal Operating System which is the 'De facto' world standard. (60% of the container terminals world-wide are using this system). The N4 version is one of the latest versions and allows to create electronic data exchanges of various elements. SAGT is introducing "Expert Decking" a software module for optimising the yard planning and is improving the gates automation.

JCT is operated by SLPA and operates through Navis Sparcs software. Navis is a recognised terminal software program is used by leading terminal operators in the world. However, this version of the Navis TOS system is outdated and lacks certain features to enable electronic transfer.

Recommendations for JCT

R62. **JCT needs to upgrade its systems** to stay efficient and be able to introduce more electronic data exchanges.

- Upgrade TOS to Navis N4 (this is a large investment)
- Thereafter start with yard module "Expert decking" to optimise the yard
- Start to use electronic data exchange with large clients and prepare for port community systems

12.6.2 Terminals and port community system

For the container terminals, a high level of automation is already available, both CICT and SAGT have TOS systems which provide the ability to share information electronically. JCT is hindered by an older version of the TOS system to do similar steps.

In the section on port community further explanation is provided.

12.6.3 Key Performance Indicators and dashboards

Key performance indicators are required to measure the performances of individual port operators and port users. The Port Authority should be able to collect information from the port users in a digital fashion which is both reliable and fast. The port community system can be used in order to collect in an on-line fashion the real-time information from port users. A sub selection should be made available for port users.

Key performance indicators should be defined and collected and mandatorily agreed with terminal operators through their concession contracts. Through online data it become possible to have online dashboards to show the key performance indicators for the most important port terminals.

Examples of terminals KPI's are:

- Throughput figures per month
- Average gross crane moves per hour for past month
- Berth occupancy

- Vessel turn-around time
- Moves per berth/hour

Recommendation for SLPA

Through the port community system, the Port Authority is also able to update the information on the port to the general public.

R63. Amend where needed the concession contracts with terminal operators with a **clause on providing key performance indicators.**

Recommendations for terminals

R64. **The online data exchange to a port community system shall enact a performance measurement tool for the Port Authority (and for port users on common data elements).**

Short Term Priority Projects

SP18. **Port Community System –** Port Community System to help data exchange and paperless environment in the port.

13 Customs and Navy in the Port

13.1 Introduction

This chapter deals with the Customs activities and related trade facilitation in the port. Furthermore the chapter describes the role of the Navy in the port and their plans.

The following approach has been used for this chapter:

- Paragraph 16.2 discusses in Customs and trade facilitation as international best practice: The example of South Korean customs is to highlight efficient systems and European system offer a high level of complexity due to multi-country synergies necessary.
- Paragraph 16.3 describes the current situation including the key observations: Sri Lankan customs still acts to independently of port operations. Often gains can be made in secure customs procedures without hampering port operations and trade.
- Paragraph 16.4 describes the main recommendations on Customs: The recommendations range from procedural recommendations to recommendations on detained goods. Requests by customs regarding the port are considered and attended to.
- Paragraph 16.5 describes the Navy and the role of the navy including their plans: The Navy should have presence in all major ports necessary because of national safety and security and coast guard function.

13.2 Customs and Trade Facilitation

13.2.1 International best practice

The UNCTAD have adopted several guidelines to improve the effectiveness of Customs. The importance is to move towards digitalisation through E-Declaration and E-Clearance by use of the Single Administrative Document and supported by a Single (Customs) Window.

The international best practises are found in countries like South Korea, Singapore and in Europe. These countries have adopted systems which, generally speaking, strive for the same objective namely; *disconnecting the administrative flow for customs duties from the physical flow. At the same time the level of risks is to be determined, monitored and controlled by customs.*

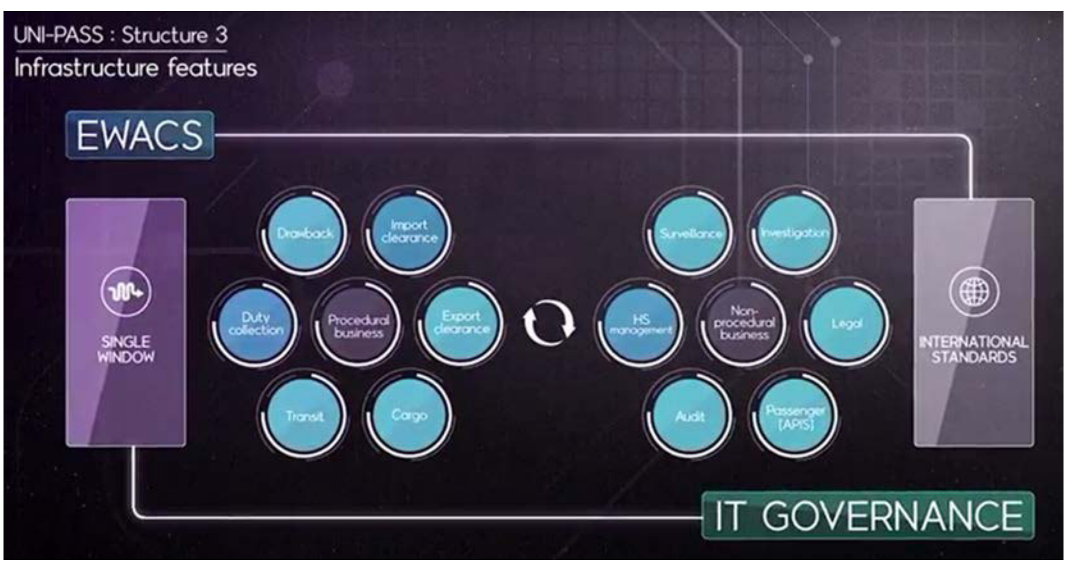
Sample of South Korea

South Korea is using and own developed single window system called **UNI-PASS**. This is an all-in real-time trade facilitation system including the customs and nation security information system. It started with a large one-stop system in the 1980s emerged with EDI applications in the late 1990s. In 2005 the Uni-pass system was incorporated as a web-based clearing system and today it has been further developed as a “smart system” with mobile, RFIDs and cloud solutions. This means that the application can be opened at any PC, Smartphone or laptop device and is open each customer 24/7.

Uni-Pass system facilitates a one trillion USD of trade. About 180 million E-documents are processed real-time each year, serving 50 million passengers. The fully paperless and single window system saved an estimated value of USD 3.8 billion on logistic administration each year. Moreover, it reduced declaration and clearance time of goods from 48 hours in the past to only 1.5 hours. The export documentation time was reduced from 24 hours to only 1.5 minute.

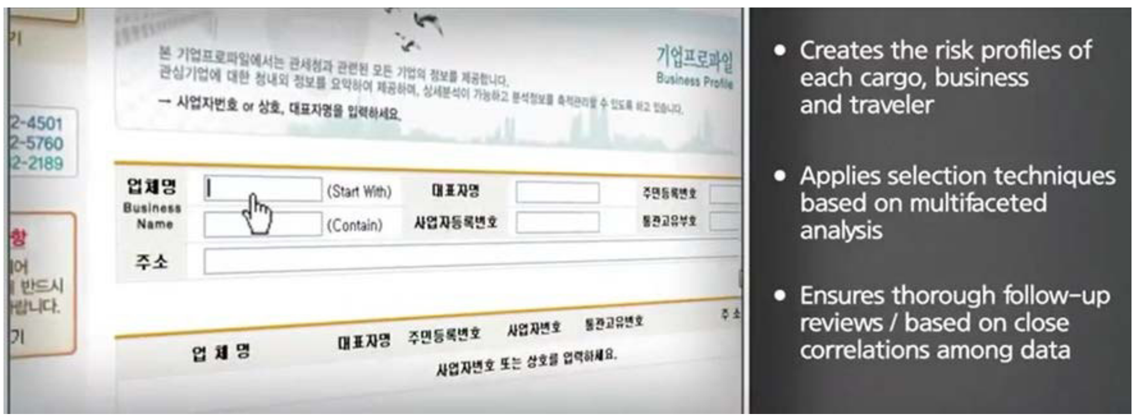
The system is organised with separate subsystems which interface with one Single Window and is compliance with international standards. The Uni-pass as single window has following supporting systems behind it:

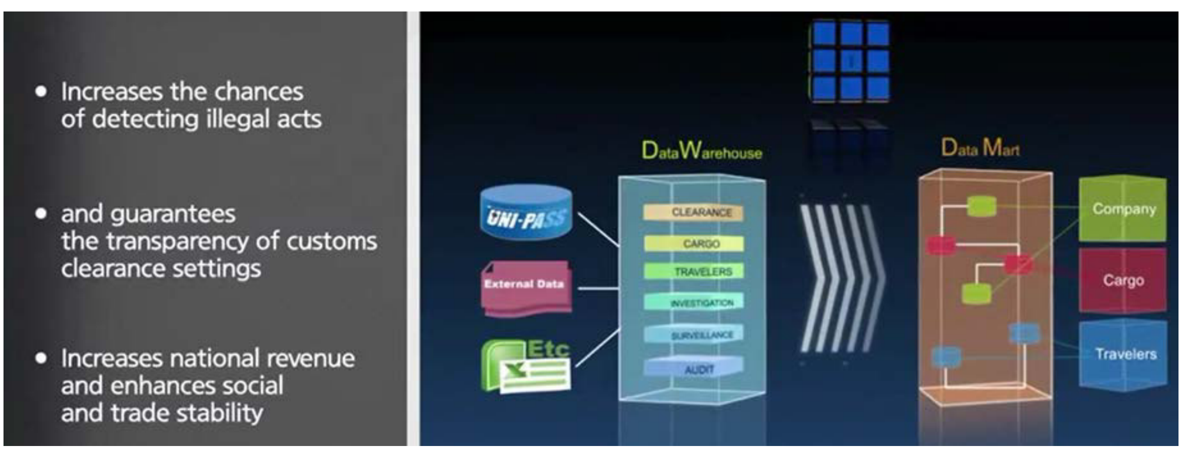
Uni Pass – Korea Single window support systems	
EWACS (Early warning and control system)	A system for early warning and control of goods and passengers. The system warns possible threats whilst goods/persons are still to arrive at the border.
IRM (Integrated Risk Management)	The risk system is based on a two-track system (safe and non-safe). It is an intelligent system which applies different risk management levels and is sorting businesses to their compliance levels. The non -safe category is monitored and/or physically examined.
CDW (Customs Data Warehouse)	The data warehouse system collects all information on clearance of cargo, passenger investigations, surveillance and audits. The system also collects external information on companies audits and prepares national statistical information.
Data Mart (Data Intelligence Integration)	The data Mart system analyses all intelligent information by linkages of Company, Cargo and Traveller information and provides intelligence support to find and trace illegal actions.
KMS (Knowledge Management System)	The knowledge management system provides intelligent information from external sources linked with investigation.
PMS (Performance Management System)	The performance system shows real-time performances of the customs and national security divisions for managers.
APIS (Passenger Information System)	The Passenger information system is an integrated personal data intelligence tool.



The system has the following main features:

- One-stop customs clearance at 24/7 along the distribution chain
- Paperless
- Single window for large and small companies
- E-Declaration
- E-Clearance
- E-Payments from banks and via internet
- No examination at the border unless regarded as “non-safe” and container are scanned
- Open to customers all-time 24/7
- Fast, reliable, trade facilitation
- Real-time integrated risk management control system
- Intelligent real time tracking systems
- Risk factors are analysed through risk profiles which threaten public safety and trade stability (tax evasion, illegal foreign-currency transactions, smuggling of hazardous items, weapons and origin laundry.





Sample of the EU:

The EU is characterized by many independent countries. They all work with a Single Administrative Document for declaration of goods based on the HS classification codes. Goods can be transported in bond and duties and VAT only needs to be paid in the country of destination. *Customs clearance takes place independently from the physical activities* by the ports or logistics service providers at warehouses. Often the logistics service provider is not required to obtain permission from customs to redistribute goods which makes it possible to operate the European Distribution Centre 24 hours a day, 7 days a week and 365 days a year. The goods can be declared independently from any delivery service.

This flexibility to warehouses is permitted by customs under strict requirements and depends on the type of license (in The Netherlands for example C-Custom-Warehouse or E-Custom-Warehouse). Consignees and shippers and logistic service providers are obtaining licenses for the digital handing of documents and payments. Full details need to be registered such as: value, tariff code, weight and origin. The customs clearance can be carried out via Electronic Data Interchange (EDI). Supplying customs with information this way allows customs to do more detailed checks on the clearances as well as the mutations of the warehouse inventory.

Clearance is done electronically and examinations are limited based on risk management.

In the port of Rotterdam a few customs inspection areas have been created. The number of containers which are physically inspected is relatively low. This because the customs provides electronically clearance for the majority of containers and directs only high risk containers to the inspection yard based on risk management.
International Organisations encourage and support the adoption of modern Customs control techniques, using Risk Management principles. For example; WTO/Kyoto Convention and APEC Sub-Committee on Customs Procedures.

Controlling risks
Risk Management is the name given to a logical and systematic method of identifying, analysing, treating and monitoring the risks involved in any activity or process.

1. Establish the risks
2. Identify the risk
3. Analyse the risk
4. Evaluate the risks
5. Treat the risks

It is a dynamic process in which monitoring and review and communication and consultation goes hand in hand.
Customs should improve the risk management system with the focus on priorities and in decisions on deploying limited resources to deal with the highest risks. It not a matter to control all, it is a matter of identifying and controlling the high risk (risk/reward).

Monitoring and learning defines the goods into new classifications over time, resulting into less likely sectors with lower risks.

Risks Classification / Occurrence	Extreme	Very high	Moderate	Low	Negligible
Almost certain	Severe	Severe	High	Major	Moderate
Likely	Severe	High	Major	Significant	Moderate
Moderate	High	Major	Significant	Moderate	Low
Unlikely	Major	Significant	Moderate	Low	Very low
Rare	Significa nt	Moderate	Low	Very low	Very Low

Treating the risks is for port activities a very important element. High levels of physical examinations in the port leads congestion and space constraints. Through increasing the development of risk profiles and industry audits the random examinations will increase and the physical examinations can be reduced.

Risk Profiles are developed as a means of putting risk management into practice at the Operational level. A risk profile is normally specific to a customs office. It describes:

1. The risk areas
2. Assessment of the level of risk
3. The countermeasures adopted
4. Activation date and review dates
5. Means of measuring effectiveness.

The profile information is used as the basis for the selection criteria. Documents received and processed by Customs, i.e., cargo and passenger manifests, goods declarations, are compared against the selection criteria through the use of automated systems. The action plan for physical examinations or random examinations is thereafter determined. In all the objective should be to increase the compliance and the control the level of risk.

13.3 Current situation on Customs

"Customs are present in all major ports in Sri Lanka. Their function is key as the custom regulations and procedures to import and export commodities may hamper the physical flow of goods when not efficiently organised."

The legal obligation is to declare all goods (imported and exported) correctly and pay the correct amount of duty before the goods are cleared and free circulations/ export is allowed. On goods, import and or export duties and VAT are to be paid.

Customs is organizing 53% of the Government Tax revenue budget which mainly consists of:

- Import duty
- Customs duty
- VAT
- Excise duty
- CIS charge
- Ports & airport levy.
- Nation building tax.

The securing of revenues is therefore an essential part of the nation's financial stability. Moreover, the control over irregularities, smuggling and preventing drugs imports are a national concern.

Customs perform the following activities:

- Collecting taxes and dues
- Clearance of cargo
- Sealing containers
- Scanning and inspection of cargo
- Creating release notes (for refunds/rebates)
- Anti-smuggling patrols (future)

Customs in Sri Lanka have implemented Asycuda (promoted by UNCTAD) in the period between 1992 and 1994. ASYCUDA has been live in Sri Lanka since January 1994. Today, the version "Asycuda World" is implemented and this is the latest version for customs applications worldwide and has the ability to connect through Electronic Data Interchange (EDI).

Several issues had to be solved during the process such as Implementation of the Manifest, Import/Export Cargo Examination, Border passing note and Import/Export CusDec submission and limiting input errors. For E- payments (online payments) two banks were connected, the Peoples Bank and the Bank of Ceylon. People's Bank branches also facilitate to connect Sri Lanka Customs through Peoples Bank's payment platform. Meanwhile Customs is working on several projects to support further use of electronic declaration and enhance the services such as on statistics portal and HS code finder. Despite this, Customs todays faces still many manual requests for customs clearance. Another issue is that many payments are still done through cash payments such as at the Customs Headquarters Banks by Bank Drafts. In the warehousing sector, cash payments are still the most dominant method. Finally, the road congestion towards the inspection areas is a major issue today. Due to various reasons (gate procedures, port access road congestion, and public road congestion the queue before the main gate is often more than 5 km!

Clearance of containers

Shipping agents send their E-declaration to customs in advance of the goods arriving in the ports of Sri Lanka. About 90-95% of all containers is declared through this principle. The clearance of container is done by customs after payment of duties. The payment is either done through E-payment and or manually at the customs counter desk.

Inspection & examination

Today, the majority of containers needs to be inspected and containers are send to designated inspection areas. This procedure is rather old fashioned and typical belongs to many countries which have not implemented E-clearance and proper risk management. In those countries the space in port became too limited and that is why bonded inspection areas have been created outside the port zones to allow goods to be inspected and cleared at those areas. In Sri Lanka the same has happened during the 1980s and 1990s when clearance was not yet automated but meanwhile Customs has implemented Asycuda World, as system which supports E-declaration and EDI.

As such today, containers can be declared electronically and can receive clearance electronically.
Inspection and examination is done based on risk profiles. The consignments are selected under three categories as Green, Amber and Red. Amber and Red Channel selected consignments are subjected for the examination whereas the Green selected consignments are released without examination. Boxes are not inspected at the terminals. The customs assign the inspection area when the container are (digitally) cleared and mentioned on the Gatepass issued by Customs. The Gatepass physically moves to the main gate at which time

Based on the risk profile, the containers follow following procedure:

1. Red Line: inspection at Gray Line I and II (about 1%) - The inspection in the Red Line concerns boxes with a high risk profile. Clearance is provided whilst they are at the terminal but containers are directed to Grayline I and Grayline II at the time of clearance. The areas of Grayline I and II have limited capacity for about 20% of the daily inspected containers. Currently around 1% follow this route.
2. Amber Line: directed towards inspection area Rank (about 92%) - The customs are sending cleared containers to inspection area Rank. About 1,000 containers are inspected daily at the inspection sides Rank, the site often receives more than 1000 per day based on the 92% share in daily traffic. Indicating that RANK site is insufficient to handle the traffic efficiently.
3. Green Line: are released from examination and go directly to consignees (7%) - The Green Line is provided to consignees with a low risk profile. Today about 47 Importers have been selected for the Green Line consisting of about 120 containers per day or 7%.

Regulations

Any import declaration has to be done by a registered and licensed entity to carry on the business as a Shipping Agent, Freight Forwarder or Non Vessel Operating Common Carrier (NVOCC). E-manifest can be obtained by registered and licensed importers and exporters. For import declarations by e-manifest, goods need to be submitted 72 hours prior to arrival of the first Sri Lankan port or later in case port of departure is within 72 hours prior to arrival in Sri Lankan ports.
The main regulations for importing goods by sea are illustrated here.

Customs main regulations	
Manifest regulations	1. Customs Ordinance (Chapter 235) 2. Gazette Notification No. 1886/55 of 31.10.2014
Electronic Sea cargo reporting (E-manifest)	Gazette Notification No. 1886/55 of 31.10.2014

For full details on regulations please read the Customs Ordinance and the relevant gazette Notifications.

Charges of customs

The following charges are applied by Customs:

Custom charge for each declaration	Price
Commodity described by HS code, volume, items and weights	As per Tariff book
Computer charges	Rs. 250
Seal charges	Rs. 100
Over time (for Full Container loads only)	Rs. 1600

Rs. 250 is charged for each and every customs declaration for computer Charges and Rs. 100/- per containerized cargo as seal charges and Rs. 1600/- as overtime charges are applicable only for full container load(FCL) cargo.

When containers are send to inspection areas the transport is secured through (additional) seals at the container when leaving the terminal or port zone. Procedures are subject to improvements and further digitalisation.

Customs inspection zones are located at Rank Container Terminals and Grayline I & II. These facilities contain scanning materials. The map below shows an overview.

Figure 13-1: Customs Inspection & Scanning Facilities

Facility	Cargo	Activity
Peliyagoda Warehouse	LCL Imports	Inspection
Bloumendhal Facility	*All Imports*	*Inspection & Scanning future development*
Grayline II	FCL Imports	Inspection
Grayline I	FCL Imports	Inspection
Rank Container Terminal	FCL Imports	Inspection & Scanning
Trico Facility	Exports	Inspection
Port Scanning Facility	Imports	Scanning

13.3.1 Customs procedures

For this section the Port of Colombo has been taken as example as the majority of goods are transported/handled by this port.

Import Cargo

After declaration by the shipping agent, the customs duties needs to be paid before Customs provides Clearance. The Gatepass is issued by Customs to the importer agent which inserts the truck number on the original Gatepass. The truck driver has a “port access pass” to enter the port with an empty truck for pick-up. With a copy of the Gatepass the truck driver is allowed to receive the import container at the terminal where the clearing agent has issued the “loading pass” and confirms the container number to the truck. The original Gatepass has now to be moved from the importer agent to the main gate by a wharf clerk which hands over the original Gatepass to Customs together with the Loading pass received from the truck driver in front of the main gate. Customs inspector then attach the seal and submits a new Gatepass to the driver.

Customs checks at the main gate;

1. Original Gatepass;
2. loading pass
3. Issues a seal number for Red and Amber inspections areas
4. Issues a new Gatepass for entering the inspection areas
5. Sometimes other documents are checked as well

Where the containers have to be examined was already decided and printed on the original Gatepass at the time of clearance.
The majority receives Amber line inspection which involves a medium inspection and those containers with high risk profile are inspected thoroughly through the Red Line procedure. Some trusted importers get an immediate 'green channel' which means that no inspection or scanning is needed others are directed towards scanning inspection facilities.

Note that Customs is not present/interfering at the terminal gates, all activities are done at the main gate and at the inspection yards except for exemptions.

Customs is preparing to move all their imports inspection facility to a newly to be realised Bloumendhal facility. In this case, the majority of boxes are aimed to be scanned in the port with new station scanners. The scanning of all boxes at the current facility would bring major logistic challenges as trucks would queue for this facility. Depending on the scanning results boxes are either send to the inspection facility or are released for public transport. The containers then sealed and tagged. Also the Customs intend to work with GPS seals. This would allow customs to track the container whilst under transport to the inspection areas.

Export Cargo
All export boxes are examined at Trico facility in Colombo. Exports need to be inspected for the potential threat of smuggling (amongst others; smuggling of iron, fauna and cultural heritage items). 90% of the boxes pass through in 10 minutes at Trico facility. Customs need to check whether goods are indeed shipped out of the country, as rebates are given for exports based on this fact. For this reason, a releases note is issued.

Activities at Trico facility

1. Examination of container
2. Weighing of container
3. Documents checked
4. Seal for export
5. CDN (container despatch note)

At the main gate the seal and container number and the CDN is checked and stamped. With the CDN the shipper is able to get the rebate depending on the type of goods.

Customs plans to have export cargo scanning facilities in dry ports. The approved boxes can then be sealed and moved to the port and smoothens customs and logistic operations. The Trico facility will be used until that time.

Transhipment Cargo

Customs does not inspect transhipment cargo which does not exit the container yard. To comply with international regulations radio-activity scanners are placed at the gates of terminals. Any MCC cargo can be selected for inspection in this regard. Due to interterminal traffic radio-activity may be detected and containers can be detained.

Scanning

Customs is using container scanning facilities to reduce the smuggling of goods and to increase the nation's safety. Containers are selected for scanning in case of doubts on the contents and or through random selections. The port of Colombo has three scanning facilities located at CFS 1 area. Two scanning machines are operational. Customs also operates scanning facilities at inland inspection areas such as at Rank Container Terminals and at Grayline I & II.

The scanning location at CFS1 is not ideal as inbound trucks have to make a right-hand turn at the main port access road to enter the scanning location and must turn back on the port access road again. This obstructs the flow of inbound trucks. Ideally the scanning of containers is done at an area where customs can take immediate action, that is at the same location as the container inspections areas.

In the long run, the role of the customs may be different once the bonded transport is allowed for both FCL and LCL and the transportation chain has become more trustworthy. The amount of physical checks shall be reduced. At the same time, the customs shall be more active at major shippers and consignees rather than at the port.

Table 13-1 Customs - Key Observations

Category	Issue	Severity
Customs		
IT	Asycuda World is able to handle E-declaration and uses HS classification codes for all commodities	Low
IT	They apply a Single Administrative Document (SAD) comparable to many developed countries	Low
IT	Asycuda World is able to handle electronic payments, yet the business is often still cash based	High
IT	Too limited consignees and shippers use the ability to do electronic declarations.	High
IT	Electronic clearance is not yet integrated in a Customs single window despite using the SAD	High
Gatepass	The Gatepas procedure is a manually intensive procedure which also involves wharf clerks to run around the trucks at main gate (safety issue). The original gatepass, the sealing and the issue of a new gatepass in all is rather a time consuming procedure.	High
Gate efficiency	The Main gate handles about 1 container each two to three minutes.	High
Logistics	High traffic queues of over 5 km are present at several days in the week. Next to manual procedures at the Main gate also the congestion in the city and in front of the inspections yards is causing this queue. Often the queue in front of the inspection area is all the way, from South Port to Grayline II.	High

Category	Issue	Severity
Logistics	Inspection areas are scattered over several sites, often not easy accessible due to traffic. The scattered locations cause sub-optimal use of resources and planning. The customs is not able to control the truck flow as consignees themselves plan the truck move to the inspection areas.	High
Green line	A few shippers and consignees have been appointed to the green line which allows the container to pass directly without standard checks. Unfortunately, only a small part of the full container loads get the green line label, resulting in many inspections still today.	High
Inspection	The total capacity on inspection is limited to about 1,000 containers per day.	High
Scanning	Customs likes to implement 100% scanning (today about 70%). Scanning would increase the daily capacity of inspecting containers which is today limited to about 1,000 Containers per day. Today the scanning at the port is limited by only two mobile scanning trucks	High
Detention	Customs has own detention areas near the inspection sites. Also in the port there are warehouses with goods under detention. The issue is here that these goods are not moved our frequently. Sometimes as auction are planned. The storage space in the port occupied by is Customs is for them free of charge. This space is however very valuable for the port and should be cleared if possible.	High

13.4 Recommendations

Customs – General

R65. **Customs should further improve and liberalise their activities** to create a split between the physical flow of goods and the administrative flow of goods. In this way, the import flow can be sped up and import duties can be paid once goods are in transport. Digitalisation of the import duties payments shall improve the flow of goods.

Customs - IT

R66. Asycuda World is able to handle electronic payments and electronic payments should be encouraged. Eg Customs should facilitate e-payment more and industry needs to be educated to use it.

R67. Customs is recommended to further improve the **customs single window** and become paperless. Further it is recommended to facilitate and promote the development of a **single maritime window** (with which customs in the future, would electronically distribute their clearances)

Customs - Clearance of goods

R68. **Goods Clearance should become independent of the physical flow**. By promoting the use of EDI the E-declaration can be done whilst goods are in transport towards the port of entry. E-Clearance can therefore (based on risk management) already be provided before the goods arrive at the port. Customs in this respect should not interfere in the physical flow with exemption of the identified goods under the high risk profiles. Digitalisation is also the best method to reduce the level of bribery.

Customs - Risk management

R69. **Risk management is key in the allowance of free movement of goods** when clearance is provided.

R70. Risk profiles in Sri Lanka is still set at high levels. **Once more trust has been built into the system the share of the green line can increase**. This can be obtained by increase fines for trespassers and reduce the costs for trustworthy consignees. “Intervention squads” should ensure that Green line consignees are indeed occasionally checked. Charge on manual declarations should be made rather than at computerized declarations to create incentives.

Customs Gate efficiency

R71. **The gate procedure needs to be simplified and to become paperless**. This can be done through a digital gatepass. Seals with GPS will enable the truck to pass through a RFID identifier at the main gate. In that case the seal needs to be mounted at the terminal gates instead of at the main gate.

Customs Green line

R72. **The Green line should be promoted and increased through proper risk management**. Due to the large number of small consignees and the rapid changes of consignees this is not easy but it is the only way forward to a more efficient transport system. Large and or regular consignees should be promoted to the green line. Customs is advised to increase the Green line volumes supported by random scanning checks at newly assigned Green line users. In the end shippers and consignees shall have a full paperless interface with customs through their customs single window and physical inspection is dramatically reduced.

Customs Scanning

R73. The **terminal inspection should be reduced to a minimum** and more containers should be send through Green Line or through to the Scanning line. Reasoning is that space at the terminals is required for cargo operations.

R74. **A Scanning Line is to be introduced next to the Green Line based on proper risk management**. This scanning is done before physical inspection is carried out and should have the aim to reduce the amount of physical inspection.

R75. Customs likes to implement 100% scanning. This is not advisable when the set-up and operational efficiency is not in place and the scanning results in unacceptable queuing and waiting times. So **the risk/reward of 100% scanning should be evaluated** as well as the cost incurred to society when 100% scanning leads to long waiting times of trucks as well as increased number of physical inspections.

R76. **The scanning is done preferably by fixed scanners in which the driver will exit the truck**. The health issue of exposure to radiation needs to be addressed and normally the truck-driver will exit the truck whilst the truck is pulled through the scanner.

Customs Inspection

R77. **Inspection should be concentrated among a few (preferably one) site(s**) to increase use of resources and planning.

R78. The area near Bloemandhal hill has been appointed for this. The total capacity on inspection should become more efficient to handle more containers simultaneously and have a **larger capacity by implementing fixed container scans** and to reduce the level of physical inspections.

Customs detained goods

R79. **The areas for customs detained goods should be allocated outside the port zone to free warehouse spaces.** Customs has several spaces in the port zone which is used for detained cargoes. These warehouses and spaces occupy valuable port land without any income for the port.

13.4.1 Customs requests for the Port of Colombo

With new port developments customs officers request the following facilities to run their operations:

- A dock for their six new 30m boats used for patrolling the coast in the newly established marine division.
- An office near South port to replace their scattered facilities. This office serve as their administrative centre for about 100 employees.
- An office near the North Port Expansion End of the port . This office should also be able to hold approximately 100 employees.

- Customs would like that marine suppliers (such as water suppliers and bunker vessels) are located in one place to ease customs operations.

13.4.2 Recommendations on customs requests for the port of Colombo

R80. **To accommodate office space to Customs it is proposed to convert an existing building near today's passenger terminal** with marine facilities alongside for the new customs vessels displayed in the figure below.

R81. The 100% scanning of container, as per directive of customs in the future will create a massive disturbance in the logistics. I**t is advised to have scanning for South Port containers near fort and the scanning for JCT and North side of the port** integrated with the customs facility at Bloumendhal hill.

Figure 13-2: Customs Facility with Quay

13.5 Navy

13.5.1 Role of the Navy

The navy has a presence in the port of Colombo, Galle and just outside of the port of Trincomalee. The de-facto functioning of the Sri Lankan navy as coast guard make it important for the port security. Thus, close coordination with the Port Authority is essential. The navy reported shortage of mooring places in the port of Colombo especially in view of the ordered new larger vessels.

13.5.2 Current Navy plans

The Navy should have presence in all major ports necessary because of national safety and security and coast guard function. The Sri Lankan Naval fleet consists of a dedicated fleet comprising missile ships, combat ships, offshore patrol ships, support ships and inshore patrol crafts. They have ordered larger vessels which cannot moor at current facilities in Colombo port. The most obvious location for the newest vessels are dedicated facilities in Hambantota and or Trincomalee due to ample development space in these ports. However also in Colombo they should be able to moor.

The two new navy vessels ordered have a length of 105m. The first vessel will arrive in August 2017 and the second in February 2018. These vessels need to have a berth once they are in port.

13.5.3 Future Navy locations

For the future of the navy it is expected that they remain in the old basin of port of Colombo. At this location, they have an own headquarter building.

Recommendation for the port of Colombo

R82. **The new navy vessels can be temporarily moored at BQ** (before passenger terminal is built) or at the old Passenger Berth once the passenger terminal is built. These locations are very near the Navy headquarters. If North Port is developed more space becomes available in the old basin in future. Other ports such as Hambantota, Galle and KKS should be able to accommodate stationary navy vessels.

14 Auxiliary Functions

14.1 Introduction

Auxiliary functions in this report can be defined as: "All activities taking place which are stand-alone functions and activities taking place to support the primary commercial port operations." This boils down to the definition being all functions except for the commercial port operations. Sometimes auxiliary port functions can be a commercial activity on itself like, bunkering services or the crew change service in Galle.

The following approach has been applied:

- Paragraph 14.2 describes the direct supportive functions: Description of all functions which are direct supportive to the commercial handling of ships. This includes tugs, pilotage and bunkering.
- Paragraph 14.3 describes the indirect supportive functions: All other functions which are not directly supportive to the commercial handling of ships like marinas and licensing.
- Paragraph 14.4 describes the benchmark against world class ports: The benchmark of Colombo port is based on the categories (i) shipping functions, (ii) logistics and industries, (iii) maritime community and finance, (iv) attractiveness and competitiveness.
- Paragraph 14.5 describes the way forward for SLPA regarding its involvement and management of aa

14.2 Direct Supportive Functions

Under direct supportive functions the following items are discussed:

- Tugs & Pilotage
- Linesmen & Mooring
- Bunkering
- Water supply
- Weighing and scanning
- Ballast water treatment and waste

14.2.1 Tugs & Pilotage

Tugs and pilotage services at Colombo, Hambantota, Trincomalee and Galle are under the purview of Harbour Master of Colombo Port. All tugs & pilotage services are provided by the Sri Lanka Ports Authority. Tugs are used to handle vessels within port while pilot boats are used to carry pilot into and out of vessels. Depending on the pilot decision one or two tugs are allocated for the vessel.

Colombo port has 9 tugs of bollard pull that ranges from 40-65 tons. There are 5 tugs with 65 tons, 1 with 55 tons, 2 with 45 tons and a one with 40 tons. However, at present only 5 tugs are operational. With current availability of tugs a maximum of 3 ships can be handled at a time. The main line vessels over 245m LOA require often two tugs[5] to manoeuvre the ship. Smaller feeder vessels can manoeuvre with assistance of one tug. Small ships under the 150m with bow thrusters commonly do not require tug assistance. Still it is up to the harbourmaster to assign tugs when conditions require this.
The tugs are stationed near the harbourmaster office (side south port) and near the navy berths inside the old basin. Adequate mooring space is available near harbour master office.

Table 14-1: Number of Tugs and Pilot Boats

Type	Unit	Colombo
Tugs	Boats	9*
Pilot boat	Boats	3

*Only 5 tug boats are operational
Source: SLPA

Colombo port requires one extra tug to ensure four ships can be handled at the same time this is based on a mix of small and large vessels handle simultaneously. Furthermore, it should be noted that the size of the vessels has grown (we now see many 400m vessels in the port) and that these ships at least require two 55-65t bollard pull tugs to be attached. The smallest tugs are not sufficient to assist them. A large bollard pull tug (e.g. 80t) can also be used in offshore salvage actions. With the development the port and the aging of existing tugs, additional tugs shall be required once more. Timely acquisition in line with port development is important to enable the new port capacity to become fully operational (e.g. WCT terminal development). Mooring spots to station the tugs boat should also be accommodated. This can be done near the harbour master office in South port where a service port has a 200m quay plus two additional quays of 100m each.

[5] Depending on the wind, wave and climate conditions and whether the ship has bow trusters or not.

Table 14-2: Tug Characteristics

Description	Unit	Colombo
Bollard Pull	Tons	40-65
Length	m	32-36

Source: SLPA

Out of 5 tugs operational at Colombo port for old two tugs a crew size of 17 each has been assigned while for the balance a crew size of 13 each has been allocated. A crew size of four has been assigned for each pilot boat.

Table 14-3: Crew

Description	Unit	Colombo
Tug	Crew Members per Boat	13-17
Pilot boat	Crew Members per Boat	4

Source: SLPA

Table 14-4:Number movements by each tug

Name of Tug	Unit	2010	2011	2012	2013	2014	2015	2016
MT Raja	Movements	1806	672	2,045	124	N/A	171	1,463
MT Nandimithra (55BP)	Movements	2,787	1517	1,358	3,615	3,422	1,798	2,320
MT Suranimala (65BP)	Movements	2,181	3408	3,012	2,872	4,104	3,388	3,920
MT Gotaimbara (65BP)	Movements	2,190	2945	3,244	3,938	3,169	4,109	3,409
MT Vijayabahu	Movements	1,469	1942	2,333	3,219	2,123	3,536	2,906
MT Barana – II	Movements	2,958	1966	2,283	2,820	3,307	4,082	2,318
MT Velusumana	Movements	383	113	13	N/A	N/A	N/A	N/A
MT Neelamaha	Movements	669	N/A	N/A	N/A	N/A	N/A	N/A
MT Airawana	Movements	1,614	N/A	N/A	N/A	1,835	2,157	1,897
Hired Tugs	Movements	*1,047	N/A	N/A	N/A	**1,722	1,304	2,239
Total	Movements	17,104	12,563	14,288	16,588	19,682	20,545	20,472

* Two tugs hired   ** one tug hired
Source: SLPA

Tugs used in the Colombo port has recorded different levels of movement as provided in the table above. It could be observed that number of movements have been dropped during 2010 to 2013 however then it started increasing by reversing the trend. Number of movements have shown a CAGR of 3% from 2010-2016. Further the SLPA has hired tugs during 2014-2016. This is due to the maintenance issues and insufficient capacity of the current fleet of tugs.

Due to the increased vessel sizes handled by the port, the amount and sizes of tug services should be adjusted as well. Whilst the port now has 9 tugs, one more tug of 80-ton Bollard pull should be acquired to maintain good marine services in the short term. The new tug should also be able to handle the expected LNG vessels [6]and the support on the SBM, located outside the port. Vessel manoeuvrability should be tested in vessel simulators to understand the appropriate jetty configuration and the required type and size of tugs. This also applies for the container ULCS vessels.

Pilotage

Pilotage to all types of vessels calling port of Colombo are provided. The following table shows number of calls of vessels to the port of Colombo over the period of 2010-2016.

Table 14-5:Number of Vessels Called by category

Type	Unit	2010	2011	2012	2013	2014	2015	2016
Container	Vessel Calls	3,076	3,187	3,093	3,142	3,239	3,643	3,804
Conventional	Vessel Calls	56	68	52	38	28	45	40
Dry Bulk	Vessel Calls	206	202	195	177	189	172	194
Oil Tanker	Vessel Calls	245	284	258	133	134	164	191
Roll on Roll off	Vessel Calls	131	149	67	28	32	47	51
Other Cargo	Vessel Calls	34	45	71	16	11	05	-
For bunkering	Vessel Calls	68	65	51	50	25	30	29
For Repairs	Vessel Calls	47	30	35	36	38	43	46
Passenger	Vessel Calls	26	72	34	32	36	37	43
For Other services	Vessel Calls	21	22	14	15	10	11	07
Total	Vessel Calls	3,910	4,124	3,870	3,667	3,742	4,197	4,405

Source: SLPA

According to the table it could be noted that total number of vessels calling the Colombo port has been increased at a cumulative annual growth rate (CAGR) of 2%. Out of the total number of vessels container ships show a CAGR of 4% from 2010-2016.

[6] The LNG vessels require special tug services due to the nature of the product.

Table 14-6:Revenue from pilotage service

Description	Unit	2010	2011	2012	2013	2014	2015	2016
Colombo	Rs. Mn	661.470	682.127	790.844	850.484	964.735	1,092.813	1,428.173
Annual Average Exchange Rate	LKR/USD	113.0647	110.5652	127.6034	129.1099	130.5606	135.9378	145.6016
Total	**USD**	**5,850,367**	**6,169,455**	**6,197,672**	**6,587,287**	**7,389,174**	**8,039,066**	**9,808,773**

Source: SLPA

Revenue earned from pilotage services has recorded a continuous growth during last seven years. SLPA has recorded cumulative annual growth of 14% from its pilotage services at Colombo port during 2010-2016. Given the increase in number of ships calling the Colombo port specially the container ships, the port has been able to sustain a growth in revenues.

Different efficiency indicators such as no of movements per vessel, revenue per movement, revenue per vessel for port of Colombo are calculated and provided below.

Table 14-7:Pilotage service efficiency indicators

Type	Unit	2010	2011	2012	2013	2014	2015	2016
Port of Colombo								
Movements per vessel	Movements	4.37	3.05	3.69	4.52	5.26	4.90	4.65
Revenue per movement	USD	342.05	491.08	433.77	397.11	375.43	391.29	479.13
Revenue per vessel	USD	1,496.26	1,495.99	1,601.47	1,796.37	1,974.66	1,915.43	2,226.74

Source: Processed data

According to the table it could be observed that movement per vessel has decreased from 2014 onwards however the revenue per movement has increased in the same period. Moreover, revenue earned from tugs services per vessel has continuously increased from 2011 to 2016.

Salvage

Due to the proximity to the east-west shipping lanes Colombo, Gall and Hambantota are well positioned to have salvage tugs stationed. It is therefore recommended that tugs have the availability for salvage capabilities. For salvage operations, the port is currently not equipped with sufficient powerful tugs. However, salvage operations may well be an additional service package to be offered by SLPA.

Maintenance of tugs and pilot boats

The maintenance of tugs is currently performed by SLPA shipyards. It is advisable that the ship maintenance is outsourced to appropriate companies. The maintenance of these vessels has become very specialised and is best performed by shipyard professionals. It is the recommendation the seeks options for outsourcing the maintenance. Additionally, instead of purchasing the vessels it is possible to have a bareboat charter or through time charters.

Recommendations for the port of Colombo

R83. Given the growth in demand for pilotage services, **it is recommended to purchase an extra tug of 80 ton Bollard Pull.** This could also avoid the costs of hiring tugs from private suppliers.

R84. **SLPA should reduce the crew size** assigned for tugs which is well above the required levels.

R85. It is advisable **to outsource the maintenance activities** of tugs in order to provide continuous pilotage service.

R86. **Tugs which perform salvage operations should be additional to the port operations** in order to the keep the port towage operations running whilst a salvage operation

R87. It is recommended **to form a company which is a fully owned subsidiary of SLPA to carryout pilotage services** in the long run as the company structure would be flexible and effective in operations and finance decision making. It should be independently operated as a profit centre.

14.2.2 Linesman & Mooring

Linesmen and mooring can be regarded as service to ships which should be aligned with the berthing operation of ships, hence this belongs to the harbour master function.

14.2.3 Bunkering

Port of Colombo being situated in strategic location of world naval routes has the enormous potential for bunkering service. Ship bunkering is a key auxiliary service that a maritime hub can provide for global shipping industry. Port of Colombo provides bunkering services through land based storage supplies and floating storage supplies. SLPA is not providing fuel to vessels commercially other than the bunkering facilities in JCT. Even though these services are important, today not a lot of vessel make use of the service. To increase the bunker operations the price of bunkers and the efficiency of supplying bunkers should be addressed adequately. SLPA must promote additional Bunker operators to supply this service. JCT has 13 fuel tanks that could store HFO 380, HFO 180 and MGO fuel categories up to a total capacity of 35,000 MT. The company supplies fuel directly to vessels and sell fuel to other companies that provide bunkering services. Ceylon Petroleum Corporation, a public entity also provides bunkering services through oil bank at JCT.

Observations

Bunkering services in port of Colombo are provided by diverse public and private entities. Jaya Container Terminals Limited, a 100% owned subsidiary of SLPA has 13 fuel tanks that could store HFO 380, HFO 180 and MGO fuel categories up to a total capacity of 35,000 MT. The company supplies fuel directly to vessels and also sell fuel to other companies that provide bunkering services. Ceylon Petroleum Corporation, a public entity also provides bunkering services through oil bank at JCT.

Table 14-8: Bunkering supplies by JCT Oil Bank

Description	Unit	2014	2015	2016
Total discharged	MT	350,329	425,401	470,380
Total loaded	MT	343,076	436,030	461,431
Total handled	MT	693,405	861,432	931,811
Profit earned	Rs. Mn	No data	36	77

Description	Unit	2014	2015	2016
Annual Average XCR	LKR/USD	130.5606	135.9378	145.6016
Profit earned	USD	No data	264,827	528,840

Source: SLPA

It could be noted that volumes handled by the JCT Oil Bank has shown a remarkable growth. The CAGR from 2014-2016 stood at 16%.

Private suppliers of bunkering include six licensed suppliers. Marine Environment Protection Authority issues licenses for private suppliers to carryout bunkering services. Private operators provide bunkering services through barges.

Table 14-9: Licensed private bunkering suppliers

Register No	Company Name	Name of Barge
2017/Bun/01	Moceti International (Pvt) Ltd	MT LMS LAXAPANA
2017/Bun/02	Lanka Maritime Services Ltd	MT LMS DUNHINDA
2017/Bun/03	Lanka Bunkering Services (Pvt) Ltd	MT SEAFALCON
2017/Bun/04,05	Lanka Marine Services (Pvt) Ltd	MT MADURU OYA, MT LM NILWALA
2017/Bun/06	Interocean Energy (Pvt) Ltd	MT KANDY, MT OCEAN GALLE, MT OCEAN TRINCO, MT SHERMAC
2017/Bun/10	Lanka IOC PLC	MT KANDY, MT OCEAN GALLE, MT OCEAN TRINCO, MT SHERMAC

Source: Marine Environment Protection Authority

Limited capacity for bunkering supply is a major issue that needs attention. More storage facilities enable to buy large volumes with discounts so that bunkering supplies can be made at competitive prices. However, it needs to be cautious on the development of Hambantota port which has more locational advantage than Colombo as it is being in proximity to naval routes than Colombo. Hambantota port has a capacity 51,000MT to store bunkering fuel. When Hambantota port is fully operational, there could be lower demand for bunkering services at Colombo which has a capacity of 35,000 MT at present.

Future of Bunkering in Colombo

It is expected that the number of vessels which bunker in the port of Colombo will increase in the future once competitive prices can be offered. Another opportunity is the supply of LNG to vessels. LNG will be handled by a planned LNG terminal which is to supply LPG through gasification to gas fired power stations. LNG as fuel for ships is earmarked to become a large fuel source for ships in the future. In this respect, the port should prepare to offer these new services in the future. This also includes drafting the Port By-laws on handling LNG, one of the regulatory functions of SLPA.

With the development of the port and the adjacent Port City development with marina’s, the demand for bunkers will rise in near future. Also, the demand for MGO and MDO is expected to increase due to the new and greener engines on board vessels. The IMO is promoting the reduction of emissions such as Sox and NOx and ship owners are increasingly reluctant to invest in cleaner engines. Due new regulations of the global sulphur cap, also the mix of fuel types will differ in the future with more marine gasoil demand and possibly LNG as well. The first will trigger additional bunker supply barges and the latter could lead to the demand of LNG barges.

With the development of the gas power station near Colombo a LNG floating regassification unit is required. This would also create the opportunity to supply LNG to vessels as well in the future.
All these requirements combined may lead to an energy cluster which was accommodated in the North Port concepts. It would encompass several jetties, to accommodate liquid tankers (featuring between 40,000 DWT and 120,000 DWT) and barges, tank storage for refined products and blended products for both imports (by pipeline) as well as for the bunker vessel industry. The "Energy Hub" would replace the current dolphin liquid facility as well. The advantage of the initial island is that it is remotely located from other activities and as such well suited to accommodate a Floating Regassification Unit (FSRU) for the LNG.

In the annex a separate section has been made on the bunker hub ports including facilities, vessel types, and examples of the ports of Singapore and Rotterdam

Recommendations for the port of Colombo

R88. It is recommended **to develop capacity for bunkering services at Colombo port** considering short and medium term needs having duly assessed the services of competing ports such as Hambantota.

R89. **LNG** being a new source of fuel for ships which is currently being tested, could become category of fuel that port of **Colombo must be ready in the long run with appropriate capacity**.

R90. It is recommended SLPA to form **joint venture company with Ceylon Petroleum Corporation**(CPC) to benefit from synergies of both. SLPA has the infrastructure while CPC has the speciality in supplies. The newly formed joint venture company should be independently operated as a profit centre.

State of LNG Bunkering in Ports

Source: www.lngbunkering.org

European ports are investing heavily in LNG bunkering facilities, such as the Montoir-de-Bretagne (France) terminal. GATE LNG in the Netherlands has also been offering this functionality since the second half of 2015 (for ships as small as 5,000 cm). In Asia only de port of Incheon offers bunkering facilities. Receiving LNG terminals with two jetties can provide bunkering services and completing transhipment.

14.2.4 Water Supply

SLPA provides water supply to vessels within port limits on request. Out of harbour water supply is not provided by SLPA. Only CICT and ECT have direct water pump connections at the quay. Water supply is provided by two means using a sump at each terminal and by water barges. But due to the low water pressure to pump water into vessels other terminals still use barges of 500 tons to supply water to vessels. SLPA purchases water from Water Board Sri Lanka to provide these services. Modernisation of the water supply and especially the barges and their pumping rates are subject for improvements.

Water supply using barges are carried out by Bandaranayke Quay(BQ). BQ has 4 barges with capacities ranging from 110-130 thousand metric tons as provided in the table below.

Table 14-10: Capacity Water Supply Barges

Name of Barge	Unit	Capacity
WB 15	MT	110
WB 16	MT	120
WB 17	MT	120
WB 18	MT	130

Source: SLPA

At present, only one barge (WB 15) is under operational condition. Barges are berthed at the water section west of BQ (Prince of Wales jetty and Kings jetty) which has a depth of 4m. One tug for each barge is used and sometimes one tug pulls two barges. Water is supplied to the vessels including those at terminals of JCT, ECT, SAGT and occasionally for CICT despite the availability of sumps at those terminals. It is due to operational issues of sumps located at terminals. At present a water supply of 300-400 MT is provided per day in average. It is expected that this demand would reduce once all operational issues of sumps at terminals are sorted. Water is supplied to vessels at the rate of 8 USD per ton. Currently the municipality is in the process to deliver water to SLPA at high pumping rates. SLPA considers making water available at JCT. It shall be important that construction of these water supply pipes at the quays of JCT shall not interfere with the day-to-day operations. It should be noted that barges will need to remain available in future to supply water within the port limits as long as water is not available through quayside pipeline. When the water barges are upgraded water supply at anchorage should also become an option.

Table 14-11: Water Supply Volumes

Description	Unit	2010	2011	2012	2013	2014	2015	2016
Volume	Tons					89,452	81,925	956,77

Source: SLPA

Recommendations for the port of Colombo

R91. **Water supply should remain in the same location**, but investments needed on water barges & pumping capacity

R92. **New quays should be equipped with water supply abilities.**

14.2.5 Weighing and scanning facilities

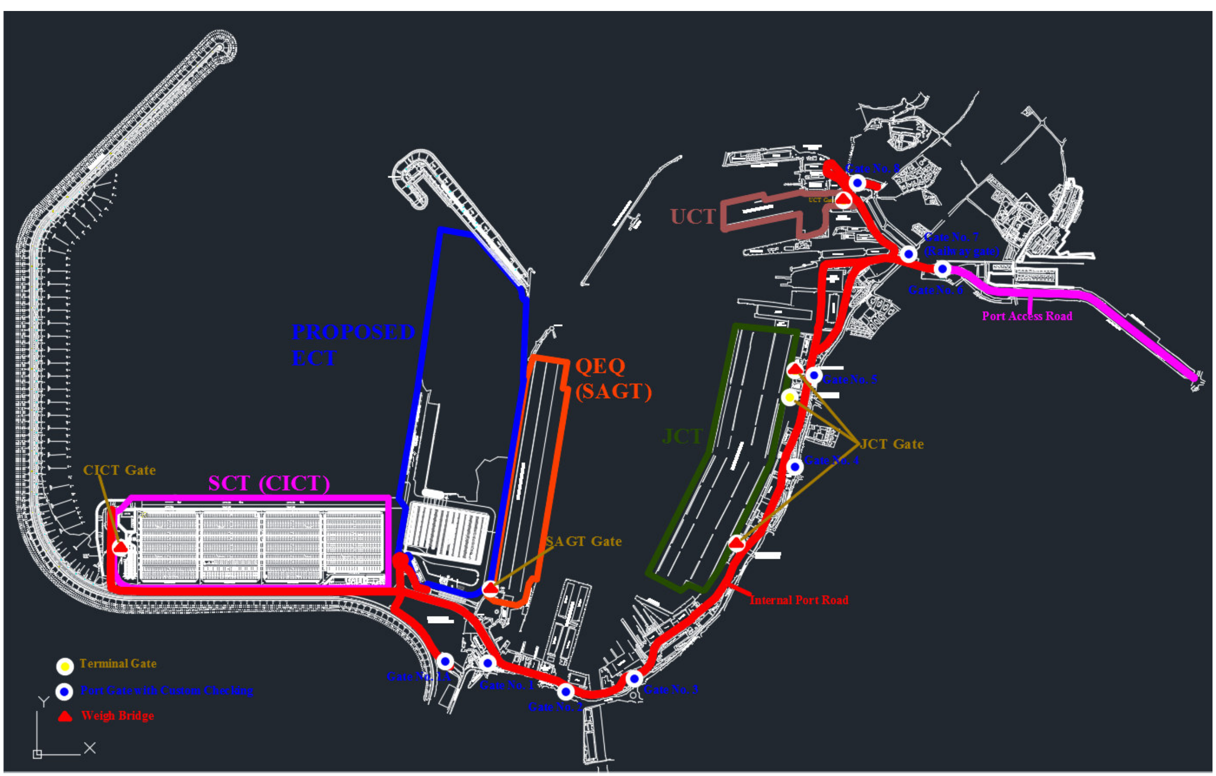
The SOLAS amendment for verification of container mass (VgM) came into force on 1st July 2016. This implies that all containers must have a certified weight and therefor Shippers and port operators and port authorities require certified weighing systems. Furthermore, the communication of this information needs to be integrated with the terminal software.

Terminals Operators must have a VGM facilities as each container should be verified otherwise they are not allowed to be loaded on a vessel. This often implies that the terminal checks in advance whether containers can be accepted at the gate-in or not. Weighing facilities at or near the port are required to ensure containers can be weighted appropriately.

Colombo port has weighing facilities at the entrance of the terminals as indicated in Figure 14-1 namely:

- Two at JCT entrances
- One at SAGT; and
- One at CICT
- At the grain facility at PVQ
- At the BQ facility
- At the UCT facility

Figure 14-1: Location Weighing Facilities



Source: SLPA

Furthermore, weighing bridges for export containers and common trucks are available in front of the main gate. The port of Colombo has ample weighing facilities. However, the digitalisation and the integration of information should be organised.

Recommendations for the port of Colombo

R93. **Terminals operators** must have a **VGM facilities** as each container should be verified otherwise they are not allowed to be loaded on a vessel

R94. The **digitalisation** and the **integration** of information of **weighing facilities** should be organised

14.2.6 Ballast Water Treatment

The IMO International Convention for the Control and Management of Ships' Ballast Water and Sediments, adopted in 2004 and commonly referred to as the Ballast Water Management (BWM) Convention, was ratified by a minimum of 30 member states representing at least 35% of the world's merchant shipping gross tonnage on 8 September 2016. It enters force one year after this date, on 8 September 2017.

The BWM Convention applies to all vessels that carry ballast water and are engaged in international voyages. It establishes global ballast water management requirements and permits national, regional and local authorities to apply their own regulatory framework in their respective territorial waters. Requirements are defined for both ballast water exchange and ballast water treatment.

The SLPA needs to accommodate the BWM regulation through facilitating the set-up of ballast water treatment facilities. Waste management and treatment is an important element for port authorities. Not only the waste collection from ships also port is often the ideal place for waste treatment facilities. In many countries, worldwide waste-to-energy facilities have been allocated in ports and in nearby areas.

Waste management in the port is important to be available adequately and efficiently. Today the service to collect ship's waste, oil and oily waters is done through third party providers.

Waste treatment is not common for the ports of Sri Lanka today. Many waste areas have been allocated near urban areas without proper waste treatment facilities. The port of Colombo because of the limited space, a proximity to the city is not suitable for waste-to-energy or other waste treatment facilities.

Other ports in Sri lank may develop these facilities pending on their logical and geographical position. The advantage of waste -to-energy facilities is that they provide heat and or energy which can be used by industries in the port.

Recommendations for the port of Colombo

R95. Investigate the **BWM regulation** and the way SLPA can conform to this.

14.3 Indirect Supportive Functions

Under indirect supportive functions the following items are discussed:

- Ship Repair Yards
- Container maintenance
- Ship Registration and classification
- Training Centre
- Fishery ports
- Marinas
- Licensing
- Ship chandlery
- Fire Department
- Medical Services
- Financial Services
- Seamen club

14.3.1 Ship Repair Yards

Port of Colombo has ship repair yards for vessels maintained by private parties. Colombo Dockyard PLC, a private party provides ship repairing services. SLPA also maintains repair yards for minor repairs of its own ships. Some private parties such as Master Drivers Company engaged ships repairing under water activities.

Observations

SLPA owned ships such as tugs, pilot boats, mooring boats, etc. A slipway of 15m in length is used for underwater repairs. The slipway is also rented out to private parties for repair services. Minor repairs of SLPA ships are carried out by Marine engineering division. The division has well equipped workshops. However, with the ongoing constructions of elevated road, it is expected that certain buildings and facilities of the department would be demolished.

However, for major repairs of SLPA ships, they are directed to Colombo Dockyard PLC. SLPA is the fifth largest shareholder of Colombo Dockyard PLC owning 3.04% of shares. Ship repair services for vessels are provided by Colombo Dockyard PLC which is in port of Colombo adjoining to the land of SLPA.

Table 14-12: Dry Docks Colombo Dockyard PLC

Dock	Length (m)	Width (m)	Depth over blocks (m)	Capacity (DWT)	Cranage (t)
No1	213	26	9.7	30,000	25
No2	107	18.5	6.7	9,000	25
No3	122	16	5.5	8,000	10
No4	263	44	8.9	125,000	50

Source: SLPA

The port registered the following amounts of ships for repair annually.

Table 14-13: Number of Ships for Repair

Shipyards	2010	2011	2012	2013	2014	2015	2016
Ships for repair	68	65	51	50	25	30	29

Source: SLPA

The ship repair and maintenance industry has become specialised. With the growing special vessels operated by SLPA, dredgers, tugs and pilot boats it already becomes sometimes mandatory to have maintenance done at special shipyards simply because SLPA slipway is not able to handle them.

SLPA should therefore consider having the periodic maintenance their own tugs and pilot boats and other marine equipment done by third parties to concentrate on their core activities. By doing so it will also highlight the costs involved with such operations. Other options are available such as selling or leasing the existing facilities to third parties.

A current issue related to the dockyards is the noise and pollution generated by the operations; e.g., particles and paint end up in the air and water. It is noted that dockyards should adhere to overarching national and industry-specific environmental policies and regulations. It should therefore be assessed whether the dockyards operations adhere to current standards in the nation.

Recommendations for the port of Colombo

R96. SLPA should consider to have the **periodic maintenance their own tugs and pilot boats** and other marine equipment done by third parties in order to concentrate to their core activities.

R97. It is advisable to **rent-out ship yard facilities** during idle times.

R98. It is recommended to **monitor Marine Engineering division as an identified business segment** of SLPA with separately tracking of revenue and costs.

R99. It is recommended to investigate to obtain **more stake in Colombo Dock Yard PLC** in the long run to benefit from repair services given to the SLPA as a related party as well as a share of the overall profits of the company from its total operations.

14.3.2 Container Maintenance and Repair

Container maintenance is done at empty depots around Colombo by private parties. Container Maintenance & repair facilities are provided by diverse private parties at port of Colombo. This include suppliers such as Ceylon Oceans Lines Ltd, Star Link Services Pvt Ltd, ACE Containers Pvt Ltd, Mclarens Logistic Ltd ,etc. SLPA does not provide container maintenance & repair services at port of Colombo.

It is expected that the container maintenance and repair facilities remain with the private sector and shall be concentrated at empty depots and cargo villages.

Recommendation for the port of Colombo

R100. **Container maintenance & repair** services to remain with the private sector.

14.3.3 Ship Registration and Classification

Ship registration and the classification of ships is currently done manually by the harbour master office. Many Port Authorities work with global fleet databases to ensure that their ship file is complete and updated.

Implications for the port of Colombo
The current manual system is prone for mistakes and cannot capture the modernisation of the marine functions at the Harbour master. Ship recognition and identification should be support by fleet database which ensures updated information on the vessels particulars and classifications.

The system is also needed to be integrated with a vessel traffic management system (VTMS) which allows for actual and online vessel positions and berth allocation features. The VTMS should be able to show which vessels is planned for which berth and should be able to show directly the position of dangerous goods.

Recommendations for the port of Colombo

R101. Ship recognition and identification should be supported by a **fleet database** which ensures updated information on the vessels particulars and classifications.

14.3.4 Training centre

SLPA operates Mahapolo Ports & Maritime Academy which offers diverse training programmes to both internal employees of port as well as external parties. The academy is located within the Colombo port.

Observations
At present, it offers 127 courses in the fields of cargo operation, equipment operation, Management, Information systems, Technical, Safety, Seamanship (STCW), NAITA Apprentices and Engineering cadets. The academy is the only institute in Sri Lanka that provides Competence Discharge Certificate (CDC) for seafarers. It should be noted that the training centre is crucial for Sri Lanka as it provides all port personnel and seafarers. However, with the modern demands of cranes drivers and other personnel, the private terminals train and educate their employees mostly elsewhere. As the Colombo training centre is not able to offer these specialist education, the SLPA, as container terminal operator, starts with a disadvantage having lower educated personnel.

Out of the enrolled students 80% are internal staff of the port while the balance is external. Internal staff are offered courses at free of charge while external parties are charged for courses. Main revenue generation of the centre stems from external students. At present major part of cost of running the academy is recovered from the generated revenue. It plans to be self-sufficient next year onwards.

Facilities & persons of the academy are presented below.

Table 14-14: Training Centre facilities

Description	Unit	Value
Lecture Halls	#	9
Auditorium	#	1
Workshops	#	1
Training yards-Equipment/fire	#	2
Labs	#	5
Library	#	1
Simulators (Ship/Fire)	#	2

Description	Unit	Value
Resource persons	#	20

Source: SLPA

Demand for training programs offered by the academy are presented below.

Table 14-15: Demand for training centre services

Description	Unit	2010	2011	2012	2013	2014	2015	2016
Total students enrolled[1]	#	3451	3,621	6,857	7,099	5,608	N/A	5,205
Training duration[1]	Man hours	685,844	432,912	583,970	739,387	643,988	N/A	829,504
Revenue earned -External	LKR Mn	13.16	14.45	18.62	13.55	11.33	N/A	19.26
Revenue earned -Internal	LKR Mn	***5.61	**9.78	*10.86	*13.72	14.20	N/A	23.39
Revenue earned-Total	LKR Mn	24.38	24.22	29.48	27.27	25.52	N/A	42.65
Annual Average Ex. Rate	LKR/USD	113.0647	110.5652	127.6034	129.1099	130.5606	135.9378	145.6016
Revenue earned in USD	USD	215,617	219,082	231,041	211,206	195,477		292,902

1. Excluding on the job training
* Including Maritime Training Institute Oluvil
** Including Maritime Training Institute at Oluvil & Training Institute at Badulla
** *Including Martime Training Institute at Oluvil & Training Institute at Badulla & Matara
Source: SLPA
N/A-Data requested but not provided.

At present the academy provides only certificate level courses and diploma courses. Academy has planned to go beyond Diplomas to include Higher diploma and degree level courses. It has already started discussions with foreign universities in China & Sweden for affiliations arrangements. Expansion plans also includes establishing five additional labs for air-conditioning repair, welding, computer-virtual training, engine simulation and language training.

The training centre is advised to find synergies with other training institutes in the world to create a level of exchange of training programmes and to stay in touch with international educational improvements and technological developments. For example, IT, has become a very important element in the business and learning programs are lacking behind on this issue.

Private shipping and port institutes have emerged in the world of seafarer's education. A good example is the set-up of international of maritime academies by the Rotterdam's maritime educational institute STC. It has set-up several maritime training institutes in countries like South Africa, Oman, Vietnam and Philippines.

Modern training centres do often use simulators to educate and train the students with port cranes and vessel simulators. The investment in simulators is however quite large. It is therefore advisable to upgrade the curriculum with simulators courses at locations elsewhere.

Recommendations for the port of Colombo

R102. It is recommended to market the courses provided by the Centre among **external students to generate revenue** and sustain as a self-sufficient centre.

R103. It is advisable to **improve the current status of the centre** to campus through external affiliations and finding synergies with other training institutes in the world.

R104. It is recommended to restructure the centre as a **fully owned subsidiary company of SLPA** in the long run which independently operates as a profit centre.

14.3.5 Fishery

Fishery forms an important source of animal protein to the population. Fishery harbours are scattered around the country and around 830,000 people were employed in the sector in 2015. The production in 2016 totalled 530 thousand tons with 22 major fishery ports around Sri Lanka. The fishery harbours are under control of the "Ministry of Fishing and Aquatic resources"; hence, they are beyond the scope of this study.

North of the port of Colombo a fish port is located. With the possible development of North Port, a new fish port has been commissioned. For the port of Colombo, no fish handling is foreseen other than attracting refrigerated containerized exports. The facilities for cool storage and fish factories are expected to be developed at places like KKS and Oluvil. The port of Colombo may take advantage from this by receiving refrigerated containers through a coastal shipping concept should this be more advantageous than road or rail transport.

Recommendations for the port of Colombo

R105. SLPA has no business with fish port developments unless being requested to provide infrastructural assistance outside of the port by the Ministry of Fishing.

14.3.6 Marinas

Colombo port being utilized as a commercial port does not have assigned facilities for marinas, however on request harbour master of Colombo port directs cruise ships and leisure boats that occasionally calls the port to idle berths.

Marinas form a non-essential part of a port and must be separated from commercial activities to ensure that pleasure boats do not interfere or cross larger commercial vessels. This is mainly due to safety concerns when amateur ship sailors enter a commercial port. On the other hand, the demand for Marina's is growing. The port of Colombo lack proper marina facilities and the nearest marina port is Galle.

The demand for Marinas near Colombo is eminent. With increased wealth of the population, it is expected that this market segment is growing. Further, Colombo is an interesting place to visit for pleasure yachts and to make day trips along the shore.

As stated above the commercial activities in the port do not combine with pleasure yachting. As such Marinas should be developed outside the commercial port. In the port city development, recreational marinas have been planned.

Recommendations for the port of Colombo

R106. It is recommended to develop **marina facilities outside the commercial port** boundaries of port of Colombo to minimize disturbances to commercial activities and possible accidents.

14.3.7 Licensing

SLPA provides licensing for private parties to enter in to the port & provide ship supplies charging a fee. In addition to ship chandlery licensing, SLPA carries out annual registration and issue of licenses to launch operators, marine surveyors, minor and major repair workshops, oil and oily water garbage reception facilitators. Number of licenses issued for these different services are provided in the table below.

Table 14-16: Number of Licenses Issued by SLPA

	Unit	2010	2011	2012	2013	2014	2015	2016
Ship Chandlers License	Licenses	64	76	76	78	90	*	*
Ship Repair License	Licenses	121	119	124	138	151	*	*
Dockyard License	Licenses	71	73	73	76	74	*	*
Survey License	Licenses	38	39	36	38	39	*	*
Boat License	Licenses	30	33	47	42	49	*	*
SAGT & SAGT & Another License	Licenses	-	-	21	19	47	*	*
Total Number of Licenses	**Licenses**	**324**	**340**	**377**	**391**	**450**		

Source: SLPA

* Data Requested but not provided

14.3.8 Ship Chandlery

Chandlery is the supply of consumables, goods and spare parts to ships. Chandlery is provided by private parties in the port of Colombo under licensing of SLPA. The ship agents organise ship chandlery for their customers.

Revenue earned by the SLPA from licensing are given below.

Table 14-17: Revenue earned from Licensing

	Unit	2010	2011	2012	2013	2014	2015	2016
Ship Chandlers License	LKR	1,885,302	2,529,817	2,482,537	2,893,588	3,262,515	*	*
Ship Repair License	LKR	2,908,659	3,068,703	3,508,140	4,273,508	4,810,908	*	*

	Unit	2010	2011	2012	2013	2014	2015	2016
Dockyard License	LKR	1,141,028	1,151,085	1,150,847	1,359,130	1,346,226	*	*
Survey License	LKR	682,332	695,130	673,668	789,060	979,876	*	*
Boat License	LKR	703,169	876,784	1,189,697	1,384,492	1,517,689	*	*
SAGT & Other License	LKR	-	-	375,990	368,354	141,711	*	*
Total Revenue earned	**LKR**	**7,320,489**	**8,321,519**	**9,380,879**	**11,068,132**	**12,058,924**	*	*
Annual Average Ex. Rate	LKR/USD	113.0647	110.5652	127.6034	129.1099	130.5606	135.9378	145.6016
Total Revenue earned	**USD**	**64,746**	**75,263**	**73,516**	**85,726**	**92,363**	*	*

Source: SLPA

* Data Requested but not provided

Recommendations for the port of Colombo

R107. The **licenses should be digitalised** where possible. An online system should show the status of licenses.

R108. It is advisable for ship chandlery service **to remain with private parties** as the SLPA should focus on core value added activities.

14.3.9 Fire Department

SLPA operates a fire department at Colombo port which is under the purview of the harbour master. Fire department provides services on land as well as for vessels. A fire department is an essential element at the port. The fire department for ports is not directly comparable with a city department due to the characteristics of various commodities. Hence, it is logical that the fire department is port specific. In other well-developed nations or for very small ports, the city fire department is so well organised that they also do the port firefighting (always with own department). However, the execution of an emergency plan always remains under final responsibility of the harbour master.

Observations

The fire department has a tug for firefighting and three fire engines. The department has 140 staff at present including 20 new recruits. Estimated time that it takes fire department staff to arrive the furthest end of the port is 8 minutes. The international norm to reach industry, for example in Europe is 10 minutes. Hence the current facility operates within the norm. It should be noted however that when South Port is further developed in future the firefighting department may have a be shifted and or split to keep similar response times. It goes without saying that North port development requires a own set-up as well.

In addition to attending emergency incidents, the department provides standby services for dangerous cargo handling, oil tankers and gas tankers, etc. Number of calls attended by the fire brigade of the SLPA are provided below.

Table 14-18: Demand for Fire department services

Description	Unit	2010*	2011	2012	2013	2014	2015	2016
Fire Response	Calls		15	5	14	14	10	32
Navy Rehearsal test calls	Calls		2	-	-	3	3	7
Emergency Calls	Calls		25	15	29	34	26	159
Stand By Duties For Oil Tankers	Calls		121	118	111	115	153	175
Stand By Duties For Gas Tankers	Calls		23	21	21	32	32	50
Stand By Duties For Hot Works On Vessels	Calls		1,486	1,071	1,309	57	908	705
Stand By Duties For D/C Handling	Calls		30	19	7	12	2	4
Supplying Water To Wash Piers/Warehouses Etc.	Calls		56	61	42	76	47	31
Pumping Out Water	Calls		33	18	12	1	2	3
Oil Pollution Control Work	Calls		2	3	7	117	22	17
Inspection Visits To Oil Tankers	Calls		807	728	621	143	646	675
Combined fire drills & Other	Calls		1	-	2	-		3
Total Calls	**Calls**	**1,800**	**2,601**	**2,059**	**2,175**	**604**	**1,851**	**1,861**

*For 2010, data is not available

Source: SLPA

The revenues earned by the port fire brigade from diverse services are as follows.

Table 14-19: Revenue earned from fire department services

	Unit	2010	2011	2012	2013	2014	2015	2016
Stand By Duties For Oil Tankers	USD	172,940	176,762	188,057	178,148	180,642	201,124	367,426
Stand By Duties For Gas Tankers	USD	25,280	26,060	26,060	27,520	24,300	41,628	69,360
Stand By Duties For Dangerous Cargo	USD	24,960	8,300	33,945*	39,161	5,780*	4,500	7,300
Charges For Inspection Visits	USD	860	8,700	18,060	7,340	8,260	8,080	8,100
Charges For Hot Work	USD	45,130	28,938	-	17,817	16,033	23,088	30,934
Fire calls	USD	19,487	2,550	-	6,090*	3,102*	-	158,465
Charges For Oil Pollution Control	USD	60,597	3,392	16,300*	4,275*	187,040*	94,026	26,234
Charges For Training Courses	USD	420	119	-	-	-	-	-
Charges for other emergencies								1,294
Total Revenue earned	**USD**	349,674	254,821	282,422	280,351	425,157	372,446	669,113

*Income earned in local currencies converted in to USD using annual average exchange rate

Source: SLPA

It could be observed that the revenue has significantly increased during 2016 compared to 2015 which is a growth of 80%. It was mainly attributable to the increase in revenue from stand by duties for oil tankers and fire calls. Cumulative annual growth rate recorded over the last 7 years stood at 11%.

Recommendations for the port of Colombo

R109. should be strengthen with adequate number of **firing engines and staff** considering the development of more terminals at Colombo Port and expected increase in oil tankers of LPG & LNG.

R110. **Fire department** service should continue to be provided by SLPA as an **essential service** under harbour master control.

R111. It is recommended to **financially monitor fire division** as an identified business segment of SLPA with separately tracking of revenue and costs.

R112. Due to the continuing expansion and changing of Colombo port, the **emergency response plan** should be updated.

14.3.10 Medical Services

There is a hospital in Colombo fully financed and operated by SLPA which started more than 20 years ago. The assets are on SLPA's balance sheet and the employees, including doctors, are on SLPA payroll. The medical division within port of Colombo provides OPD services, dental services and minor accident surgeries. The division provides services only for port employees. However, minor accidents of any port user also attended by the division.

Observations

The division has eight bedded wards and four ambulances. It caters to about 150 patients per day. All services to the employees are provided at free of charge. Staff composition of the division is as follows.

Table 14-20: Staff at Medical Centre

Category	#
Doctors	6
Nurses	2
Pharmacists	3
Dispensers	5
Nursing aids	26
X-ray operator	1
Radiogram	1
Drivers	13
Administration	6
Work assistants	9

Source: SLPA

Division provides 24 hours service under three shifts. Improvement needs of the division includes the need of recruiting three more permanent doctors to the staff. The following table shows the number of patients attended by the division from 2011-2016

Table 14-21: Demand for medical services

	Unit	2011	2012	2013	2014	2015	2016
No of patients attended	Patients	32,428	35,901	31,862	31,060	33,439	31,276
No of Employees	Employees	72	66	63	61	63	68
Expenses Incurred	**LKR**	13,527,447	15,818,969	16,998,564	18,908,849	18,111,000	20,646,603

Source: SLPA

Average number of patients catered during 2011-2016 stood at 33,000. Medical division has used 66 employees in average to cater its services. Annual expenses incurred have been increased at a CAGR of 9% over the same period.

It is rather uncommon to still have a port hospital which is for all port personnel and still under responsibility of the Port Authority. In other countries, the hospital is privatised whilst still offering services to employees but only in a limited setting. The port authority, as employer, does not pay for services and the employees can choose which health care they like to take. In a transition period, often the Port Hospital offers packages of health care to port employees at interesting discounts.

Health care is important for employees of the SLPA. However, it is today uncommon to run a hospital under the umbrella of the Port Authority. It is advisable that the port authority outsources the social health care of its employees to private or public/private Hospitals. In that case the hospital becomes a concession within the Port of Colombo. It should be noted that a medical centre (whether run by private sector or not) remains an important asset within the port unless the hospital can be located very near to the port.

Recommendations for the port of Colombo

R113. It is recommended that port authority should consider **outsourcing medical services** to private/public entity to focus on more value added activities.

14.3.11 Financial Services

Banking services are provided by Bank of Ceylon, Peoples Bank, Hatton National Bank and Samapath Bank at port of Colombo.

Observations

Three premises on free of rent basis have been given to the Bank of Ceylon with the approval of the management to maintain cash collection centres for the payments to be made to the authority depending on the requirements of the Authority. These premises are situated in the permit office, canal yard and Peliyagoda warehouse complex. Routine banking activities are not carried out within these centres and except for banking activities for port users. The salaries of port employees can be obtained from banks and banking activities are maintained within the port premises for the welfare of the employees.

These banks are only used by port users and by the employees of the authority. Accordingly, 02 premises where ATM machines of the Hatton National Bank and one premise maintained by the Bank of Ceylon has been given on nominal rent.

Banks should be an integral part of the logistical chain. Many elements of today's transactions still depend on manual and paper transactions. In future, the electronic transfer and electronic payment notification should prevail allowing cargo to be smoothly released without delays on related to financial unclarities or disputes.

Even though digital payment should prevail it is expected that Banks near custom inspection areas, and warehouses are still required to facilitate a transaction should electronic payments fail.

Recommendations for the port of Colombo

R114. SLPA should promote **electronic payments** among port users by providing required platforms.

14.3.12 Seamen Club

A seamen's club offers crews of international vessels to leave the ship and stay at the club. It is often a designated location within the port. At present a seamen club is operated by Mission to Seafarers a private party outside the port. SLPA only provides permission to seafarers and family members to visit the port.

Recommendations for the port of Colombo

R115. It is advisable for the **seamen club** activities to remain operated by private suppliers.

14.4 Benchmark of Colombo World Ports

14.4.1 Introduction

This analysis compares Colombo port to other hub or excelling ports to gain insight in how to boost the Colombo port cluster. The analysis is based on four main topics:

1. **Shipping Functions** – Which shipping facilities and activities are there in the port?
2. **Logistics and Industries** – What logistics and industries are there to support the port?
3. **Maritime Community and Finance** – How does the port community function?
4. **Attractiveness and Competitiveness** – Which policy schemes and physical connections are there to support the port?

The Colombo hub is compared to several ports with different characteristics:

- **Singapore** – As a global leading hub port
- **Tanjung Pelepas** – As a competitor of Colombo
- **Rotterdam** – As an example of large European port
- **Tangier** – As a transhipment hub
- **Athens** – As a transhipment hub

Each topic will have a list of (auxiliary) functions and descriptive. This will give an indication on which terrains Colombo can improve as a hub. Please note that this is still a long list for discussion with SLPA. The discussion will lead to a qualitive analysis on a selected number of topics which will yield concise recommendations for SLPA.

14.4.2 Shipping Functions

Shipping function of course form the basis for the maritime operations in a port. High quality facilities and world class facilitators can attract more business to the port. The following aspects are highlighted when reviewing the shipping function of Colombo port to the other ports:

- The number of shipowners is very limited also due to the limited national registry. Flag state control and port state control are provided through the Merchant Shipping Secretariat (MSS).
- In Sri Lanka there are no or limited ship managers registered.
- Bunkering is provided as a basic service in most ports but real hub ports such as Singapore and Rotterdam have become large bunkering ports. Note that from a (bulk) shipping perspective a discharge port is often more attractive than a port in the loading region.
- Bunkering of LNG has become a new feature at bunker ports.
- Cruise cluster is more oriented to touristic values in combination with airport proximity than to container hub ports
- Life rescue and emergency response units including heavy offshore tugs are welcome in large ports. The long distance between ports make it attractive also for Sri Lanka.

Table 14-22: Shipping Functions Characteristics

Item	Specification	Colombo	Singapore	Tanjung Pelepas	Rotterdam	Tangier	Athens
# shipping agents		Yes	Yes	Yes	Yes	Yes	Yes
# shipowners		No	Large	Limited	Large	Limited	Large

Item	Specification	Colombo	Singapore	Tanjung Pelepas	Rotterdam	Tangier	Athens
Flag state	# national flag registry	Limited	Yes	No	Yes	No	Yes
Shipowners society		No	Yes	No	Yes	No	Yes
Ship management companies		No	Yes	No	Yes	No	Yes
Bunkering	MDO, HFO, GO	Limited	Large	Limited	Large	Limited	Yes
Bunkering LNG	LNG	No	No	No	Yes	Yes	Yes
Cruise Cluster		No	Yes	No	Yes	No	Yes
Life rescue response unit		Limited	Yes	Yes	Yes	No	Yes
Offshore/heavy ship response unit		Limited	Yes	No	Yes	No	Yes
Fast crew response units		Yes	Yes	Yes	Yes	Yes	Yes
# Ship chandlery		Limited	Yes	Limited	Yes	Limited	Yes

Source: MTBS

14.4.3 Logistics and Industries

Large ports often have a main industry and specialisation or/and a logistics cluster attached. Logistics clusters boost port efficiencies and large industries boost port throughput. The following aspects are highlighted when reviewing the logistics and industries of Colombo port to the other ports:

- Warehousing at dry ports is a common feature for hub ports The CFS (container freight station) or distri-parks (cluster area with distribution centres) are located in the proximity of the quay. Sri Lanka has scattered dry ports in the city and no distri-parks inside the port boundary due to space limitations.
- Container maintenance and repair is offered in large (hub) ports. Colombo is lacking these facilities.
- Heavy industry, many large ports have a dedicated heavy industry such as refineries/chemical installations, power stations or steel factories. Colombo refinery industries have been surrounded by city developments. Due to the proximity of the city is it also not well located for new industries. Hambantota can be considered as the promising industrial port in Sri Lanka.
- Medium industry at port is often provided through (re)processing of commodities and semi-finished goods. A good example is the Prima Flour plant in Trincomalee. Colombo is lacking such facilities due to the space constraints in the port and the proximity to the city.
- Light industry, The prime examples are found in the logistic industry where packaging and labelling or other light processes are done to finished products. It would also encompass for example the handling of refrigerated or cold foods to pack and re-transport. The light industry is also the garment industry which an important industry for Sri Lanka (like in several surrounding nations)
- Offshore repair cluster. This cluster very much depending on the proximity to oil and gas fields. However several ports in the world have seen the development of Offshore supply basis. This consists of terrains on which offshore companies assemble or even manufacture pipelines, repair oil platforms and other appliances used in the offshore industry. Ports In Sri Lanka do currently not have such activity.

Table 14-23: Logistics and Industries Characteristics

Item	Specification	Colombo	Singapore	Tanjung Pelepas	Rotterdam	Tangier	Athens
Warehousing (CFS) at dry ports		limited	Yes	Yes	Yes	limited	Limited
Container maintenance & repair		No	Yes	Yes	Yes	No	No
Empty depots at port		No	Yes	Yes	Yes	Yes	No
Heavy industry	Chemical cluster, steel cluster	No	Yes	No	Yes	No	No
Medium industry	Processing, manufacturing cluster	No	Yes	No	Yes	No	Limited
Light industry	Logistic cluster	No	Yes	Yes	Yes	Yes	Limited
	Food cluster	No	Yes	No	Yes	No	Limited
	Automotive cluster	No	Yes	No	Yes	No	Yes
Offshore support cluster		No	Yes	No	Yes	No	Yes

Source: MTBS

14.4.4 Maritime Community and Finance

World class parties as well as active local companies and financiers make for an attractive port environment boosting investments and activity. The following aspects are highlighted when reviewing the maritime community and finance of Colombo port to the other ports:

- The maritime society often also consists by the presence of the navy. Several larger port in the world don have their navy at other dedicated (small) ports
- Ship newbuilding is an industry which is often carried out at large ports. Asian countries like Japan, South Korea and China have become the largest shipbuilding nations with dedicated ports as “newbuilding shipyards”. Today the newbuilding segment faces oversupply due to the massive entrance of Chinese dock yards over the last two decades.
- Ship repair originated from history at many commercial ports to offer dry docks to support the repair of their own vessels and to offer repair services to foreign flag ships. Today the ship repair industry is characterised by private companies which often have also become regional or even global players. Colombo dock yard is a still a local player. Hambantota is also earmarked to attract the ship repair industry in later phases of the port development
- Financial services and insurance in the maritime industry are clustered around the financial centres in the world. London, Singapore, Rotterdam, Oslo all have dedicated shipping banks and insurance companies. The development of such financial infrastructure has also been subject to a number of Chinese ports such as Shanghai.
- Classification societies are often also centred around maritime cities such as London, Singapore, Hamburg, Oslo and Rotterdam. A nation without a flag state is most often not able to attract these classification societies, other than agencies of same.

Table 14-24: Maritime Community and Finance Characteristics

Item	Specification	Colombo	Singapore	Tanjung Pelepas	Rotterdam	Tangier	Athens
Navy Cluster		Yes	Yes	No	No	No	Yes
Marinas		No	No	No		No	Yes
Ship newbuilding	Newbuilding docks available	No	No	No	Yes	No	No
Ship repair	Repair docks available	Yes	Yes	No	Yes	No	Yes
Maritime training Centre	STCW	Yes	Yes	No	Yes	No	Yes
	Maritime University	No	Yes	No	Yes	No	Yes
Financial services	Shipping trading & chartering	No	Yes	No	Yes	No	Yes
	Shipping finance	No	Yes	No	Yes	No	Yes
	Large shipping banks	No	Yes	No	Yes	No	Yes
	Hull insurance	No	Yes	No	Yes	No	Yes
	P&I clubs	Limited	Yes	Limited	Yes	No	Yes
Classification society	Ship classification	Limited	Large	No	Large	No	Yes
International Organisation agencies	IMO, SOLAS, UNCTAD etc.	No	Yes	No	Yes	No	Yes

Source: MTBS

14.4.5 Attractiveness and Competitiveness

The regulatory environment and the policy facilities available are an important aspect of attracting investments. As well as regional connections. The following aspects are highlighted when reviewing the maritime community and finance of Colombo port to the other ports:

- Free trade zones have become an important feature at logistics hub ports worldwide. The Sri Lankan free trade zone policy is not adequate in this respect.
- Tax incentives should attract manufacturer and industries and forms a basis for ability to attract foreign direct investments. Most ports (through governmental tax regimes with trading nations) specialise into those products especially due to the tax advantages.
- Logistic performance index. This index prepared by the World Bank shows the ease of doing logistics in the country. Sri Lanka scores low on this ranking mainly due to road congestion and poor accessibility to hinterlands.
- Ease of doing business. This is a ranking from the World Bank to summarize the ease of doing business. It includes customs bottlenecks and bureaucracy in general. Sri Lanka is marked very low compared to other nations.

- Hinterland connections contribute to an efficient and large port.
- Airport proximity is important to create the port – airport relationship. This is very important for the cruise industry, the navy and for time sensitive products.

Table 14-25: Attractiveness and Competitiveness Characteristics

Item	Specification	Colombo	Singapore	Tanjung Pelepas	Rotterdam	Tangier	Athens
Free trade zones		No	Yes	Yes	No	Yes	Yes
Tax Incentive free trade zones		Yes	Yes	Yes	Yes	Yes	Yes
Logistics performance index: Efficiency of customs clearance process	1= Low, 5=High	2.5	4.2	3.1	4.1	2.2	2.9
Ease of doing business	Ranking per country; 1 = highest	110	2	23	28	68	61
Physical Hub port?		Yes	Yes	Yes	Yes	Yes	Yes
Hinterland connections		Limited	Limited	Limited	Yes	Limited	Yes
Strong regional connections		Yes	Yes	Yes	Yes	Yes	Yes
Airport nearby		Yes	Yes	No	limited	limited	limited

Source: MTBS

14.4.6 Recommendations

R116. Port of Colombo lacks development space for **distribution centres and logistics**. This is either to be found in several sections North of Colombo (but preferably one) or at reclaimed land as part of north port development.

R117. Port of Colombo has to cater for new industries like the new **LNG powerplant**

R118. **Bunkering** is an auxiliary function which hold promises for the future. The port should prepare to offer this in a liquid bulk hub.

R119. Port of Colombo should be part of a **national unit which offer emergency response** and salvage through supplying heavy offshore tugs.

R120. The Sri Lankan **free trade zone policy** is not adequate, and should upgraded in this respect.

R121. **Tax incentives** are provided to new industries and port zones but a one-stop shop for FDI is required.

R122. Through **investments in the logistics chain** and port accessibility, Sri Lanka should move up in the ranking of the World Bank Logistic performance index.

R123. **Ease of doing business**. This is a ranking from the World Bank to summarize the ease of doing business. It includes customs bottlenecks and bureaucracy in general. Sri Lanka is to upgrade its position through implementing trade facilitation policies and a Single Window.

R124. The **airport to sea function** should be promoted to attract additional cruise vessels.

14.5 Way Forward SLPA and Auxiliary Functions

The table below indicates the auxiliary functions in the port of Colombo and what the role of SLPA should be in each function. This is a clear recommendation on the role of SLPA outlined in the previous paragraphs.

Table 14-26: Auxiliary Functions Recommendation

Auxiliary function	Availability in Colombo	Current Operations	SLPA Future Operations?	Main considerations
Tugs & Pilotage	✓	SLPA	✓	Maintenance outsourcing
Linesman & Mooring	✓	SLPA / 3rd Party	⦸	Private sector
Bunkering	✓	3rd Party	⦸	Best operated by private sector
Water Supply	✓	SLPA	⦸ ✓	Investments needed on barges & pumping capacity
Weighing and Scanning Facilities	✓	3rd Party	⦸	Customs & private operators
Warehousing and CFS	✓	SLPA	⦸	Competition from private sector
Maintenance workshops	✓	SLPA	✓	As long as demand exists
Logistic Zones & Dry Ports	✓	3rd Party	⦸	SLPA not as operator but as land lord
Ship Repair Yards	✓	3rd Party	⦸	Outsource as much as possible
Container Maintenance and Repair	✓	3rd Party	⦸	Private sector
Ship Registration & Classification	✓	SLPA	✓	SLPA to invest in VTMS and databases
Training Centre	✓	SLPA	⦸	Should operate as a standalone entity, SLPA remains as main stakeholder
Fishery Port	✓	Min. of Fish	⦸	Private sector, ministry of fishing
Marinas		3rd Party	⦸	Private sector
Licensing	✓	SLPA	✓	Future need less, open port boundary, secured terminal areas
Ship Chandlery	✓	3rd Party	⦸	Private sector
Fire Department	✓	SLPA	✓	Under harbour master's control
Medical Services	✓	SLPA	⦸	Merge with public medical institution
Financial Services	✓	3rd Party	⦸	Private sector
Seamen club	✓	3rd Party	✓	Private sector
Ballast Water Treatment		-	⦸	SLPA should facilitate

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Part D: Project Identification and Selection

15 Project Identification for Pre-feasibility

15.1 Introduction

This chapter outlines the selection of the short-term priority projects to the pre-feasibility phase. For pre-feasibility three high level studies are performed:

- Financial feasibility
- Economic feasibility; and
- Environmental and social impact analysis.

The 6 projects selected for pre-feasibility are:

1. JCT Modernisation Plan
2. (F)LNG Handling and Storage Facility
3. Dedicated Passenger Terminal on BQ
4. Port Community System
5. BQ Warehousing Relocation Plan
6. PVQ Upgrade Plan

The port community system and PVQ upgrade plan are plans which need to be evaluated on an operational level with in depth recommendations. SLPA has requested to focus the prefeasibility study of these two projects on the operational and technical level instead of the financial level.

Reading guide

The selection process is done through an analysis method outlined in section 15.2. The results of the scoring process are presented in section 0.

15.2 Selection Methodology

In the figure below an overview is given of the numbers involved in the selection process. The 39 issues are displayed in paragraph 3.2. The port issues are identified based on:

- Site visits and observations
- Desk Research
- Stakeholder consultations

ADB

Technical Assistance Consultant's Report

Project Number: 50184-001
February 2020

Democratic Socialist Republic of Sri Lanka: National Port Master Plan

(Financed by the Japan Fund for Poverty Reduction)

The Colombo Port Development Plan – Volume 2 (Part 5)

Prepared by

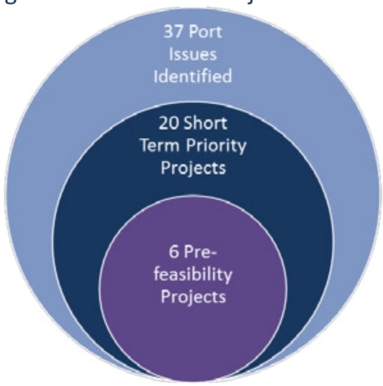
Maritime & Transport Business Solutions B.V. (MTBS)

Rotterdam, The Netherlands

For Sri Lanka Ports Authority

Asian Development Bank

Figure 15-1: Overview Project Numbers



Source: MTBS

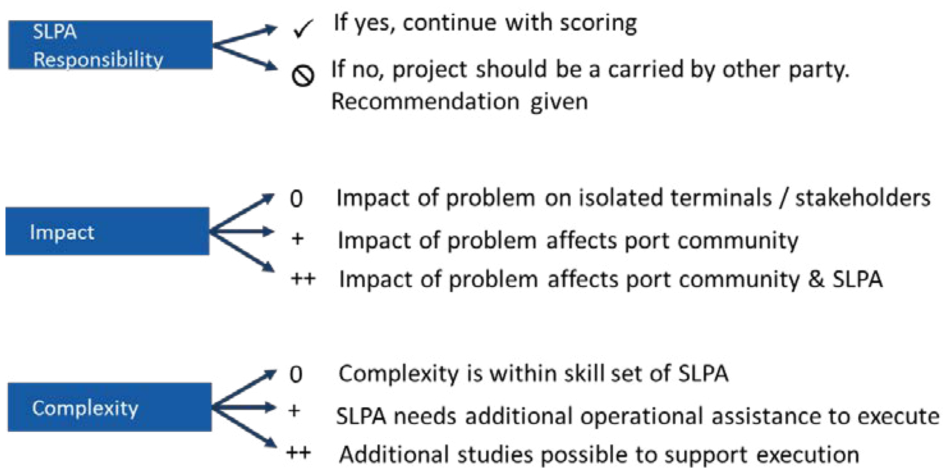
The short-term priority projects are identified then on the basis of:

- The severity of the issue
- Low / Medium / High
- Short term means <10 years

These 20 projects are then scored on the basis of:

- Whether or not it is a SLPA responsibility
- The complexity; and
- The impact

Figure 15-2: Explanation scoring



Source: MTBS

A minimum score of three is needed to be selected. As displayed in diagram below.

Figure 15-3: Selection Threshold

0	No Selection	✖
+	No Selection	✖
++	No Selection	✖
+++	Selection	✓
++++	Selection	✓

Source: MTBS

15.3 Selection Results Short Term Priority Projects

Based on the selection criteria's the following 6 projects were selected as Short Term Priority Projects:

1. JCT Modernisation Plan
2. PVQ Upgrade Plan
3. (F)LNG Handling and Storage Facility
4. Dedicated Passenger Terminal on BQ
5. Port Community System
6. BQ Warehousing Relocation Plan

The table below displays the selection evaluation:

Table 15-1: Scoring Short Term Priority Projects

Nr.	Short Term Priority Projects	SLPA Responsibility	Impact	Complexity	Score
	Cargo Operations				
SP1	**JCT Modernisation Plan**	✓	++	++	++++
SP2	Dedicated berth for grains and cement	✓	0	+	+
SP3	**PVQ Upgrade Plan**	✓	++	+	+++
SP4	Sapugaskanda oil refinery	⦸ **CPC**			
SP5	**(F)LNG Handling and Storage Facility**	✓	+	++	+++
SP6	UCT Transformation Plan	✓	0	+	+
SP7	**Dedicated Passenger Terminal on BQ**	✓	++	++	++++
SP8	Port Gate Upgrade Plan	✓	+	+	++
	Warehousing				
SP9	**BQ Warehousing Relocation Plan**	✓	++	+	+++
SP10	Relocation Mechanical and electric workshops	✓	0	+	+
SP11	The resettlement of underutilised buildings	✓	0	+	+
	Hinterland Connectivity				

Nr.	Short Term Priority Projects	SLPA Responsibility	Impact	Complexity	Score
SP12	Port road plan (widening & upgrading)	✓	+	+	++
SP13	Port Gate Automation	✓	+	+	++
SP14	PAEH Simulations	⃠ **RDA**			
SP15	PAEH Development	✓	+	+	++
SP16	Securing Future Rail Path to South Harbour	+	0	+	+
	IT				
SP17	**Port Community System**	✓	**++**	**++**	**++++**

Source: MTBS

16 Pre-Feasibility Studies

16.1 Introduction

This chapter presents the financial and economic pre-feasibility studies for the selected projects, as well as the preliminary environmental and social impact assessment.

Selected Projects
The 5 Colombo projects selected for pre-feasibility are:

1. JCT Modernisation Plan
2. (F)LNG Handling and Storage Facility
3. *Port Community System*
4. BQ Warehousing Relocation Plan
5. PVQ Upgrade Plan

The passenger terminal has been delivered in a separate document. The port community system and PVQ upgrade plan are plans which need to be evaluated on an operational level with in depth recommendations. SLPA has requested to focus the prefeasibility study of these two projects on the operational and technical level instead of the financial level.

In paragraph 17.2 the methodology is explained as well as the objective, framework, methods approach and basic assumptions.
In paragraph 17.3 the results are displayed, basically showing both financial and economic viability for JCT Modernization Plan, (F) LNG handling and Storage Facility and the BQ Warehousing Relocation Plan. The PVQ plan is not considered financially viable nor economically viable.

16.2 Methodology

16.2.1 Objective

The objective is to indicate whether or not the identified projects are viable from a financial, economic and social and environmental perspective.

As a rule, it is recommended to implement a project, if it is economically viable. The financial viability determines whether or not government and/or public In case it is also financially viable, then there is no need for government subsidy.

Economically viable	Financially Viable	Recommendation
✓	✓	• Implement the project • Project generates sufficient return to recover the investments
✓	✗	• Implement the project • Government/SLPA subsidy is needed or the tariffs should be redefined to make the project financially feasible as well
✗	✗	• Don't implement the project

Economically viable	Financially Viable	Recommendation
		• It is very unlikely that a project is feasible
×	✓	• Don't implement the project • This is a very unlikely scenario[1)]

1) It could be financially viable and economically not, if developing a project leads to a shift in volumes. In that case the project generates revenues that are a loss for a different project within the same economy. Another possibility for this scenario could be severe negative environmental or social impacts.

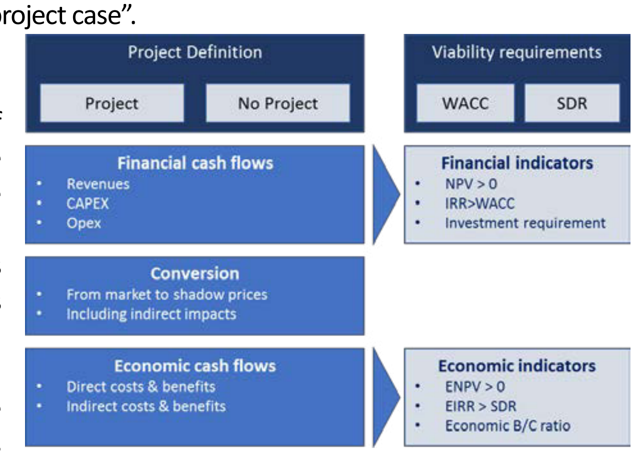
16.2.2 Framework for the Studies

The basic set-up or framework for the studies is as follows.

1. **Background to the Project** – A description of the priority project in general, initial observations and the problem and bottlenecks to be solved.
2. **Supporting Analyses** – This analysis differs per pre-feasibility. The JCT modernisation plan will need a thorough operational analysis whereas the BQ warehousing relocation plan needs a location analysis.
3. **Project Scope -** A clear and concise definition of project scope as input for the financial, economic and environmental analyses
4. **Financial Pre-Feasibility** – A high-level financial pre-feasibility assessment resulting in project NPV and IRR.
5. **Economic Cost-Benefit Analysis** – A high-level economic benefit analysis resulting in economic NPV and IRR.
6. **Environmental and Social Impact Analysis** – A high-level ESIA resulting in mitigation measures for the environmental and social impact of the project.

16.2.3 Approach to Prefeasibility

The general approach to the financial and economic prefeasibility is visualised in the following figure.



- Starting point is the **definition of the project**. Since SLPA has the choice to implement a project or not, the project case should be compared with the "no project case".
- Secondly, one should understand, when a project is deemed to be viable. For the financial pre-feasibility, the weighted average costs of capital (WACC) is relevant as hurdle rate. For the economic prefeasibility the social discount rate (SDR) is considered as hurdle rate.
- Then, the **financial cash flows**: investments (capex), revenues and operational expenditures (opex) are defined to arrive at a project free cash flow.
- This project free cash flow is used to calculate the **financial indicators**. The project is considered to be financially viable, in case the internal rate of return (IRR) exceeds the WACC. In that case the net present value (NPV), the sum of the discounted expected free cash flows, is positive. If the project is financially feasible, it is recommended to implement the project. The funding requirement is added to indicate the budget that is needed to implement the project.

- The financial cash flows, which are based on market prices, are **converted** into economic cash flows, based on shadow prices.
- The conversion results in **economic cash flows**. Indirect costs and benefits are added. Those can include quantified social and environmental impacts.
- These **economic indicators**, based on the economic free cash flows eventually indicate whether the project is considered viable from an economic point of view. This is the case, ir the economic internal rate of return (eIRR) exceeds the SDR. In that case, the economic net present value (ENPV) is larger than zero and the economic benefit – cost ration exceeds one.

16.2.4 Basic Assumptions

Considering the pre-feasibility character of the analyses, some basis assumptions are applied to all analyses. The following table summarises some key assumptions applied here.

Item	Value	Comment
FINANCIAL		
Perspective	SLPA	The port projects are typically part of broader project plans. For the financial analysis, SLPA's perspective is taken as a basis.
WACC SLPA	10%	No official WACC or hurdle rate for financial viability is known.
Inflation	-	As a pre-feasibility analysis, the model is in real terms
Currency	USD	
Sri Lanka Rupee exchange rate / USD	153.4	Per 1st of December 2017
Tax Rate	10%	According to the SLPA's Financial statements: • Operational profits from port operations are exempt (Inland Revenue Act) • The subsidiary company is liable for the tax at 10% • For other sources of income, the tax rate is 28%.
Modelling period	2018-2050	
Basis for revenues	SLPA tariff book SLPA financial report	
ECONOMIC		
Perspective	Sri Lanka	
Social Discount Rate	7.8%	Based on calculation: r = e*g + p • e: elasticity of marginal social welfare with respect to public expenditure: 1.5 (estimate, typically between 1 and 2) • g: expected per capita consumption growth: 4.35% (IMF projection real GDP per capita growth) • p: pure tie preference: 1.3 (empirical studies)

Item	Value	Comment
Conversion factor CAPEX:	1.0	No evidence for market distortions. It is likely that an important part is to be imported. In that case, the “border prices are to be applied.
Conversion factor OPEX:		
• Fuel, maintenance, insurance	1.0	No evidence for market distortions.
• Labour	0.85	Based on an average income tax of 15%
Conversion factor Revenues:	> tariff WTP	“Willingness to Pay” The applied tariffs are based on the tariff book and not on market efficiency. For the ECBA, the “Willingness to Pay” (WTP) is relevant as revenues. The applicable official tariff is a lower limit of this WTP (else the volumes wouldn’t come with these tariffs). If the project – with the official tariffs is already economically viable, then it is not needed to estimate the higher WTP. Else, an estimate will be made on a case-by-case basis.
Allocation factor	1.0	All economic costs and benefits are in principle allocated to Sri Lanka. Only for external impacts, with foreign businesses, the allocation factor may become less than one (between 1 and 0)

16.3 Results

The results from the prefeasibility studies are displayed in the table below. The JCT Modernisation plan, the (F)LNG project and the BQ Warehouse relocation plan are both financially feasible and economically feasible. The PVQ Upgrade plan is considered not feasible.

Table 16-1: Results & Recommendation Pre-feasibility

Project	Financial Feasibility		Economic Feasibility		Recommendation
JCT Modernisation	✓	NPV 40.3 M USD IRR: 16.2%	✓	ENPV USD 88.8 M USD ERR: 20.8%	Implement Project
LNG Jetty	✓	NPV 0 USD IRR: 10.0%	✓	ENPV: USD 1.8 B USD ERR: 529%	Implement Project
BQ Warehousing Relocation	✓	NPV 2.5 M USD IRR: 11.8%	✓	ENPV 15,9 M USD ERR: 16.4%	Implement Project
PVQ Upgrade	✗	NPV -11.05 M USD IRR: N/A	✗	ENPV: -2.53 M USD ERR: 5.99%	Do not implement project

17 JCT Modernisation Plan

17.1 Background to the Project

The Jaya Container Terminal (JCT) is one of the largest container terminals in the port of Colombo in terms of capacity, with a design capacity of 2.45 M TEU per annum. The table below provides an overview of the facilities at the terminal, as well as historic throughput figures.

The following key observations can be made regarding JCT's facilities and throughput:

- Container volumes have increased from 1.5 M TEU in 2005 to 2.1 M TEU in 2015.
- The bend in the JCT's quay wall hampers simultaneous berthing of 2 large vessels at JCT III and JCT IV, as quay length of JCT III and IV combined is 660m.
- The JCT III and IV berths have a water depth of approximately CD -15.0m, which is insufficient to handle the largest container vessels. Water depth cannot be improved due to the quay wall structure. The JCT I and II berths have an even more restrictive water depth of approximately CD -12 to -13.0m.
- Container handling equipment is outdated, with the majority of quay cranes being 20 to 30 years old.
- JCT has a terminal depth of approximately 300m, which is considered only marginally adequate.
- The bended quay wall limits the flexibility to berth vessels. To build a new quay wall in front will be very costly and challenging during construction time, in that case the full old basin should be deepened to cater for larger vessels, quay wall rehabilitated and the basin entrance, turning circle and entrance channel adjusted accordingly.

The JCT terminal needs an upgrade to at least survive another 10-15 years in the challenging market. This project is focussed around berth optimisation and the lifetime extension of the terminal considering existing lay-out of the old basin . The project is initiated to keep JCT at acceptable levels of operating, increase flexibility to handle large container vessels and to enable JCT to cope with competition. The project will lengthen the terminal lifetime in a period in which Port of Colombo requires the container terminal capacities as demand for the facilities remain strong in the future.[7]

17.2 JCT Quay Extension

17.2.1 Existing Infrastructure

At the south end of Berth no. 4, it has been proposed to extend the container quay across the adjacent basin. The length of the quay extension will be approximately 120m. With this extension, no access for vessels to Feeder Berth and JCT Cross Berth on the opposite side of basin will be possible any longer. In effect this is a loss of 180m Feeder berth and 190m Cross berth. The latter is merely used for berthing of ships which do not handle cargo.

It is assumed that the basin at the back of the new quay will be filled and used as stacking area.

[7] A more detailed analysis of JCT (re)development options has been conducted, as part of a separate assignment. The options discussed in the "JCT deepening" report are variations on the JCT (re)development option discussed in this section. However, none of the proposed solutions for JCT (re)development were selected as the preferred solution.

Figure 17-1: JCT Berth 4 - Corner Looking South

17.2.2 Technical Observations

During the site visit it was observed that the corner section of the existing quay (assumed to be the corner caisson) has experienced some movement. This movement resulted in a vertical gap of approximately 5cm width across the apron. The water table could be seen through the gap.

Apparently, the STS-cranes do not actually enter the corner section. But in the future, they will have to move across this section for access to the proposed new quay extension. Further investigation of the problem is recommended.

Figure 17-2: Gap at Corner Section

17.2.3 Proposed Development

In the event that the basin behind the quay extension shall be backfilled and paved for stacking of containers the new quay shall be designed as a closed structure (caissons or equivalent) of sufficient capacity to carry container cranes.

17.2.4 Cost Estimates Quay Extension and Back Fill

Table 17-1: Cost Estimates Quay Extension and Back Fill

HP	PO	UP		Unit	Quantity	Rate (USD)	Cost (USD)
04			**JCT Quay Extension**				
	01		**Quay Structure**				
		01	New quay	m	125	45,000.00	5,625,000.00
		02	Quay equipment	m	125	1,800.00	225,000.00
		03	Crane rails	m	260	800.00	208,000.00
		04	Crane accessories	Sum	1	500,000.00	500,000.00
	02		**Other Works**				
		01	Dredging (-15m)	m^3	75,000	20.00	1,500,000.00
		02	Reclamation	m^3	225,000	6.00	1,350,000.00
		03	Pavement	m^2	28,000	90.00	2,520,000.00
		04	Utilities	Sum	1	1,000,000.00	1,000,000.00
	02		Subtotal				12,928,000.00
	03		Site installation costs	10%			1,292,800.00
	04		Planning and design	5%			646,400.00
	05		Contingencies	15%			1,939,200.00
							16,806,400.00

17.2.5 Proposed Operational Upgrades

- RTG upgrade
  In case additional RTGs will be required in the future, it is worthwhile to invest in a larger type of equipment, capable of stacking 1-over-6 high (41t), instead of the current 1-over-5 machines. This can increase the yard capacity of the JCT terminal with almost 20% under the condition that the terminal pavement allows for stacking of one additional layer. During the procurement process of new RTGs, it is recommended to opt for electric driven units, which require less maintenance and are much more environmental friendly. Electrification of the equipment fleet requires some additional investments in civil infrastructure to provide electrical power to the machines.

- <u>TOS system upgrade</u>
  It is recommended to upgrade as quick as possible from the current 'outdated' terminal operating system Navis 3.7 version to the 'state-of-the-art' version N4 of the same supplier. This will enhance the terminal operations as well as the gate processes and the communication interfaces to the outer world: consignees, agents, shipping lines, port authority, customs, through automatic notifications, etc. This should also interlink with the port community system. While the conversion of a terminal operating system has a thorough impact on the ongoing terminal operations, it is of upmost importance to assign a dedicated team for this project. The new system will be utilised to its maximum including: OCR, Yard optimisation, distance to quay, equipment allocation, equipment availability, MIS reporting package, real-team operations dashboard and information, link to billing and financial central system.

- <u>Operators per equipment</u>
  Current shift system can be compared to the other operators. SLPA uses two operators for most types of container hanlding equipment; this compares to 1.3 or 1.7 operators per equipment in other terminals. A cost reduction could be made here without impacting the productivity.

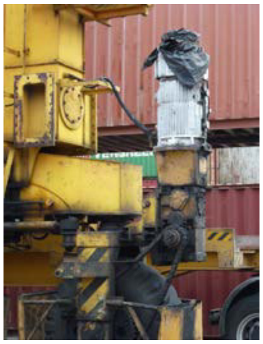
- <u>Shift system</u>
  SLPA works in a shift from approx. 12 hours (07:00 – 18:00 day shift) - (17:30 to 07:00 nigth shift). Overlap within the shift change is not uniform. In many international cases container terminal operators have preferred a 3 * 8 hours system. This results in less labour force once a different roster scheme is applied.

- <u>Labour Unions</u>
  The labour unions in the Port of Colombo are strong, impacting the flexibility to change shift systems or to reduce labour. It is noteworthy that CICT has been set-up without labour unions. Some other major container ports in the world have organised a common labour pool for all terminal in their ports. This has resulted in more effective labour utilisation and less workers. In the case of Port of Colombo it is noted that with a mixture of private and public terminals the labour pool can not easily be implemented.

- <u>Yard behind new quay extension</u>
  Ideally the stack should be placed at the back of the new quay. Technical issues are the settlement of soil (solutions for quick settlements are also available in the international markets) which takes time before the yard can be constructed. Having the stacking yard there would allow operations to optimise the distance between stack and ship operations. It is understood however that SLPA will not develop the yard in this section as overall yard area is sufficient.

- <u>Equipment maintenance.</u> No computerised maintenance management system (CMMS) is in place and new systems should be evaluated to optimise preventive maintenance and corrective maintenance as well as spare part management, job work planning and availability of equipment. A well-known and accepted key performance indicator for the maintenance is the MMBF, mean moves between failure to monitor the status of the equipment. It is important to note that ordering of spare parts should not be hindered by budget constraints especially when the equipment is vital for the operations. Currently there is imbalance between the number of units under repair and the optimum available equipment.

Figure 17-3: Maintenance issues



- <u>Communication in operations</u>
  The new TOS system will improve communication between all container handling equipment in operation through wireless communication. This compares to today's situation with VHF (radio post).

- <u>Interterminal traffic</u>
  The interterminal traffic is very important for the Port of Colombo Transhipment hub. The ITT traffic is around 3000 movements per day. Today the transport is outsourced but the level of quality and availability of trucks is questionable. The service level agreements should be readdressed. It needs a thorough assessment aiming for more efficient container transport guided by an automated data exchange system. SLPA should take the initiative on this issue. This traffic should have easy terminal gate procedures and should not be hampered by queues on the main road. Special lanes are suggested. Charging the Shipping line should be reduced to the minimum and mostly recovered by port dues. It is important to have full digitalised booking system between and within terminals for quick movement of ITT. The inter terminal traffic is considered part of the services in a transhipment hub.

- <u>OOG cargo</u>
  Out of Gauge cargo needs to be located at designated areas which do not interfere with main operations. New areas may be found after the review of yard optimisation and demolishment of buildings.

- <u>Safety and environment</u>
  The international safety procedures on Occupational Health and Safety have to be applied. Personal protection equipment (PPE) like helmets and safety jackets as well as safety shoes are required. The following international dock workers regulations are relevant in all SLPA terminals;
  For container terminals:
  - International Labour Organization (ILO) Code of Practice for Safety and Health in Ports (2005);
  - General Conference of the International ILO Convention concerning Occupational Safety and Health in Dock Work, C-152, (1979);
  - General Conference of the ILO Recommendation concerning Occupational Safety and Health in Dock Work, R-160;
  - International Maritime Dangerous Goods Code (IMDG Code).

  And for other terminals:
  - IMO Code of Practice for Solid Bulk Cargo (BC Code);
  - International Code for the Construction and Equipment of Ships carrying Dangerous Chemicals in Bulk (IBC Code);
  - International Code for the Safe Carriage of Grain in Bulk (International Grain Code);

- Code of Practice for the Safe Loading and Unloading of Bulk Carriers (BLU Code); and

Figure 17-4: Safety issues

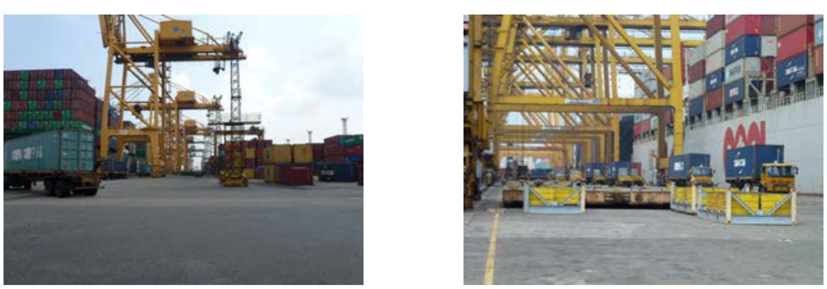
- <u>ISPS</u>
  The ISPS code needs to be adhered too. Gate security needs to be improved. No public cars / bicycles / motorbikes should be allowed on the terminal and persons needs to be registered in and out.

- <u>Twin lifts and dual hoist or tandem lifting</u>
  The news cranes will have to accommodate twin lift handling, i.e. capable of handling two 20ft containers in one move. For twin lift the crane should have a lifting capacity of 65 tons under the spreader or 80 tons under hook. Dual hoisting or tandem lifting would allow to lift four 20ft simultenously or two 40ft containers in one move. This would improve the crane productively heavily. For tandem lift the cranes should be able to lift 130t under the spreader or 160t under the hook. Dual hoisting will make the cranes more heavy and this weight cannot be supported by existing quay structures.

- <u>Crane outreach and heights</u>
  To handle ULCS (vessels wider than 48m), a crane outreach of 24-25 rows is recommended. The height is depending on the structure of quay, vessel design and tidal influences. For example the CICT cranes have an outreach of 22 rows and a maximum lifting height above rail of 45m. The height has reportedly been too limited for the latest ULCS vessels. SLPA has ordered three STS for JCT V with an outreach of 19 rows, limiting the future vessel sizes to neo-panamax classes of around a maximum width of approx. 48.2m. This related to a vesselsize of about 13,000 TEU.

- <u>Hatch covers</u>
  The existing cranes have no back reach resulting in the hacth covers positioned underneath the crane (in between the crane legs). The logistics on the quay is hampered by this. This has been described in the section on port operations of container terminals. Three new cranes will be purchased with sufficient back reach. Additional cranes ordered in future, if any, needs to have the same specifications.

Figure 17-5: Operations issues



Existing cranes.

The JCT I and II berth have a crane rail gauge of only 18m. This limits cranes to panamax type, 13 rows across. These cranes are aged and are not upto efficient feeder operations anymore. Replacement with the cranes from UCT (when converted to general cargo) or the obsolete feeder berth may be investigated. Regarding the cranes at JCT III and IV, the following observation is made:

The quay cranes do not match with the vessels berthing at JCT3 and JCT4 in terms of height, speed and outreach. There are three options:

1. Just some refurbishment to lengthen the life span. The data received lead to the conclusion that the cranes as-is have just a limited life span left.
2. Check the status of the cranes to see whether the cranes can be modified. These modifications can be lengthening the boom, increasing the height of the cranes, maybe add a back reach to the cranes. This is more a theoretical than a practical thought due to the technical status of the cranes.
3. Look for refurbished cranes at the used equipment market to replace most of the quay cranes with new ones. New cranes are no option unless JCT will stay at least 20 more years in operation.

- Existing JCT III and IV required actions:

1. Detailed study of the yard layout.
2. Remove first RTG block behind the quay cranes when new cranes arrive with back reach (hatch cover area).
3. Assessment of the technical status of all equipment.
4. Review the landside layout, demolish old buildings, free-up space for container storage and roads.
5. Refurbish the surface of the apron and the yard.
6. Build empty container block stacks, carry out an assessment of empty container handler (ECH) or Top-Lifters.
7. Investigate the need for additional or replacement of prime movers.
8. Review the maintenance equipment and repair area; demolish workshops and replace where needed.

The output of the studies is an action plan aiming at increasing the efficiency, capacity, reliability of the facility and consequently reduction of operating cost.

- Training of employees

  Regular training, training on the job and training for new equipment should be implemented. Managers should familiarise themselves with the latest developments in the industry by following courses, literature and special port visits abroad.

- Scrap/amortisation of old tractors and trailers (not in running condition anymore)

  A huge area of several thousands of square metres is occupied with tractors and trailers that are out of service and which will/cannot be repaired anymore. Due to complicated administrative procedures, it seems to be difficult to amortise and/or scrap this fleet of equipment that by far exceeded both the financial and economic lifetime of these assets. Evacuation of this site could generate some revenues (scrap value) and would result in a much more clean, neat and tidy looking area with additional valuable space.

- Labour indication for modernisation
  The following text box shows an approximation of the required labour force after modernisation. The actual number might become different due to policies, operational practises etc.

Sample on manpower

This box describes a generic container terminal organization.
Assumptions:
The facility is handling cargo 7 days a week 24 hours per day in three shifts.
The throughput is 2,500,000 TEU; TEU factor is 1.7 thus 1,500,000 boxes
The workload per quay crane, based on 18 cranes is 85,000 lifts per year.
Assuming 20 moves per hour crane productivity results in 50% crane utilisation. Rounded, on average 10 cranes are in use. Each crane drives 4 RTG's and 5 prime movers.

A crane team consists of one crane driver, a tallyman, 4 RTG drivers, 5 prime mover drivers and 2 twist lock handlers, thus 13 employees per shift. Three shifts per day (8 hrs) plus a fourth spare team is 52 employees per crane.
Total: 520 employees.

A waterside- and a landside- shift leader plus spare are 8 employees.
Four reefer mechanics per shift plus spare is 16 employees.
Four gate operators per shift plus spare are 16 employees.
Five empty / special cargo handlers per shift plus spare are 20 employees.
Total: 60 employees

Planning and operations management:
Estimated: 25 employees.

Equipment Maintenance:
Crane engineers, 12
RTG engineers, 12
Prime movers and empty handler's engineers, 16
Electric engineers, 12
Planners, spare part procurement, management, 18
Total: 70 employees

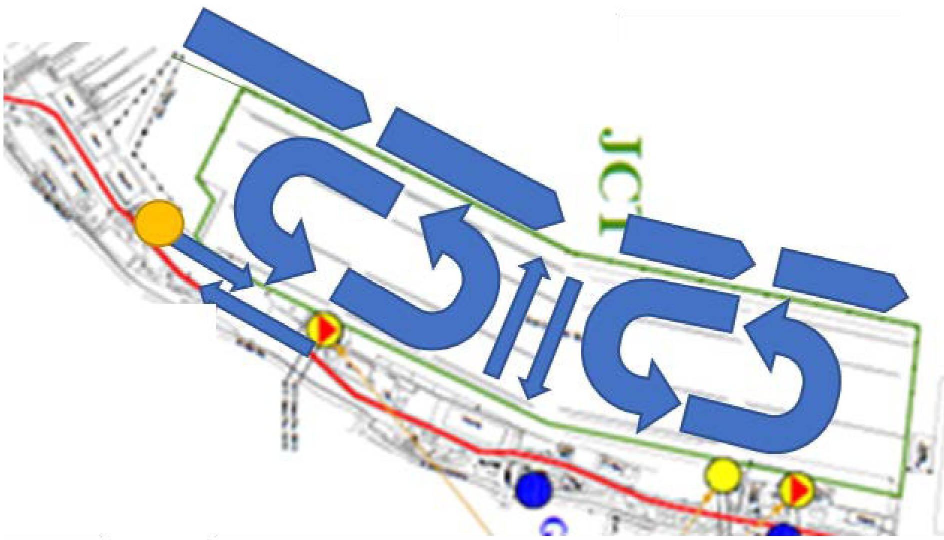
Terminal management, administration, invoicing, personal, IT, marketing and sales:
Estimated: 65 employees

Based on the calculations above a JCT container terminal has 740 employees.
Some tasks maybe overlooked or could be underestimated thus assume a total of **800 employees.**

Note: These estimates are assuming a container terminal as a business unit. Port Authority tasks, like Customs, ITT, Port IT systems, Harbour Master, Security, Pilots, and Tugboats are not included in the headcounts. Some tasks like lashing can be done via a port labour pool. All terminals call these lashing services when needed.

- <u>Gate configuration</u>
  This topic is analysed in more detail (OCR and truck appointment) in the logistics section in paragraph 8.2.3. Regarding the gate positions mentioned in that section an alternative can be made. In case the stack at the back of the new quay is not developed the opportunity arises to develop the main gate in this section, as illustrated by the yellow dot. Main traffic flow directions at the terminal will go counter clock wise as ships will be moored on starboard side instead of port side today (in case two vessels of more than 330 m are berthed at JCT III-IV).

Figure 17-6: JCT traffic pattern on terminal



17.2.6 Cost Estimates Operational Upgrade

Table 17-2: Cost Estimates Operational Upgrade

HP	PO	UP		Unit	Quantity	Rate (USD)	Cost (USD)
04			**JCT operational upgrade**				
	01		Equipment & IT				
		01	Quay Cranes	Crane	3	8,300,000.00	24,900,000.00
		02	RTG's	RTG	12	1,250,000.00	15,000,000.00
		03	Other Equipment		1	5,000,000.00	5,000,000.00
		04	IT Systems		1	4,000,000.00	4,000,000.00
		05	Project Cost		1	500,000.00	500,000.00
	02		Subtotal				49,400,000.00
	03		Contingencies	15%			7,410,000.00
						Sum	56,810,000.00

Note: Other equipment consists of some additional prime movers replacement and reachstacker for general operation.

17.3 Miscellaneous Works

17.3.1 Proposed Development

There is a need for upgrading of outdated workshop facilities and gate-facilities. The gate area needs to be upgraded to allow for modern OCR equipped gate. To create this area also an existing old workshop needs to be replaced, also due to the development of the PAEH.

The following building areas are tentatively assumed for demolition and reconstruction:

- Workshop: 500 m2
- Gate complex: 100 +400 m2

17.3.2 Cost Estimates Misc. Works

Table 17-3: Cost Estimates Misc. Works

HP	PO	UP		Unit	Quantity	Rate (USD)	Cost (USD)
05			**JCT Miscellaneous works**				
	01		Workshop and gate				
		01	Demolition works	Sum	1	500,000.00	500,000
		02	Workshop	m^2	500	1,000.00	225,000
		03	Gate (a)	m^2	100	1,000.00	208,000
		04	Gate (b)	m^2	400	500.00	500,000
	02		Subtotal				1,433,000.00
	03		Site installation costs	10%			143,300
	04		Planning and design	5%			71,650
	05		Contingencies	15%			214,950
							1,862,900.00

17.4 Pre-Feasibility JCT Modernisation Plan

17.4.1 Introduction

The financial pre-feasibility of the JCT modernisation plan is assessed through generation of the business plan for JCT. A detailed separated study on the options to expand JCT and deepen the basin has also been conducted. The deepening solutions have not been chosen as preferred solution due to high commercial risks and technical constraints. Hence this paragraph is focussed on modernisation of JCT terminal and the assumptions and results of the financial pre-feasibility analysis. Please note that the upgrade of JCT berth 1 to a general cargo area is not part of the business case.

The financial pre-feasibility is based on additional revenues and costs which are incurred when executing the JCT modernisation plan. For example, it is assumed that throughputs will diminish when not implementing the plan and that the lifespan of the terminal is shorter with 10 years.

The main benefits of execution of the JCT modernisation plan are the following:

- Shipping lines can be offered a higher service level.
- Two large vessels can be handled at the same time (increased berthing flexibility).
- The yard area created behind the quay extension can be used for stacking.
- A continuation of revenues for SLPA.
- The prevention of possible and eminent equipment malfunction.

17.4.2 Project Scope

The current estimated lifetime of Jaya Container Terminal considering the state of equipment especially and operational aspects is considered to be lengthened by 10 years following the modernisation plan. It can be further noted that due to the state of JCT, equipment malfunctions can severely impact performance in the next years if no additional investments are made.

The table below describes the differences when implementing the JCT modernisation plan (project case) versus not implementing the plan (non-project case).

	Project Case	Non-project Case
Construction	Starts in 2019	-
Operations	Starts in 2020	Continuous
Service Level	Two 366m large vessels can be handled at the same time adding to higher service level to the shipping lines.	Malfunctions may hamper service
Terminal estimated lifespan	Until 2035	Until 2025
Throughputs	Diminishing with 4% per year until end of life time	Diminishing with 8% per year until end of life time

The modernisation plan includes the following elements:

- JCT quay extension
- Miscellaneous works which includes gate upgrades and demolishing and replacement of maintenance shops

- Purchase of IT and equipment.

17.4.3 Financial Pre-feasibility

Forecast

The main assumptions of the forecasts are:

- Starting volume for 2017 is 2.0 M TEU
- In the non-project case JCT's volume diminish with on average 8% per year due to opening of new terminals and general deterioration of the facility as no incremental or additional future CAPEX expenses are accounted for.
- In the project case volumes will diminish by 4% as from 2020 onwards due to opening of additional terminals in the port of Colombo, whilst still offering reasonable service levels.
- Under the non-project case JCT will stop operations in 2025; under the project case an additional 10 years until 2035.

Item	Unit	2017	2018	2019	2020	2021	2022	2023	2024	2025	2030	2035
JCT Project Case Forecast	M TEU	2.0	2.0	2.0	1.9	1.8	1.8	1.7	1.6	1.6	1.3	1.1
JCT Non-Project Case Forecast	M TEU	2.0	2.0	2.0	1.9	1.7	1.6	1.5	1.4	1.3	-	-

Please note that the additional revenues used for the calculations are the revenue driver. Which means that the difference between the project and non-project case is considered. In the non-project cast JCT will shut down in 2025.

Revenue Estimations

SLPA provided the following estimations of container handling revenues excluding the marine side handling fees:

- 54.0 USD per TEU

OPEX Estimations

SLPA provided the following data regarding OPEX for JCT. The number excludes security personnel costs:

- 29.0 USD per TEU

Of the 29.0 USD 50% is assumed to be labour costs.

CAPEX Estimations

The CAPEX estimations as seen in paragraphs 17.2 and 17.3 total 75.5 M USD and consist of:

- Quay extension and back fill: 16.8 M USD
- Operational upgrade including equipment and IT: 56.8 M USD
- Miscellaneous works including gate upgrades and new workshops : 1.9 M USD

The investments are expected to be made in 2019 with start of operations in 2020. Depreciation is linear with 25 years expected life span and no residual value to be conservative in estimates.

Results

The results show a project financial IRR of 16.6% and a payback period of 8 years. As a financial investment, this result is sound. The NPV of the project is positive (40.3 M USD) thus making it financially feasible.

A few important notes regarding the results need to be made:

- The pre-feasibility results are based on high level assumptions as no JCT actual financial figures are available.
- CAPEX figures have been estimated conservatively but based on international benchmarks.
- No additional CAPEX investments are considered in the project case. It is to be noted that future investments in equipment replacements can be expected over the lifetime of the project to keep the terminal operational until 2035. This fact has been partially mitigated by reducing JCT volumes by 2% per year in the project case to attribute to a possible downsizing.

Table 17-4: Financial pre-feasibility Result JCT

Output	Value	Unit
NPV - Free Cash Flow	40,282,880	USD
FIRR	16.24%	%
Payback Period	8	Years

The results in the figure below display the additional revenues and costs for JCT when the modernisation plan is fully executed. The financial data reflect *the difference* between the two cases. The figure shows the initial capital expenditure in 2019. After the 2025 the revenues (and costs) continue for an additional 10 years, compared to the non-project case in which JCT was closed.

Figure 17-7: Results Financial Pre-feasibility JCT

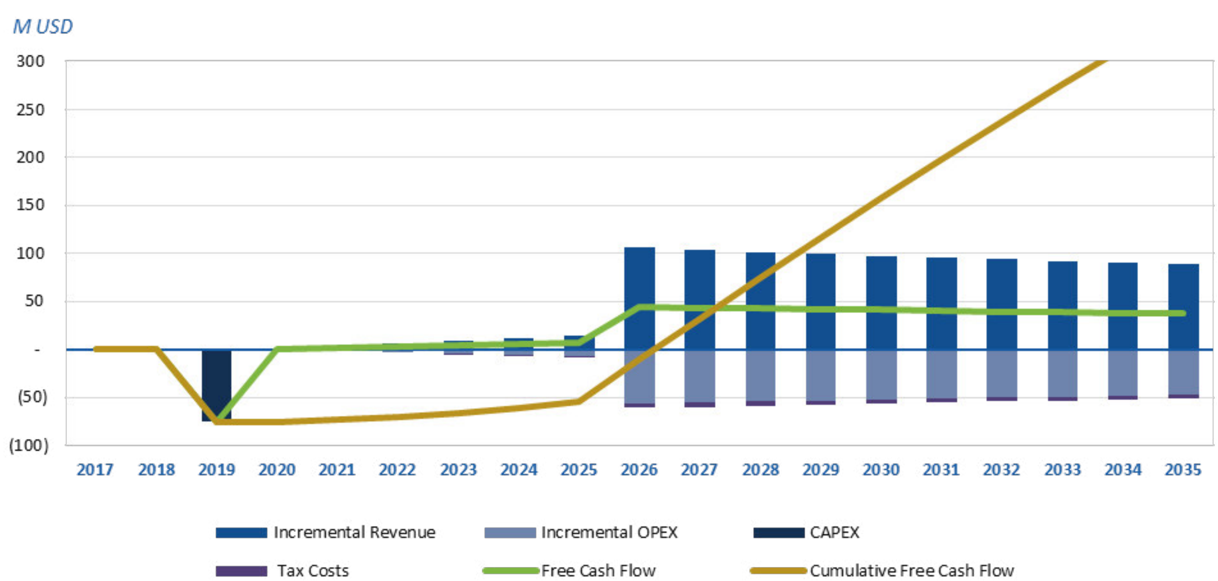


Table 17-5: Results Financial Pre-feasibility JCT ('000 USD)

	Assumption	2019	2020	2021	2022	2023	2024	2025	2030	2035
Incremental Revenues	**54 USD per TEU**	**-**	**3,846**	**7,259**	**10,278**	**12,936**	**15,265**	**17,296**	**70,155**	**57,662**
Incremental OPEX	**29 USD per TEU**	**-**	**(2,066)**	**(3,899)**	**(5,520)**	**(6,947)**	**(8,198)**	**(9,288)**	**(37,676)**	**(30,967)**
CAPEX - JCT Quay Expansion		16,806	-	-	-	-	-	-	-	-
CAPEX - JCT Operational Upgrade		56,810	-	-	-	-	-	-	-	-
CAPEX - JCT Misc. Works		1,863	-	-	-	-	-	-	-	-
CAPEX - Total		**75,479**	-	-	-	-	-	-	-	-
Tax Expense	**10.0%**	**-**	**-**	**(34)**	**(174)**	**(297)**	**(405)**	**(499)**	**(2,946)**	**(2,368)**
Free Cash Flow		**(75,479)**	**1,781**	**3,327**	**4,584**	**5,692**	**6,662**	**7,508**	**29,533**	**24,328**

17.4.4 Economic Feasibility

Results

The conversion factors for the financial cash flows are set to except for the labour costs. Labour costs are estimated at 50% of JCT OPEX. The project is estimated to create substantial economic value based on these results:

Table 17-6: Economic Indicators Pre-feasibility Result JCT

Output	Value	Unit
NPV - Economic Cash Flows	88,785,997	USD
ERR	18.5%	%

Table 17-7: Results Economic Pre-feasibility JCT ('000 USD)

	2019	2020	2021	2022	2023	2024	2025	2030	2035
Economic Benefits									
Incremental Revenues	-	3,846	7,259	10,278	12,936	15,265	17,296	70,155	57,662
Economic Costs									
Incremental Labour Costs	-	878	1,657	2,346	2,952	3,484	3,948	16,012	13,161
Incremental Other OPEX	-	1,033	1,949	2,760	3,473	4,099	4,644	18,838	15,483

Incremental CAPEX	(75,479)	-	-	-	-	-	-	-	-
Economic Free Cash Flows	**(75,479)**	**1,936**	**3,653**	**5,172**	**6,510**	**7,682**	**8,704**	**35,305**	**29,018**

17.4.5 Potential for Private Financing and PPP

The SLPA currently fully owns and operates the JCT, and intends to do so in the remaining operational years of the terminal; hence, leveraging expertise of external private parties through a PPP is considered unlikely.

Private investments may however be possible. The table below presents pros and cons for private investments in the brownfield terminal development. From these factors, it is concluded that private investments are likely not attractive for the JCT brownfield development.

Pro	Con
Expected positive NPV from investment	Existing terminal with limited lifespan
JCT is an operational terminal; hence, there is no ramp-up for volumes	JCT's market share in the port is expected to decrease over the remaining lifetime of the terminal, resulting in a commercial risk for an investor
	As JCT is an existing terminal, share allocation to the private investor for the brownfield investment is complex, as compared to a joint greenfield investment
	The investor may require that the terminal is not phased out before it can recoup its investment; this results in decreased port planning flexibility for the SLPA.

17.5 JCT 1 Upgrade to General Cargo Technical Assessment

17.5.1 Existing Infrastructure

The JCT 1 Upgrade to general cargo assessment is not part of the JCT modernization planned aimed at improving JCT operations. It is a reference writing for SLPA for future changes to JCT to provide more general cargo berthing space in the port.

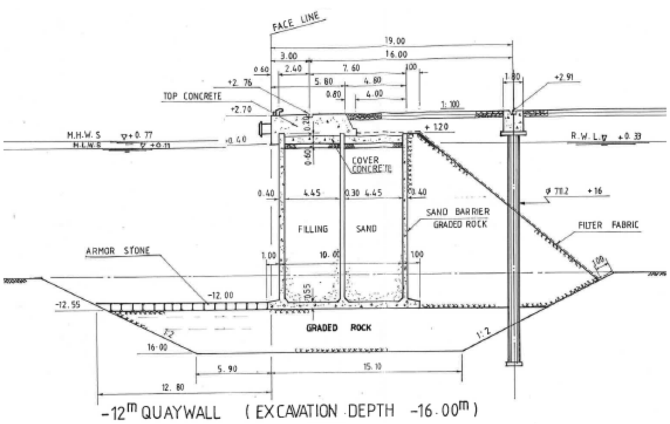
Berth nos. 1 and 2 have a total length of 600m in one alignment. Water depths are 12m/13m (CD) respectively. Berth nos. 3 and 4 have a total length of 660m also in one alignment, but with a bend relative to berth nos. 1 and 2. The water depth is here 15m (CD).

The quays are designed as a gravity structures based on pre-fabricated RC caissons with sand fill. Caissons are topped with a RC superstructure which transfers quay loads, including seaside rail forces to the caisson.

Caissons are founded at -12.5m (Berth 1) on a base layer of graded rock. The thickness of the rock base varies, supposedly reflecting the top level of a natural rock base.

The cross section of Berth 1 is shown below. It shall be observed that the rail gauge for the STS-cranes is only 16m along Berths 1 and 2.

Figure 17-8: Berth 1 Quay Structure



17.5.2 Technical Observations

The corner at the north end of Berth 1 was briefly visited (see photos below). No apparent signs of structural weakness were observed, other than superficial wear and tear. Two old STS container cranes were parked at the northernmost end of the rail track.

Figure 17-9: Berth 1 - View Along Main Berth

Figure 17-10. Berth 1 - View along lane behind STS-cranes

17.5.3 Proposed Development

Berth 1 is proposed transformed from container berth into a specialized general cargo berth with an increase of the water depth from the present CD -12m to CD - 13m.

Transformation of the berth into a general cargo berth is assumed to result in a relief of the very significant, concentrated load impacts from STS-cranes. This change in design conditions may result in a reduction of the overturning moments on the caisson and consequently in less concentrated foundation pressures under the caisson onto the bedding layer of graded rock.
In this case it may be possible to remove material from the seabed down to at least CD -13m without jeopardizing the stability of the quay.

It is recommended to review the design calculations to investigate if the desired draught can be achieved without major reconstruction works, other than some redressing and stabilization of the seabed in front of the quay.

If this way forward is not possible it will most likely be necessary to introduce a new, advanced quay front with a RC slab on a row of piles, as previously proposed and described for the PVQ-Jetty.

For a total quay length of 300 m and partly based on the cost estimate for the PVQ-Jetty the following costs are roughly estimated:

- Minimum solution (redressing of seabed): 300m of 10.000 USD/m = 3.0 mio USD
- Reconstruction as per PVQ-Jetty: 300m of 30.000 USD/m = 9.0 mio USD

17.6 Environmental Impact Assessment

- Risks associated with the demolition of structures on, and infrastructure of the quay; emissions (noise, dust, gaseous), unprofessional handling and indiscriminate disposal of hazardous waste (asbestos, polluted soil).
- Impacts related to dredging (spreading suspended material with possibly contaminants, hazards from blasting, indiscriminate disposal of dredge spoil. When the dredging commences the area in which the dredger works creates a plume of suspended particles resulting in murky water. This could disturb the entire other areas of inner harbour unless controlled. Depending on the current patterns this plume could even affect the other parts of the harbour basin giving hindrance to the port activities.
- Existing workshops have polluted the soil and oil/grease flows into the drainage. The same can happen in the new workshops planned.
- Occupational health risk associated with demolition and construction works.
- It should be noted that in case the basin behind the new 120m quay wall is not filled, additional care of this water pocket is required and water circulation should be provided. It is apparent that the inner harbour basin gets collected both dry and wet weather flow from outside the port premises through outfalls. This wastewater laden with suspended particles get deposited in the harbour basin as calmness is introduced within the inner harbour. The study done by Jayaweera (1999) showed that the inner harbour has been polluted particularly with faecal matter. As a result, dissolved oxygen levels are depleted. Hence the extension of quay wall would leave a pocket of water filled with pollutants. That would therefore cause further deterioration of water quality, likely resulting in bad odour.

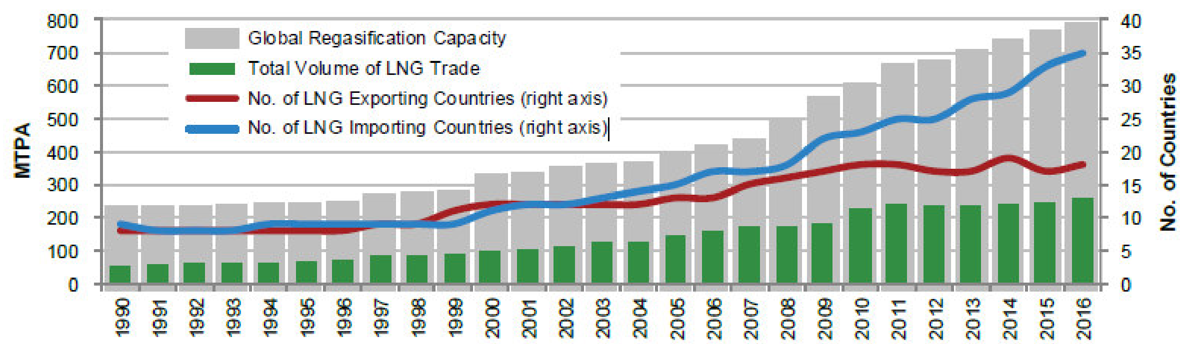
18 LNG FSRU Colombo Break Water

18.1 Background to the project

In its 2017 document "Vision 2025" the Sri Lankan government indicated that inadequate physical infrastructure services are a significant drag on growth. One of the measures to upgrade the energy infrastructure is to shift from coal fired power plant in current CEB projects to LNG fired power plants.

In recent years there is a boom in LNG demand arising from a shift towards this cleaner fuel. The number of importing countries is increasing and the exporting volumes as well. The big factor in the next decade is the emergence of the US as a net exporter of LNG. Floating storage units become a popular form to provide LNG storage to power facilities.

Figure 18-1: Growth of World Wide LNG Production



Source: IHS Markit, IEA, IGU

In 2017 the Sri Lanka government set a tender for the conversion of 300 MW power plant to LNG. In the future a 2 x 300 MW power plant units will be added. The conversion will most likely take place in 2020 to cater for the national energy demand.

An import facility needs to be created to facilitate LNG imports for the national demand. SLPA has chosen to facilitate this demand with a floating storage and regasification unit in the south port break water initially. Due to expansion in the port this facility will likely be moved to either the expanded South Port break water or a new energy hub.

This analysis assumes SLPA will construct the jetty and that the private party will cater to the management of the FSRU vessel. This is a form of a PPP deal, but alternatively the jetty structure could be constructed by private parties as well.

18.2 Supporting Analyses

A "standard" LNG carrier can transport about 125,000 – 145,000 m3 of LNG which is sufficient to fuel an 800 MW power plant for about one month. These vessels would measure about 300m with a beam of 43m and has a draught of 12m.

Newer types of LNG FSRU now opt for 173,400 m3 (a dwt of 93,500 long DWT, GT 113,000) with a LOA of 300m, a beam of 46.5m and a draught of 12.5m. This FSRU cost around USD 200 to USD 230 M and can be constructed in 2.5 years. The vessel would have a maximum discharge capability of 14400 cu.m./hr.

December 2016, Maran Gas has firmed up its move into floating storage and regasification units (FSRUs), this weekend signing an order for its first vessel, with an option for two additional LNG carrier newbuildings, at Daewoo Shipbuilding & Marine Engineering (DSME) in South Korea. DSME will build the 173,400m³ FSRU for Maran Gas Maritime at Okpo shipyard on Geoje island, for delivery in the first half of 2020. The shipyard values the three-vessel deal at US$589 million.

18.2.1 LNG Ships

At the end of 2015 there were 424 LNG ships in worldwide service. There is no universally accepted naming convention for LNG ships but the following names are often used.

LNG type	Vessel size
Medmax	75,000 m3
Conventional or standard	125,000 – 145,000 m3
New conventional or standard	150,000 – 175,000 m3
Qflex	210,000 - 216,0000 m3
Qmax	260,000 – 267,000 m3

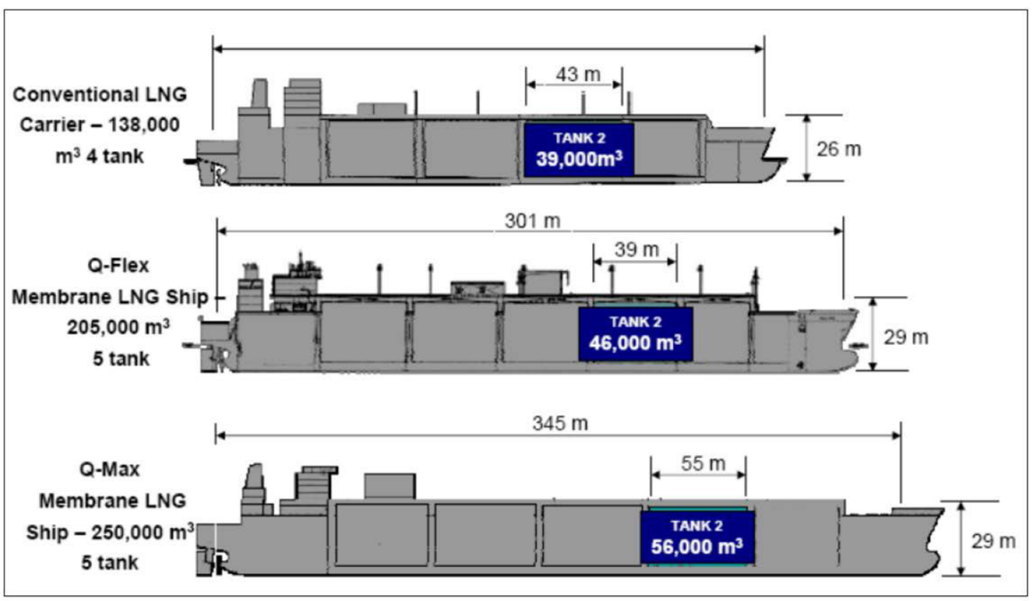
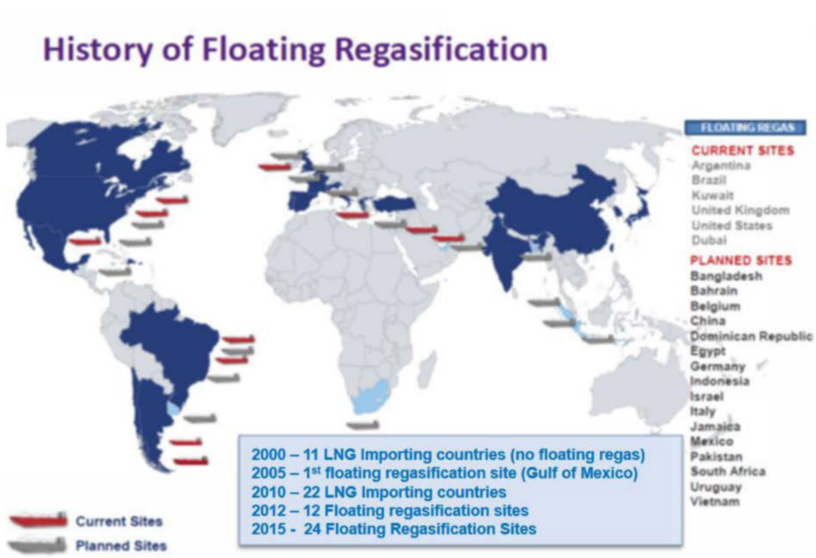


Figure 27

Conventional, Qflex and Qmax Ships (Source: Exxon Mobil)

The LNG vessels can be reconverted into FSRU by placing the vaporisers on board. The conversion is common practise in this market.

Worldwide about 24 floating storage sites are present including facilities under development in countries like Indonesia, Singapore, Pakistan and South Africa.



18.2.2 FSRU versus Onshore terminals

There are advantages and disadvantages between an onshore terminal and a floating FSRU

Onshore Terminals	FSRU's
> million ton per annum, large scale power stations > 1000 MW	Used for < 3 million ton per annum (usually for about 1.5 – 2 million-ton throughputs or small-scale power stations up to 1000 MW.
Provides a more permanent solution	Allows for quicker fuel switching (vaporisers on board)
Offers long-term supply security	Greater flexibility if there are space constraints or no useable ports
Greater gas storage capacity	Capable of operating further offshore
Generally, requires lower operating expenditures (OPEX)	Generally less CAPEX
Options for future expansions	Less land regulations
Storage tanks normally in proximity of quay	Storage tanks located at distance and fed by gas pipeline
Long construction times and high fixed costs	Limited implementation time but risk involved that operator can easily move out
Maintenance easier	Disadvantage: ship maintenance

Source: IGU

To supply the power station in Colombo both options can be provided for. Only the FSRU can be offered in a fast timeframe when it is positioned at the northern break water. A fixed terminal is not possible to construct in a short time. Construction time would be at least 5 to 8 years. For this option either a liquid bulk island is required or as fixed terminal in the future as part of North Port development.

18.2.3 Floating Storage

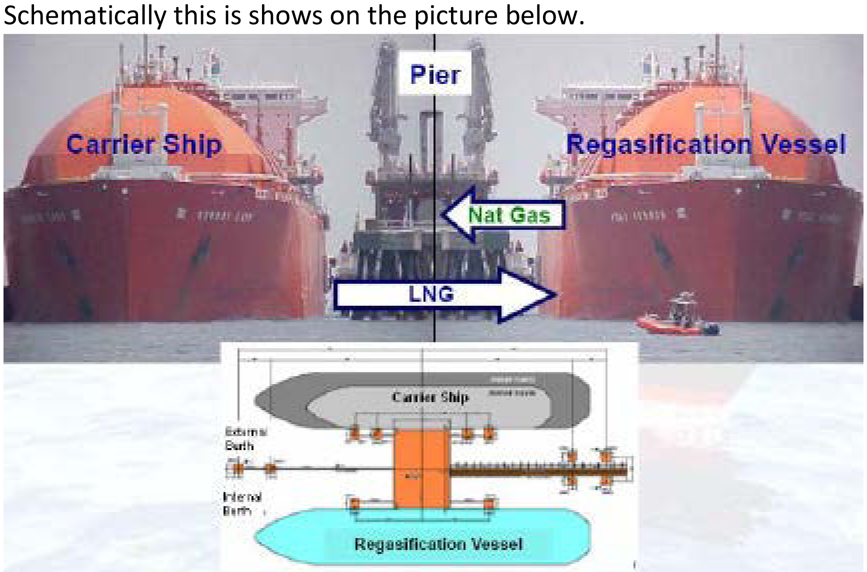
There are two options adopted worldwide to moor FRSU vessels.

1. With Jetty between FRSU and visiting vessel
2. Without jetty between FRSU and visiting vessel

With Jetty between FRSU and visiting vessel

The first option is to moor the vessel behind a jetty which would allow the visiting vessels to moor on the opposite site of the jetty. This has the advantages that mooring can be efficient and without difficulties on the replacement of water whilst pushing the ship to the berth. The disadvantage of this system is that a jetty has to be constructed which dimentionalise the berthing spot of the FSRU. With other words the flexibility to change the FSRU is more limited.

Schematically this is shows on the picture below.



Without jetty between FRSU and visiting vessel

The second options are to moor the FSRU on a jetty next to the breakwater and mooring the visiting vessel next to the FSRU.

The advantage of this system is that the berth of the FSRU is not limiting the size. Another advantage is that there is no major structure required between the vessels which is particular of interest when the FRSU should be replaced to another location. The disadvantage is that the visiting vessel needs to moor side by side to the FSRU which in practise increases the risk and the time of mooring compared to a fixed jetty.

Reviewing both options the latter is the preferred option when the facility is built on the North-western breakwater with the intention to replace the facility once WCT II is developed.

18.2.4 Safety

When assessing safety distances for a FSRU (Floating Storage and Regassification Unit) or an LNGC (Liquefied Natural Gas Carrier) development for a LNG Terminal, with the purpose to provide the elements to assess whether the proposed development sites are viable, no International regulations define deterministic safety distances to be applied to the assessment of LNG installations, in particular to FSRU developments.

International regulations provide, instead, risk-based criteria for the assessment of the compatibility of an LNG plant with the territory, based on accidental distances associated to accidental event frequency. Consider also that a recent IFC Guideline (EHS Guidelines for Liquified Natural Gas Facilities) of April 2017 requires "provisions for safe distances between reservoirs and between the facility and adjacent buildings" but without providing any value. It also says that if you cannot have "safe distances" then you need other prevention measures.

For Colombo port it is advised to review the corresponding risk of locating a FSRU near to the city. As per international practise and elaborated here below, it is recommended to take a least 2km distance from urban residential areas.
This guideline would enforce the argument to place the FSRU on the breakwater rather than near the shore.

International and National Standards on Safety Distances and territorial compatibility
The only internationally known acceptability criterion specific for risk around LNG installations (onshore) is given in Annex L of European Standard EN1473:2007 (it has to be noted that this criterion is given as "informative" only, and is not mandatory).
The EN1473:2007 criterion is based on the assessment of the cumulative frequency of occurrence of all plant accidents causing a given level of damage. From the value of frequency of occurrence and the Consequence severity class, three Risk Levels are identified based on a Risk Matrix approach:

- Level 3: situation which is undesirable and cannot be tolerated. Remedial action required (Not Acceptable);
- Level 2: situation which shall be improved. A level at which it shall be demonstrated that the risk is made As Low As Reasonably Practical (ALARP);
- Level 1: normal situation (Acceptable).

The identification of the three risk levels for outside plant boundaries according to frequency and consequence classes is made based on the following Matrix (a similar matrix exists for assessment of risk inside plant boundaries):

Figure 18-2: Determination of Risk Levels outside the boundary plant (from EN1473:2007)

Risk		Consequences class	Consequences Class	Consequences Class	Consequences Class	Consequences Class
Frequency for all plant accidents	Cumulative frequency (per year)	5	4	3	2	1
Range 1	> 0,1	2	3	3	3	3
Range 2	0,1 to 0,01	2	2	3	3	3
Range 3	0,01 to 0,001	1	2	2	3	3
Range 4	0,001 to 10^{-4}	1	1	2	2	3
Range 5	10^{-4} to 10^{-5}	1	1	1	2	2
Range 6	10^{-5} to 10^{-6}	1	1	1	1	2
Range 7	< 10^{-6}	1	1	1	1	1
TOLERABILITY OF HAZARDS: 1 = normal situation 2 = ALARP region 3 = not acceptable						

The attribution of the frequency to a frequency class follows the criteria given in the matrix, the attribution of the consequence to a consequence class follows the criteria given in the following Figure (from Annex K, EN1473:2007).

Figure 18-3: Classes of consequence for hazard assessment (from EN1473:2007)

	Criteria unit	Class 1	Class 2 [a]	Class 3	Class 4	Class 5
Fatalities	Dead persons	More than 10	1 to 10	0	0	0
Accident with loss time	Injured persons	More than 100	11 to 100	2 to 10	1	0
Release of hydrocarbons	Tons	More than 100	10,01 to 100	1,01 to 10	0,1 to 1	Less than 0,1
[a] The class is close to SEVESO Directive criteria [Council Directive 96/82/EC of 9 December 1996 on the control of major-accident hazards involving dangerous substances].						

In the USA, NFPA59A provides requirements for the safety of LNG onshore installations. NFPA 59A defines "design spills" and provide criteria to assess exclusion zones in terms of allowable thermal radiation flux at the plant property line and as minimum distances from Containers (onshore tanks) and property lines (minimum distance from a container of capacity >265 m3 is minimum 30 m). If the separation distances between equipment and property lines required by NFPA59A are met, and if the design spill exclusion zones remains inside the plant boundaries, this is considered to be sufficient to ensure safety of the nearby area. The NFPA59A, as the European Standard EN1473, however do not explicitly consider the LNG ship but are applicable to onshore plants.

At European Level, LNG installations follow the rules for Major hazard Plants ("Seveso" EU Directive). The approaches adopted in European Countries to assess compatibility of Major Hazards installations with the territory (Land Use Planning) are different, and all of them have in common the need to assess, for a specific establishment and site, distances associated to predefined levels of damage to human beings or to predefined values of individual risk. The allowable land uses are then defined, according to the various criteria, with a deterministic, semi-probabilistic or fully risk-based approach.
Two documents prepared by a research Institution (Sandia National Laboratories) on behalf of the USA Department of Energy, provides discussions on spill scenarios and related hazard distances with potential impact on public safety, mainly with reference to accidental (collisions and grounding) and intentional spills from an LNG ship (Sandia, 2004 and 2008). These reports however provides a discussion on the various hazard distances that are associated to different hypotheses of breach on the ship hull, with specific emphasis on terrorism issues, and do not provide a firm value of safety distances to be utilised in a generic case. The Sandia 2008 report, in addition, provides an analysis focused on very large LNG carrier, with capacity higher than 200.000 m3, as example.

Another Informative Publication by SIGTTO (Society of International Gas Tanker and Terminals Operators), the Information Paper no. 14 "Site Selection and Design for LNG Port and Jetties", at chapter 10.2.4 (Hazardous Penetration) specifies that "It therefore becomes feasible to consider ways to analyse port approach channels so that any risk of cargo containment rupture can be removed and the remote possibility of an uncontrolled release of LNG reduced to non-credible proportions", suggesting - de facto - to approach the problem with a Risk Based methodology to check whether it is possible to rule-out the largest events based on reliability considerations.

As a conclusion, no specific value of safety distances is given by international or National standards for LNG installations, and in particular for FSRU units. All standards refer to an analysis of "credible" or "representative" accidental scenarios to assess, case by case, damage distances associated to a tolerable risk value.

As a further element, in the following Figures 13 and 14 information on distances from (onshore) LNG regassification plants and populated areas are given, for two European plants, located in Barcelona (Spain) and Zeebrugge (Belgium).

Figure 18-4: LNG Terminal in Barcelona (Spain)

Figure 18-5: LNG Terminal in Zeebrugge (Belgium)

18.2.5 Technical Assessment

Liquefied gas will be supplied in tanker vessels. The gas will be transformed into vapor (re-gasification process) in the terminal and transported to the power plant via a submerged/buried pipe line connection.

For this priority project pre-feasibility study, the LNG terminal is planned to be located behind the outermost section of the main breakwater, i.e. north of the proposed West Container Terminal. It is however foreseen that the outermost section of the main breakwater may be relocated further north within the foreseeable future, with implications the for the location of the LNG terminal.

This breakwater location is only foreseen if LNG is required to be handled in the short term (< 5 year horizon), as the North Port Island Terminal – part of the preferred Energy Hub North Port option – is not considered feasible in the short term. If the LNG terminal becomes a medium to long term development, the identified island terminal option becomes the preferred implementation option. In that case also storage tanks can be accommodated. In general a LNG terminal with land based storage would have the size of approximately 42 hectares based on the Rotterdam LNG Gate terminal, further specified in the annexes.

It is therefore proposed that the permanent works of the LNG terminal shall be constrained to a workable minimum.
The terminal is therefore proposed to include:

- A dedicated tanker berth with a central operational platform
- Dolphins for breasting and mooring
- Bridges and catwalks

Re-gasification capacity shall in this case be provided as a floating unit to be permanently moored at the berth and later relocated in the event of a change to the breakwater.

The cost estimates for these works are as follows:

HP	PO	UP		Unit	Quantity	Rate (USD)	Cost (USD)
06			**LNG-Terminal**				
	01		LNG-terminal				
		01	Platform	Sum	1	6,000,000.00	6,000,000.00
		02	Dolphins	Nos	8	1,000,000.00	8,000,000.00
		03	Bridge and catwalks	Sum	1	2,000,000.00	2,000,000.00
	06		Subtotal				16,000,000.00
	07		Site installation costs	10%			1,600,000.00
	08		Planning and design	5%			800,000.00
	09		Contingencies	15%			2,400,000.00

Indicatively, the cost of a submerged pipeline is estimated at USD 12,000 -15,000 per metre.

18.2.6 LNG bunkering

It is noteworthy that in the future the facility should also be able to supply bunkering to LNG vessels. An ever-growing segment of ships are converting to LNG and the major shipping lines are investing in new LNG vessels.

LNG as a bunker fuel is expected to become a new standard for commercial shipping. The driving force is the IMO regulations to reduce emissions from ships. The sulphur content of fuels have to be reduced to < 0.5% by 2020. As stricter standards on exhaust emissions from merchant ships have taken effect around the world, LNG, which can significantly reduce not only SOx, but also CO2 (which is a cause of global warming), and NOx (which is a cause of acid rain), is expected to see wider use as vessel fuel. Hence it is a solution which shipowners adopt in their new ship ordering strategy. For existing ships either cleaner fuels (MGO/MDO instead of HFO) or scrubbers have to be applied. As such, ports and shipping companies are preparing themselves, together with the bunker industry for this. Ports like Rotterdam and Zeebrugge already have implemented LNG bunker facilities. In Rotterdam the LNG bunkering is organised by small LNG barges with carrying capacities of 3,000m3 or 6,500m3. Next to this the facility offers direct LNG truck loading. In Zeebrugge a 5,000m3 LNG bunker barge is available. Meanwhile in Singapore, bunker offerings are still in a trial phase and so far has been focussed on truck -to-ship supplies. The Maritime and Port Authority of Singapore has announced to set aside USD 9 million for initiatives aimed at boosting LNG bunkering in the port. There are two LNG suppliers in Singapore and Fuel LNG completed the first commercial LNG bunkering in September 2017 which was a truck-to-shore operation. Also the port of Yokohama in Japan wants to offer LNG bunkering as part of the Transpacific trading route.

As mentioned the main demand for LNG as bunker fuel still needs to develop. In Rotterdam ship to ship transfer is already taking place due to the inland barges and some coastal vessels which are equipped LNG as fuel. In container shipping CMA CGM ordered nine 22,000 TEU container vessels which shall be powered by LNG. Each vessel has the capacity to carry 18,000m3 of LNG. Moreover United Arab Shipping ordered 17 ready-fit LNG vessels, 6 of 18,000 TEU and 11 of 14,000 TEU. This is an indicator that LNG will also be applied in the very large categories, of which vessels can only call at deep drafted hub ports. Furthermore many local vessel may actually be powered on LNG such as tug boats for example. Another shipping segment in which LNG is becoming popular is Cruise shipping. Carnival Corporation awaits four LNG powered cruise ships to be delivered 2019 onwards.

Industry experts expects that on the East West routes mainly Singapore and Rotterdam/Zeebrugge will play a major role as there are located at the beginning or end of trades. Port of Colombo is however also strategically positioned along the route and may be able to play a role in this new market. The markets can be further expanded when also the local ad coastal markets around the Indian Ocean adopt the new IMO regulations tis is however expected to take some time.

18.3 Pre-Feasibility

18.3.1 Introduction

The business case for the jetty structure to house the LNG floating storage and regasification units is relatively straight forward as SLPA will not be responsible for the management of the vessel or the operations. This is to be provided and operated by the government selected entity. SLPA should be compensated for its CAPEX investments.

It is to be noted that upon construction of extend break water of south harbour, the LNG unit will need to be relocated. The costs association with this movement is not incorporated in this analysis.

18.3.2 Project Scope

To set up this business case the project case and non-project case are identified as:

- **Non-project Case –** This would be the current situation where no LNG imports take place.
- **Project Case –** SLPA constructs the jetty infrastructure and walkway. The FSRU vessels investments are done by the government selected entity.

	Project Case	Non-project Case
Construction	Starts in 2019	-
Operations	Starts in 2020	-
Terminal estimated lifespan	Until 2050	-
Throughputs	Per requirement of the power plant.	-

18.3.3 Financial Pre-feasibility

Forecast

The LNG import terminal in the South Port break water will cater to the first imports of LNG in 2019 after which a ramp-up is expected of the production in Colombo. The forecast is based on a national energy generation of LNG of which a share of LNG generation is expected. Under current assumptions Hambantota will have a LNG power plant running as of 2025.

		2017	2018	2019	2020	2021	2022	2023	2024	2025	2030	2040	2050
LNG Forecast Project Case	'000 Tons	-	-	32	343	545	767	1,009	1,273	781	995	1,508	1,994
LNG Forecast Non-Project Case	'000 Tons	-	-	-	-	-	-	-	-	-	-	-	-
Incremental Volumes		**-**	**-**	**32**	**343**	**545**	**767**	**1,009**	**1,273**	**781**	**995**	**1,508**	**1,994**

Revenue Estimations

This project is estimated to be budget neutral for SLPA, which means the net present value of the project should be equal to zero. To achieve this SLPA should receive a concession fee, either a fixed annual fee or variable fee based on tonnage. These fees are thus a minimum to make the project feasible:

- Fixed annual concession fee for project life time: 2.3 M USD.

- Variable concession for project life time: 2.6 USD per ton LNG imported.

OPEX Estimations

Maintenance and repair costs for the platform, dolphins, bridge and catwalks are estimated at 1.0% of the initial investment of 20.8 M USD. The costs total at 208 thousand USD annually.

CAPEX Estimations

The CAPEX estimations as seen in paragraphs 18.2.5 consists of:
- Platform structure – 6.0 M USD
- Eight Dolphins to moore the FSRU – 8.0 M USD
- Bridge and catwalks – 2.0 M USD

The total investment is 20.8 M USD including site installation costs, planning and design and contingencies.

Results

As mentioned, the business case for the LNG structure is set to break-even to recover the costs made by SLPA. Based on this structure the project is financially feasible.

Output	Value	Unit
NPV - Free Cash Flow	0	*USD*
IRR	10.0%	*%*
Payback Period	10	*Years*
Concession Fee Annual*	2,321,022	USD
or Variable Concession Fee*	2.62	USD / Ton

*Either the fixed annual concession fee or the variable concession fee is to be applied; both have approximately the same impact on the business case. For this example, the fixed annual concession fee is applied.

'000 USD	Assumption	2019	2020	2021	2022	2023	2024	2025	2030	2035
Incremental Revenues	*2.3 M USD*	2,321	2,321	2,321	2,321	2,321	2,321	2,321	2,321	2,321
Incremental OPEX	*1% of CAPEX*	(208)	(208)	(208)	(208)	(208)	(208)	(208)	(208)	(208)
Platform		(6,000)	-	-	-	-	-	-	-	-
Dolphins		(8,000)	-	-	-	-	-	-	-	-
Bridge and catwalks		(2,000)	-	-	-	-	-	-	-	-
Design & Installation		(2,400)	-	-	-	-	-	-	-	-
Contingencies		(2,400)	-	-	-	-	-	-	-	-
CAPEX - Total		(20,800)	-	-	-	-	-	-	-	-
Tax Expense	**10.0%**	(128)	(128)	(128)	(128)	(128)	(128)	(128)	(128)	(128)
Free Cash Flow		**(18,815)**	**1,985**	**1,985**	**1,985**	**1,985**	**1,985**	**1,985**	**1,985**	**1,985**

18.3.4 Economic Feasibility

The conversion of financial cash flows to economic cash flows a conversion factor is used of 1.0 for all cash flows. The tax expense is exempt in the calculation as it is a benefit to the nations. Additionally, by providing the jetty the Sri Lanka is able to generate power from LNG instead of coal. This has a significant economic benefit which can be attributed to this project. Without these added benefits the business case is already economically feasible.

Emission Cost Savings

The following assumptions underline the economic costs savings related to switching from coal fired power plant to a gas fired power plant:

- CO_2 emission per to LNG: 2.81 ton
- CO_2 emission per to coal: 2.54 ton
- Cost of ton CO2 emission per ADB guidelines: 36 USD.

The savings as indicated in the table below are significant due to the difference in emission of coal and gas. Inclusion of these numbers in the economic business case significantly increase the benefits.

		2019	2020	2021	2022	2023	2024	2025	2030	2040	2050
Colombo LNG Forecast	'000 Tons	32	343	545	767	1,009	1,273	781	995	1,508	1,994
Equivalent Coal Forecast	'000 Tons	97	1,033	1,641	2,307	3,036	3,832	2,350	2,996	4,539	6,001
Emission LNG	'000 Tons	90	964	1,532	2,154	2,834	3,577	2,194	2,797	4,237	5,603
Emission Equivalent Coal	'000 Tons	246	2,623	4,168	5,861	7,712	9,733	5,969	7,610	11,528	15,243
Economic CO2 Savings	'000 USD	5,639	60,210	95,690	134,548	177,046	223,445	137,030	174,710	264,664	349,958

Results

The business case is strongly economically viable based on these results:

- ENPV (@ 7.83%): USD 1.8 B USD
- ERR: 529%

	2019	2020	2021	2022	2023	2024	2025	2030	2040	2050
Economic Benefits										
Incremental Concession Fee	-	-	2,321	2,321	2,321	2,321	2,321	2,321	2,321	2,321
CO_2 Savings	5,639	60,210	95,690	134,548	177,046	223,445	137,030	174,710	264,664	349,958
Economic Costs										
Incremental OPEX	(208)	(208)	(208)	(208)	(208)	(208)	(208)	(208)	(208)	(208)
Incremental CAPEX	(20,800)	-	-	-	-	-	-	-	-	-
Economic Free Cash Flows	**(13,048)**	**62,323**	**97,803**	**136,662**	**179,159**	**225,558**	**139,143**	**176,823**	**266,777**	**352,071**

18.3.5 Potential for Private Financing and PPP

Volumes for an LNG import terminal are typically well defined and guaranteed through offtake agreements, as the gas-fired power plant that uses the LNG as inputs has a long-term stable LNG requirement. Due to this volume security, such LNG import terminals are suitable for private investments. In this pre-feasibility study, it is assumed that the construction/procurement and operations of the LNG vessels are thus carried out by a private party.

However, the platform, mooring dolphins, and bridge and catwalk investments required to moore the LNG vessel are assumed to be carried out by the SLPA in this pre-feasibility study. Such marine infrastructure investments are typically allocated to the (landlord) port authority; hence, private sector investments are not considered likely for these project components.

18.4 Environmental Impact Assessment

Environmental Risks

The operation of a LNG handling and storage facility inherently is associated with a number of risks, of which the most important one is the risk of accidental fire and explosions. Other issues concern:

- Hazardous material management
- Wastewater discharges
- Air emissions
- Waste management
- Noise generation
- LNG transport related issues & LNG fuelling related issues

Mitigation Measures

- EIA to be carried out for LNG floating terminal; this activity is mandatory as per the ADB Environmental Safeguard Policy Statements and CEA regulations. This study could in general address all adverse impacts in detail. This EIA basically covers all possible construction and operation impacts on environment, as well as contingency plan will be prepared in order to manage a catastrophic situation that could arise at any moment of the time.
- A buffer zone to be maintained; it is usual that a buffer zone be maintained in the case of a fire in the proposed development. However, Sri Lanka does not have a guideline on the selection of a particular distance for the buffer zone. But for the LNG facilities located in Hambantota port, it was decided to be 100 m because strong wind could blow, which would trigger the fire towards downwind directions. Hence, decision on the buffer zone distance is crucial for the management authorities and accordingly the buffer zone area must be kept devoid of ant development activities.
- Fire control unit is to be established nearby; when a fire breaks up it is difficult to bring in fire brigade vehicles and gear from other part of the port. Hence, it is advisable to have established a unit within the same area so that it can mobilize as early as possible to minimize the devastations that are very likely from a LNG plant.
- For the workshop to be established, end of pipe treatment facilities to be provided; As mentioned earlier for the modernization of JCT, this facility should also be provided with the end of pipe treatment to avoid any deterioration of water quality.

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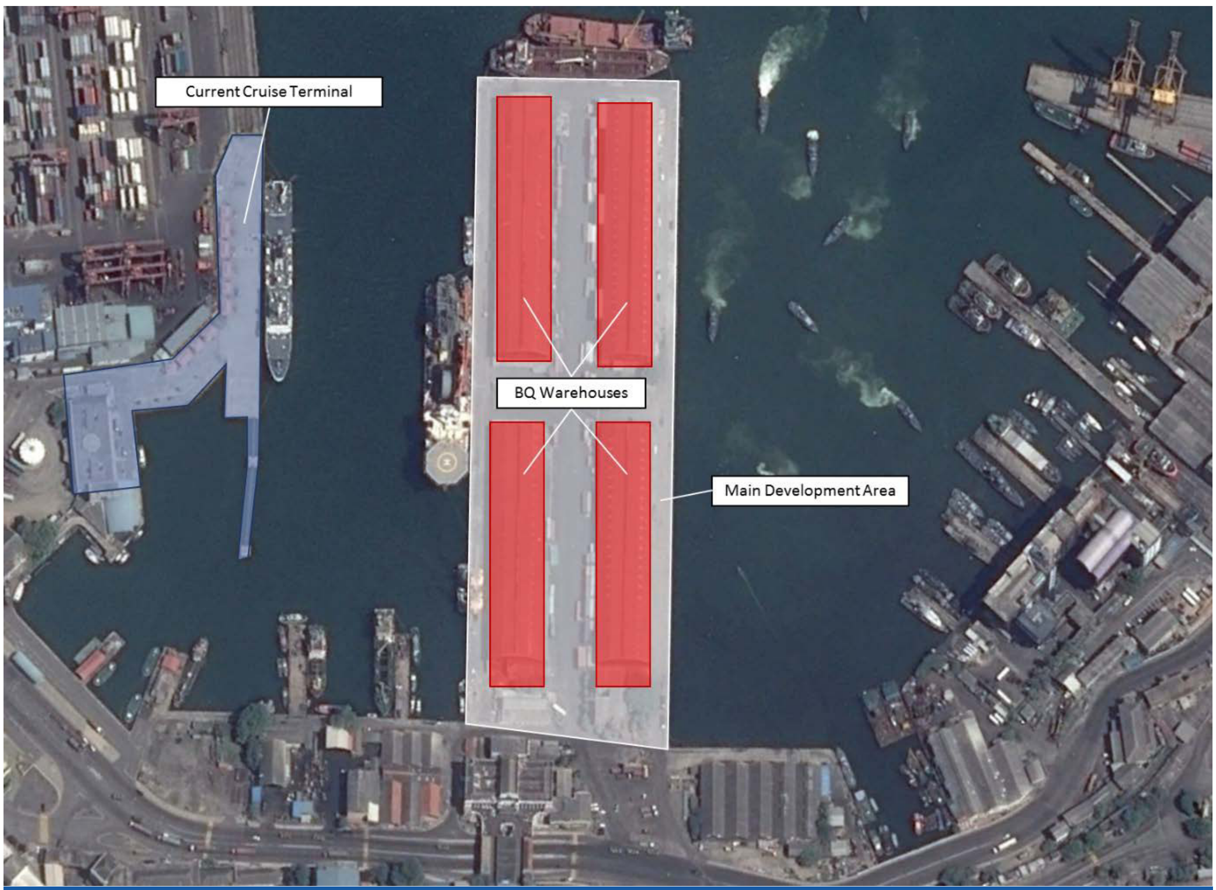
19 BQ Warehousing Relocation

19.1 Background to the Project

Due to the construction of the passenger terminal on the Bandaranaike Quay (BQ) in the port of Colombo per 2019 the warehouses need to be replaced. The capacities of the warehouses total 20,000 m2. SLPA is opting to have the new facilities built in a PPP structure, essentially letting private parties handle the current activities. The choice for private warehouse operators will most likely increase efficiency of the warehouse, increasing the capacity as compared to the current BQ use.

Figure 19-1: BQ Warehouses



Description	Type of Cargo	Capacity (m^2)
BQ1	General non-dangerous cargo	5,000
BQ2	Local cargo/Transhipment/Dangerous cargo	5,000
BQ3	General non-dangerous cargo	5,000
BQ4	Transhipment/MCC cargo	5,000

19.2 Supporting Analyses

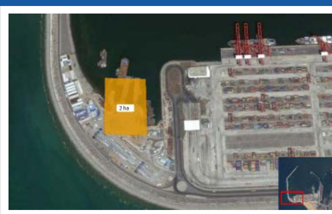
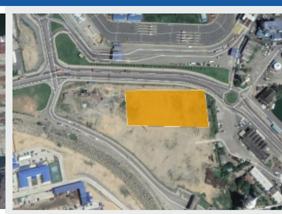
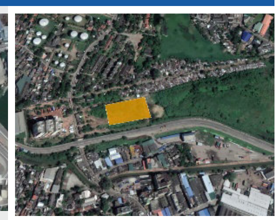
19.2.1 Relocation Options

Three locations are considered when replacing the warehousing activities for SLPA:

- **South Port -** The corner between CICT future west container terminal could be used for warehousing activities. This valuable port land however and costs of landfill would need to be included in the business case. These costs are estimated at 18 M USD. This is too large of an expense for warehousing activities.
- **"Triangle" –** The area below CICT is currently unused. However setting up warehousing facilities on this piece of land is challenging as there are no expansion options. The elevated highway access ramps are also planned in this area.
- **Bloumendhal Hill** - This area is designated as warehousing location for SLPA. The main challenge however are the soil improvement costs as this area used to be a garbage dump site. This location is the most feasible for SLPA as expansion options are necessary to for long-term development of warehousing facilities.

The most feasible option for SLPA would be development on Bloumendhal Hill. The costs of soil improvements though are not considered in the business case as this is a one-time costs and these should not be attributed to the operations.

Table 19-1: MCA warehouse location

Criteria	South Port	Triangle	Bloemandhal Hill
			
Availability of area	-	-	+
Accessibility	+	+	+
LCL bonded transport	+ +	+	-
PPP possibilities	+	+	+
Potential for future expansion	-	-	+++
Costs	+++	+	+++

19.2.2 Warehouse Facility

The new warehouse facility is designed at Bloumendhal Hill with a surface of 8,000 m^2. It is noted that the land area required for a warehouse is development is approximately 1.5 – 2.0 times the size of the warehouse; hence, a land area requirement of 1.2ha to 1.6ha is foreseen. Loading bays will facilitate efficient transfer of goods from truck to warehouse where goods can be stored in pallet racks of approximately 7 m high.

HP	PO	UP		Unit	Quantity	Rate (USD)	Cost (USD)
07			**New CFS-warehouse**				
	02		Buildings				
		01	Cargo shed 100x80m (Inc. Loading bays)	m^2	8,000	1,200.00	9,600,000.00
		02	Restroom etc. 400m^2	m^2	400	1,500.00	600,000.00
		03	Loading Bays (reception)	#	10	15,000	150,000.00
		04	Loading Bays (delivery)	#	10	15,000	150,000.00
		05	Pallet Racks	m	1,872	125	234,000.00
		06	Sewage, lights, fencing	m^2	8,000	12	96,000.00
	03		Subtotal				10,830,000.00
	04		Site installation costs	10%			1,083,000.00
	05		Planning and design	5%			541,500.00
	06		Contingencies	20%			1,624,500.00
							14,079,000.00

To operate the warehouse pallet trucks and reach trucks are necessary. A warehouse OS combined with bar scanning handhelds should ensure efficient operations.

HP	PO	UP		Unit	Quantity	Rate (USD)	Cost (USD)
07			**New CFS-warehouse**				
	01		Equipment				
		01	Pallet trucks	#	20	8,500	170,000.00
		02	Reach trucks	#	12	28,000	336,000.00
		03	Warehouse OS	#	1	150,000	150,000.00
		04	Bar scanning handhelds	#	20	1,500	30,000.00
	03		Subtotal				686,000.00
	06		Contingencies	15%			102,900.00
							788,900.00

19.3 Pre-Feasibility

19.3.1 Introduction

The pre-feasibility of the warehousing relocation is based only on LCL cargo as MCC cargo will remain in the bounded port area in the to be constructed UCT warehouse. The costs of soil improvements are also excluded from the business case as it is unclear whether SLPA, UDA or the government will incur the costs of such operations.

19.3.2 Project Scope

To set up this business case the project case and non-project case are identified as:

- **Non-project Case –** Warehousing is not relocated. Under capacity will be created in port.
- **Project Case –** A 8,000 m^2 warehouse is constructed at the the Bloumendhal area, on a land plot of approximately 1.2 – 1.6 ha.

	Project Case	Non-project Case
Construction	Starts in 2018	-
Operations	Starts in 2019	-
Terminal estimated lifespan	Until 2050	-
Throughputs	LCL Cargo will be handled at facility	Capacity shortage for handling LCL cargo in port.

19.3.3 Financial Pre-feasibility

Forecast

The forecast for the warehouse is based on the Colombo Base Case gateway cargo forecast. The following assumptions are applied:

- It is assumed that the LCL stream that will be handled at warehousing facilities is equal to 2.31% of the gateway container volumes, based on average LCL container volumes handled at Peliyagoda, Pettah, CFS I, CFS II, BQ I, BQ III between 2012 and 2016.
- Currently, nearly all of the LCL containers are handled by SLPA; it is assumed that all SLPA LCL handling will be relocated to the warehouse at Bloumendhal Hill to achieve economies of scale and optimally utilize the new and technologically advanced warehouse facility. However, it is noted that the market has been liberalised, enabling private parties to set up LCL facilities; it is thus assumed that the market share of the Bloumendhal Hill facility will decrease from 90% in 2019 to 50% in 2050.

Item	Unit	2019	2020	2021	2022	2023	2024	2025	2030	2040	2050
Colombo Gateway TEU Forecast	‘000 TEU	1,552	1,643	1,749	1,855	1,959	2,058	2,153	2,498	3,026	3,289
Market Share Bloumendhal	%	90%	89%	87%	86%	85%	84%	82%	76%	63%	50%
LCL Volume Bloumendhal	‘000 TEU	32	34	35	37	38	40	41	44	44	38

Revenue Estimations

Revenues are derived from the SLPA tariff book. The main revenue generators are stuffing and destuffing activities of the LCL boxes. The main revenue assumptions are:

- Stuffing and Destuffing Rate 20ft (50% of 20ft) - 22 USD
- Stuffing and Destuffing Rate 40ft (50% of 40ft) - 33 USD
- Stuffing and Destuffing Rate 20ft - Full service (50% of 20ft) 100 USD
- Stuffing and Destuffing Rate 40ft - Full service (50% of 40ft) 150 USD
- Additional revenues including box handling and administrative charges total at 30% of handling revenues.

The projected revenues are presented in the table below.

('000 USD)		2019	2020	2021	2022	2023	2024	2025	2030	2040	2050
Stuffing and Destuffing Rate 20ft	22 USD per Box	118	123	129	135	141	146	150	160	161	139
Stuffing and Destuffing Rate 40ft	33 USD per BOX	177	185	194	203	211	218	225	241	242	209
Stuffing and Destuffing Rate 20ft - Full service	100 USD per Box	538	561	589	615	640	662	682	729	733	633
Stuffing and Destuffing Rate 20ft - Full service	150 USD per Box	1,613	1,683	1,766	1,846	1,919	1,986	2,045	2,187	2,198	1,899
Revenue Container Handling		**2,446**	**2,553**	**2,678**	**2,799**	**2,911**	**3,012**	**3,102**	**3,317**	**3,334**	**2,880**
Other Revenues Containers	30% of total	734	766	803	840	873	903	930	995	1,000	864
Total Revenues		**3,180**	**3,319**	**3,481**	**3,639**	**3,784**	**3,915**	**4,032**	**4,312**	**4,334**	**3,744**

OPEX Estimations

OPEX are estimated at 45% of revenue per MTBS benchmark with a following breakdown of elements:

	Share of OPEX	2019	2020	2021	2022	2023	2024	2025	2030	2040	2050
Labour cost	50%	(715)	(747)	(783)	(819)	(851)	(881)	(907)	(970)	(975)	(842)
Capital (facility, equipment, systems)	20%	(286)	(299)	(313)	(327)	(341)	(352)	(363)	(388)	(390)	(337)
Running cost (M&R,	15%	(215)	(224)	(235)	(246)	(255)	(264)	(272)	(291)	(293)	(253)

	Share of OPEX	2019	2020	2021	2022	2023	2024	2025	2030	2040	2050
materials/supplies, etc.)											
Services (communication, HR, insurances, 3rd party services)	15%	(215)	(224)	(235)	(246)	(255)	(264)	(272)	(291)	(293)	(253)
OPEX Total	**100%**	**(1,431)**	**(1,494)**	**(1,567)**	**(1,637)**	**(1,703)**	**(1,762)**	**(1,814)**	**(1,940)**	**(1,950)**	**(1,685)**

CAPEX Estimations

The CAPEX estimations as seen in paragraphs 19.2.2 consists of:

- Warehouse infrastructure – 14.1 M USD
- Equipment and OS – 0.8 M USD

The total investment is 14.9 M USD including site installation costs, planning and design and contingencies.

Results

The business case for the BQ relocated warehouse is financially feasible with a financial IRR of 11.2%, just above the required rate of 10%. It is to be noted that if a PPP option is selected further changes in revenues can be made to deviate from the SLPA tariff book.

Output	Value	Unit
NPV - Free Cash Flow	1,506,316	*USD*
IRR	11.2%	*%*
Payback Period	9	*Years*

	2018	2019	2020	2021	2022	2023	2024	2025	2030	2040	2050
Total Revenue	-	3,180	3,319	3,481	3,639	3,784	3,915	4,032	4,312	4,334	3,744
Total OPEX	-	(1,431)	(1,494)	(1,567)	(1,637)	(1,703)	(1,762)	(1,814)	(1,940)	(1,950)	(1,685)
Total CAPEX	(14,868)	-	-	-	-	-	-	-	-	-	-
Tax Expense	-	(328)	(345)	(365)	(384)	(402)	(418)	(432)	(466)	(469)	(397)
Free Cash Flow	**(14,868)**	**1,421**	**1,480**	**1,550**	**1,617**	**1,679**	**1,735**	**1,786**	**1,905**	**1,915**	**1,662**

19.3.4 Economic Feasibility

For the conversion of financial cash flows to economic cash flows, the following conversion factors are applied:

- Tax - As the tax cash flows flow to the country, it is not considered a cost in the economic business case; as such, a conversion factor of 0.00 is applied.
- Labour costs – A factor of 0.85 is applied, in order to reflect the average income tax of approximately 15% on salaries.
- Revenues – A factor of 0.80 is applied to reflect that some of the revenues could be generated in the remaining old warehouses in the port in the no-project case.
- CAPEX – A conversion factor of 0.90 is applied to reflect some benefits to the economy resulting from the construction, such as sourcing of local materials.
- For all other cash flows, a conversion factor of 1.00 is applied.

Results

The business case is considered economically viable based on these results:

- ENPV (@ 7.83%): USD 4.6 M USD
- ERR: 11.4%

'000 USD	2018	2019	2020	2021	2022	2023	2024	2025	2030	2040	2050
Incremental Revenues	-	2,544	2,655	2,785	2,911	3,027	3,132	3,226	3,450	3,468	2,995
Incremental OPEX	-	(1,324)	(1,382)	(1,449)	(1,515)	(1,575)	(1,630)	(1,678)	(1,795)	(1,804)	(1,559)
Incremental CAPEX	(12,671)	-	-	-	-	-	-	-	-	-	-
Economic Free Cash Flows	**(12,671)**	**1,220**	**1,274**	**1,336**	**1,396**	**1,452**	**1,502**	**1,547**	**1,655**	**1,663**	**1,437**

19.3.5 Potential for Private Financing and PPP

Warehouse operations are considered suitable for private sector involvement:

- Fully private – If the development is not on SLPA lands, a private operator may fully invest in and develop the warehouse and operate it.
- PPP – If the warehouse is developed on SLPA lands, the SLPA may act as a landlord authority. In this case, the SLPA will provide basic infrastructure (i.e., the land) and the private operator will invest in superstructure and equipment. In this structure, the private operator will typically pay a land lease fee to the port authority.

19.4 Environmental Impact Assessment

Environmental Risks

- Risk of demolishing archaeological interesting structures (national heritage)
- Risks associated with the demolition of structures on, and infrastructure of the quay; emissions (Noise, dust, gaseous), unprofessional handling and indiscriminate disposal of hazardous waste (asbestos, polluted soil). Same as for JCT Modernisation.
- Risks related to dredging (similar to JCT modernisation Plan)
- Occupational health risk associated with demolition and construction works.

Mitigation Measures

- Archaeological Impact Assessment to be done with Archaeological Department (AD). As per the Antiquity Ordinance of Sri Lanka, it is essential to get the clearance from the AD in order to ensure that no heritage building, or archaeological artefact be destroyed or disturbed. This department will usually decide whether to sacrifice or preserve such an artefact if found.
- As mentioned for the JCT modernization plan, demolition plan needs to be worked out and approval from CEA will have to be obtained prior to the demolition work begins.
- Material transfer plan for hazardous material to be prepared and approval to be obtained from CEA; this could be taken to be a part of demolition plan as well. All adverse impacts that are very likely need to be addressed.
- Dredging plan and dredge material disposal to be done as per USEPA protocol; this is the same as for the JCT modernization.
- Safety plan for demolition work to be prepared; as explained for JCT modernization health and safety plan needs to be worked out.
- EIA/IEE or environmental clearance is to be prepared for the relocation and environmental clearance for the new location to be obtained; it is not yet clear whether either IEE or EIA is required for this activity; it is decided based on the anticipated impacts and their magnitudes as well.

20 PVQ Upgrade Plan

20.1 Background to the Project

The current users of the Prince Vijaya Quay (PVQ) have indicated the need for an upgrade of the berth due to:

- Water depth constraints;
- High berth utilisation; and
- Low discharge rates

A possible solution to be provided by SLPA is the upgrading of the quay to allow for deeper draft vessels up to 13m. A possible solution can be found in the placing an existing quay front of the old one as analyses show. The business case for SLPA is deemed financially and economically not feasible.

Figure 20-1: PVQ & North Pier

20.2 Supporting Analyses

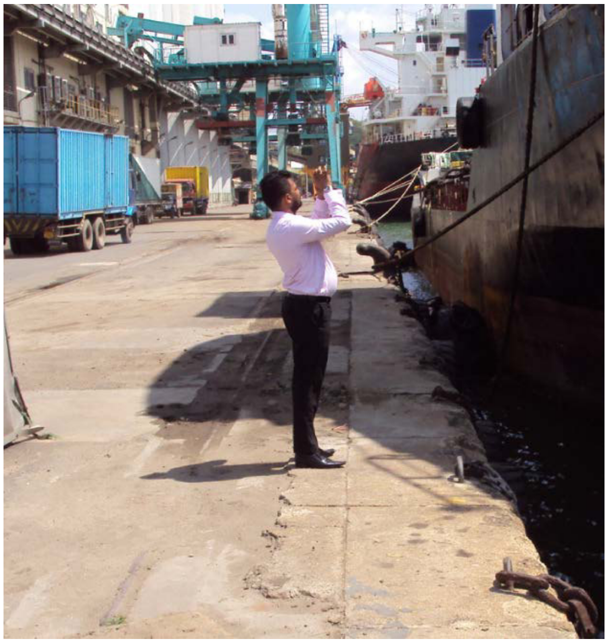
20.2.1 Infrastructure Development

Existing Infrastructure

The Prince Vijaya Quay is constructed as a marginal quay along the combined grain/cement-pier which is located at the north perimeter of Colombo Port. The northern side of the pier is constructed with wave protection for waves from north. The length of the quay is 378m and the design water depth is CD -10m with actual vessel draughts allowable upto 9.4m

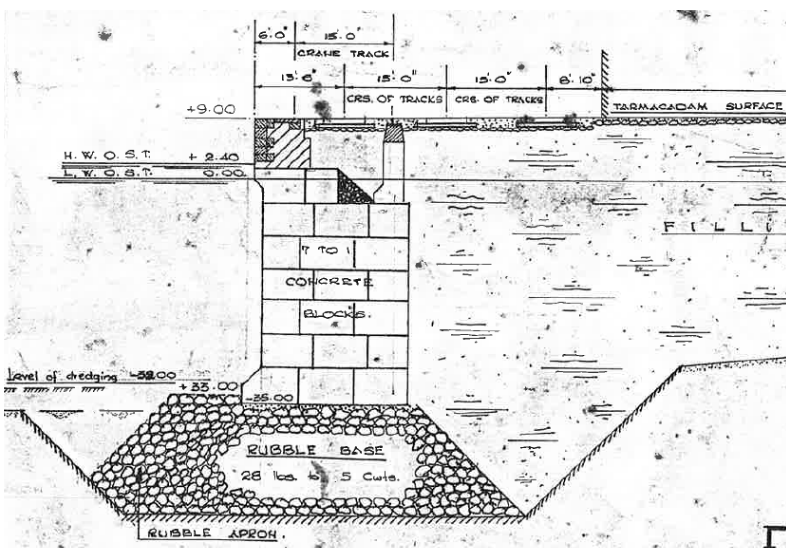
There are several structures (silos, warehouses etc.) situated on the central part of the pier; furthermore, two rail-mounted unloading units are operating on the quay apron in the full length of the pier.

Figure 20-2 PVQ Quay Front



The quay is designed as a gravity structure based on mass concrete blocks. They are founded on an approximately 5m thick rubble base which is assumed to reach solid ground of firm clay/rock. The figure below presents a cross section of the quay wall.

Figure 20-3 PVQ Quay Wall Cross Section



Observations

At the site visit the quay structure appeared rather old with many signs of wear and tear. However, no misalignment or apparent depressions in the quay apron were observed - this suggests that the basic quay structure may be in a reasonably good condition.

The road behind the buildings (in front of the shore protection) was not visited, but is reportedly in rather poor condition

Proposed Development

In the port planning an upgrading of the quay is considered a possibility with the objective to prepare the quay for accommodation of larger bulk-carriers than today bulk carriers up to LOA 170 with draughts of 9.4. With a deeper water depth up to CD -14m, allowable vessel draughts may increase to 13m. This would boost vessel sizes from Handysize/Handymax up to 40,000 DWT to Panamax sizes of up to around 80,000 DWT.

Table 20-1 Dry Bulk Vessel Classes

Dry bulk vessels	DWT (tons)	LOA (m)	Beam (m)	Draught (m)	Able to call old basin?	Future at PVQ*
Handysize	10,000 - 40,000	140 - 180m	22 - 28m	8 - 10.5m	YES	YES
Handymax (supramax)	40,000 - 65,000	169 - 200m	31 - 32.4m	9.8 - 12.3m	Partly	YES
Panamax (incl. new)	67,000 - 99,000	223 - 233m	32 - 48m	13.2 - 14.1m	NO	YES
Capesize	100,000 - 200,000	250 - 300m	43 - 50m	14.2 - 18.5m	NO	NO
Ultra Large cape	250,000 - 320,000 +	300 - 360m	50 - 64m	18 - 24m	NO	NO

Source: Clarksons; MTBS

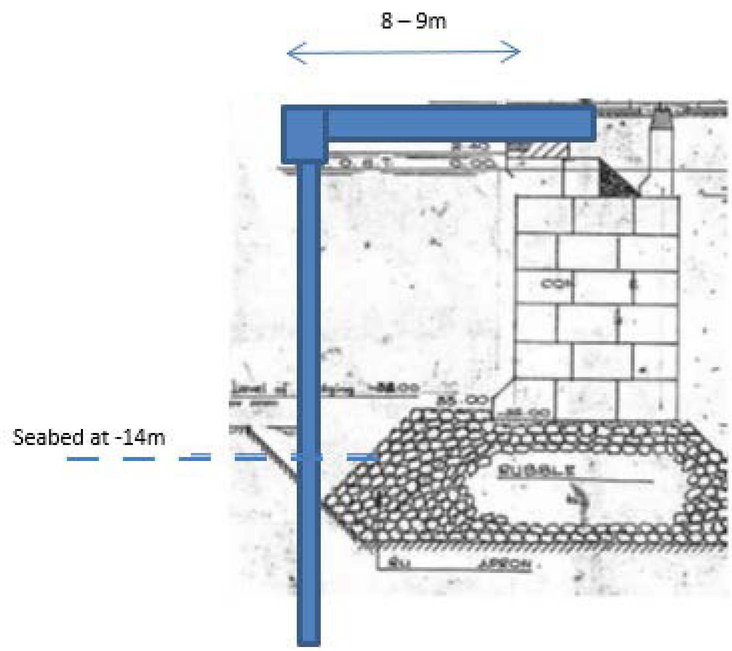
*Assuming that the PVQ quay wall is renewed and deepened.

A future water depth of 14m has been proposed at quay side. According to the sea chart this water depth is already available in the basin close to the end of the PVQ Jetty.

Due to the mode of foundation of the existing block wall a future water depth of 14m will be difficult to achieve without advancing the quay front to a safe distance from the footing of the block wall. An advance with approximately 9 m compared to the existing alignment is considered necessary. Furthermore, this extension of the quay apron will provide additional space for traffic in front of the buildings.

To close the gap, it is proposed to install a new RC deck slab which shall be partly seated on the existing block wall and partly supported on a row of new piles in front of the block wall. Piles shall be driven or drilled (depending on soil conditions) to a depth which ascertains sufficient bearing capacity. The existing rail track for unloading equipment shall be relocated accordingly to an appropriate distance from the new quay front. Furthermore, the slab and the piles shall be designed for loads from mobile crane pads (Liebherr MHC 420 or equivalent).

Figure 20-4 Proposed Reconstruction of PVQ Quay (Conceptual)



Potentially, the volume between the pile row and the existing block wall may be partly filled with rock/gravel material – depending on the actual conditions of block wall.

The horizontal stability of the combined quay structure may potentially be strengthened by installation of ground anchors under 45˚ under the existing buildings.

Cost Estimates

The table below provides an overview of estimated costs for the improvement works to the PVQ quay, as identified and detailed in the preceding sections.

Table 20-2 PVQ Upgrade - Cost Estimate

HP	PO	UP		Unit	Quantity	Rate (USD)	Cost (USD)
03			PVQ Upgrading to -14m				
	01		**Quay Wall**				
		01	Structural works	m	370	18,000.00	6,660,000.00
		02	Quay equipment	m	370	1,500.00	555,000.00
	02		**Quay Apron**				
		01	Rails relocation	m	370	1,800.00	666,000.00
		02	Pavement upgrading	m	370	400.00	148,000.00
		03	Utilities refurbishment	m	370	250.00	92,500.00
	03		**Dredging**				

	01	Seabed dredging	m^3	200,000	10.00	2,000,000.00
	02	Submerged oil pipeline	Not incl.			
04		**Subtotal**				10,121,500.00
05		Site installation costs	10%			1,012,150.00
06		Planning and design	5%			506,075.00
07		Contingencies	15%			1,518,225.00
		Total	**USD**			**13,157,950.00**

20.2.2 Operational Analysis

In terms of cargo handling operations, no operational adjustments are foreseen for the improvement plan. However, to efficiently serve the larger vessels that are expected to berth at the terminal once the deepening is completed, an improvement of the loading/discharging equipment can be further investigated.

In terms of navigability, the envisaged new quay wall, which is to be constructed in front of the existing quay wall, limits the space available for navigating and manoeuvring. As the PVQ already has limited manoeuvring space, the envisaged quay wall improvement may result in issues related to navigation.

20.3 Pre-Feasibility

20.3.1 Project Scope

To assess and present the financial and economic impact of the envisaged project, a project case and non-project case are defined:

- **Project Case** – SLPA constructs the quay wall infrastructure and dredges the PVQ berth pockets, resulting in larger vessels and volume capacity at PVQ.
- **Non-project Case –** No new quay wall structure is placed, thus limiting the vessel size and volume capacity at PVQ.

The table below describes the elements of the cases further:

Table 20-3 PVQ - Project Scope

	Project Case	Non-project Case
Construction	Starts in 2019	-
Operations	Operations at current quay until 2019; operations at renewed quay commence in 2020. Due to construction works in 2019, it is assumed that the berthing downtime causes a 25% reduction in 2019 grain and cement throughout, as opposed to the non-project case.	Continuous
Service Level	Panamax vessels, with capacities between 50,000 and 80,000 DWT, can be accommodated at the port.*	20,000 ton vessels remain the largest vessels to be berthed at PVQ
Business Case Scope	Until 2050	Until 2050
Throughputs	Throughput is assumed to remain the same as in the non-project case. However, cost savings can be realized using the larger vessels. It is assumed that the average vessel size deployed for the grain and cement trades at PVQ and New North Pier will gradually shift from the current 20,000 ton 40,000 tons (for PVQ and New North Pier operations combined).	Grain throughput is estimated to increase to 0.3 m tons by 2050; cement throughput is estimated to increase to 2.3 m tons by 2050.

**Water depth of CD -14m enables berthing of medium-sized or not fully loaded Panamax vessels. However, the limited width of the berth/channel may result in navigational issues, especially as the new quay wall is positioned in front of the old quay wall.*

The project scope and investment divisions are as follows:

Table 20-4 PVQ - Cash Flow Allocation

Item	Cash Flow Attribute To
Revenues	
Regular fees and charges per tariff book	SLPA

Item	Cash Flow Attribute To
Concession fee / royalty charges	To be negotiated by parties
Business operations revenues	Grain and cement companies
PVQ Quay Wall Improvement CAPEX	
Quay Wall	SLPA
Dredging	SLPA
Operational Expenses	
Maintenance and repair quay wall and dredging	SLPA

20.3.2 Forecast

The tables below present the vessel and volume forecasts for (i) the project case; (ii) the non-project case; and (iii) the difference between the two cases.

Table 20-5 PVQ - Forecasts

Item	Unit	2017	2018	2019	2020	2025	2030	2040	2050
Project Case									
Volumes*	M Tons	2.45	2.64	2.13	3.08	3.13	2.86	3.16	2.68
Average DWT per Vessel*	DWT	20,000	20,000	20,000	20,000	23,333	26,667	33,333	40,000
Vessels*	Vessels	122	132	106	154	134	107	95	67
Average GT per Vessel*	GT	11,765	11,765	11,765	11,765	13,725	15,686	19,608	23,529
Non-Project Case									
Volumes*	M Tons	2.45	2.64	2.83	3.08	3.13	2.86	3.16	2.68
Average DWT per Vessel*	DWT	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000
Vessels*	Vessels	122	132	142	154	156	143	158	134
Average GT per Vessel*	GT	11,765	11,765	11,765	11,765	11,765	11,765	11,765	11,765
Difference									
Incremental Volumes*	M Tons	-	-	(0.71)	-	-	-	-	-
Incremental Vessels*	Vessels	-	-	(35)	-	(22)	(36)	(63)	(67)

*Vessels and volumes presented are for the grains and cement handled at both the PVQ and New North Pier.

20.3.3 Financial Feasibility

The sections below present the estimated financial cash flows related to the PVQ quay improvement project. First, the estimated revenues, OPEX, and CAPEX are assessed individually; subsequently, overall key financial indicators are presented for the envisaged project.

Revenues

From the perspective of the SLPA, revenues from the grain and cement trades in Colombo port comprise (i) port dues and (ii) concession fees.

Port Dues

The table below presents the assumptions for the port dues revenues.

Table 20-6 PVQ – Port Due Assumptions

Assumption	Value	Unit
Tariffs		
Light Dues	4.00	USD / 100 GT
Entering Dues	5.00	USD / 100 GT
Pilotage Fee	5.00	USD / 100 GT
Pilot Fee	32.00	USD / Move
Tug Fee	350.00	USD / Tug / Hour
Dockage Fee	0.22	USD / 100 GT
Landing & Delivery Fee	0.22	USD / Ton
Operations		
Pilot Moves per Vessel	2	Moves
Tug Moves per Vessel	2	Moves
Tugs per Vessel	3	Tugs

Subsequently, the table below summarizes the port dues revenues for (i) the project case; (ii) the non-project case; and (iii) the difference between the two cases. It can be observed that the revenues from port dues are estimated to be lower in the project case, despite the fact that the volumes remain constant between the two cases. This is due to the fact that the higher fees paid by larger vessels do not fully compensate for the decreased number of vessels estimated to be handled at the PVQ and New North Pier.

Table 20-7 PVQ - Port Due Revenues

Item	Unit	2017	2018	2019	2020	2025	2030	2040	2050
Project Case									
Port Dues	M USD	1.01	1.09	0.88	1.27	1.24	1.10	1.17	0.96
Non-Project Case									
Port Dues	M USD	1.01	1.09	1.17	1.27	1.29	1.18	1.30	1.10

Item	Unit	2017	2018	2019	2020	2025	2030	2040	2050
Difference									
Port Dues	M USD	-	-	(0.29)	-	(0.05)	(0.08)	(0.14)	(0.14)

It is assumed that the incremental annual concession fee is set at a specific tariff to cover for SLPA's:

- decreased operational profit (incremental port dues – incremental OPEX); and
- incremental CAPEX.

As such, the concession fee is calculated after assessment of the OPEX and CAPEX.

OPEX

The OPEX related to the PVQ improvement project comprise (i) labour and fuel costs for the marine services and (ii) maintenance for the additional infrastructure.

Labour and Fuel Costs for Marine Services

It is expected that SLPA's labour and fuel OPEX related to the marine services are equal to 50% of the marine services revenues, as presented in Table 20-7. The table below summarizes the OPEX related to the marine services.

Table 20-8 PVQ - Port Due OPEX

Item	Unit	2017	2018	2019	2020	2025	2030	2040	2050
Project Case									
Marine Services OPEX	M USD	0.50	0.54	0.44	0.63	0.62	0.55	0.58	0.48
Non-Project Case									
Marine Services OPEX	M USD	0.50	0.54	0.58	0.63	0.64	0.59	0.65	0.55
Difference									
Marine Services OPEX	M USD	-	-	(0.15)	-	(0.02)	(0.04)	(0.07)	(0.07)

Maintenance OPEX

Besides operational costs related to providing marine services, the development of additional infrastructure will result in increased maintenance costs. The table below presents the maintenance costs for the new infrastructure, based on a benchmark of 1% of CAPEX per annum.

Table 20-9 PVQ - Maintenance OPEX

Item	Unit	2017	2018	2019	2020	2025	2030	2040	2050
Project Case									
Infra Maintenance Costs	M USD	-	-	-	0.13	0.13	0.13	0.13	0.13
Non-Project Case									

Item	Unit	2017	2018	2019	2020	2025	2030	2040	2050
Infra Maintenance Costs	M USD	-	-	-	-	-	-	-	-
Difference									
Infra Maintenance Costs	M USD	-	-	-	0.13	0.13	0.13	0.13	0.13

It is noted that the actual incremental maintenance costs may be lower, as the new infrastructure may reduce the need for maintaining the old infrastructure; hence, the maintenance costs of the new infrastructure may (partially) substitute maintenance costs of the old infrastructure, rather than being fully complimentary. However, the full maintenance costs are considered to arrive at a conservative estimate.

CAPEX

The table below summarizes the CAPEX for the PVQ development, based on the CAPEX items identified in Table 20-2.

Table 20-10 PVQ - CAPEX

Item	Unit	2017	2018	2019	2020	2025	2030	2040	2050
Project Case									
Infra CAPEX Costs	M USD	-	-	13.16	-	-	-	-	-
Non-Project Case									
Infra CAPEX Costs	M USD	-	-	-	-	-	-	-	-
Difference									
Infra CAPEX Costs	M USD	-	-	13.16	-	-	-	-	-

Feasibility

The feasibility is based on the incremental cash flows, to provide insight in the value that is created by improving the PVQ.

<u>Without Incremental Concession Fee</u>

The table below summarizes the financial results before considering an incremental concession fee from the grain and cement companies to the SLPA. The presented cash flows result in the following financial performance indicators:

- NPV (10% WACC): USD -11.15 M
- Payback period: N/A
- IRR: N/A

It is concluded that, without considering an incremental concession fee, the project is not financially feasible.

Table 20-11 PVQ - Financial Feasibility without Concession Fee

Item	Unit	2017	2018	2019	2020	2025	2030	2040	2050
Revenues	M USD	-	-	(0.29)	-	(0.05)	(0.08)	(0.14)	(0.14)
OPEX	M USD	-	-	(0.15)	0.13	0.11	0.09	0.06	0.06
Operational Cash Flow	M USD	-	-	(0.15)	(0.13)	(0.16)	(0.17)	(0.20)	(0.20)
CAPEX	M USD	-	-	(13.16)	-	-	-	-	-
Investment Cash Flow	M USD	-	-	(13.16)	-	-	-	-	-
Pre-Tax Free Cash Flow	**M USD**	**-**	**-**	**(13.30)**	**(0.13)**	**(0.16)**	**(0.17)**	**(0.20)**	**(0.20)**

With Incremental Concession Fee

However, as the grain and cement companies can realize (i) reduced costs from marine services fees and (ii) transport cost savings by transporting the grains and cement in larger vessels.

Reduced Marine Services Costs

The reduced costs from marine services paid by the grain and cement companies are equal to the reduction in marine services revenues for SLPA, as calculated in Table 20-7.

Transport Cost Savings

From market consultations, it has been identified that cement is mainly sourced from Pakistan, Indonesia, and Vietnam. The table below presents the calculation for the average shipping distance between Colombo and these three destinations, assuming an equal distribution of cargoes between the three destinations.

Table 20-12 PVQ - Transport Cost Savings - Distances

From	To	Unit	
Karachi, Pakistan	Colombo, Sri Lanka	Nautical Miles	1,341
Tanjung Priok, Indonesia	Colombo, Sri Lanka	Nautical Miles	1,842
Saigon, Vietnam	Colombo, Sri Lanka	Nautical Miles	2,213
Average Distance		**Nautical Miles**	**1,799**

According to Clarkson's Research, the transport cost savings between a Panamax vessel and Handymax vessel are estimated at approximately USD 1.00 per 1,000 tons of cargo per mile. The table below presents the estimated shift from Handysize vessels to Panamax vessels; it is noted that the share of cargoes transported by Panamax vessels is not expected to exceed 50% of the total volumes, as the total volumes also comprise volumes handled at New North Pier, which is not suited to handle Panamax vessels.

Table 20-13 PVQ - Transport Cost Savings - Vessel Shift

Item	Unit	2017	2018	2019	2020	2025	2030	2040	2050
Volumes by Panamax	%	-	-	-	-	8.33%	16.67%	33.33%	50.00%
Volumes by Panamax	M Tons	-	-	-	-	0.26	0.48	1.05	1.34

Subsequently, the table below presents the estimated transport cost savings, given (i) the estimated USD 1.00 saving per 1,000 tons per mile; (ii) the transport distances; and (iii) the volumes transported by Panamax volumes.

Table 20-14 PVQ - Transport Cost Savings

Item	Unit	2017	2018	2019	2020	2025	2030	2040	2050
Avg Transport Distance	NM	1,799	1,799	1,799	1,799	1,799	1,799	1,799	1,799
Volumes by Panamax	M Tons	-	-	-	-	0.26	0.48	1.05	1.34
Savings per 1,000 ton	USD / NM	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Transport Cost Savings	**M USD**	**-**	**-**	**-**	**-**	**0.47**	**0.86**	**1.90**	**2.41**

Total Savings Private Parties

The table below summarizes the total savings that are realized by the private parties due to the envisaged PVQ improvement.

Table 20-15 PVQ - Total Cost Savings Private Parties

Item	Unit	2017	2018	2019	2020	2025	2030	2040	2050
Marine Services Costs Savings	M USD	-	-	0.29	-	0.05	0.08	0.14	0.14
Transport Cost Savings	M USD	-	-	-	-	0.47	0.86	1.90	2.41
Total Cost Savings	**M USD**	**-**	**-**	**0.29**	**-**	**0.52**	**0.94**	**2.03**	**2.55**

The table below summarizes the financial results for the SLPA, if the cost savings of the private parties fully flow to the SLPA through concession fees or royalties. The presented cash flows result in the following financial performance indicators:

- NPV (10% WACC): USD -5.15 M
- Payback period: 19 Years
- IRR: 5.51%

It is concluded that, despite a substantial improvement of the financial performance caused by the concession fees, the project is not financially feasible.

Table 20-16 PVQ - Financial Feasibility with Concession Fee

Item	Unit	2017	2018	2019	2020	2025	2030	2040	2050
Revenues Incl Cost Savings	M USD	-	-	-	-	0.47	0.86	1.90	2.41
OPEX	M USD	-	-	(0.15)	0.13	0.11	0.09	0.06	0.06
Operational Cash Flow	M USD	-	-	0.15	(0.13)	0.36	0.77	1.83	2.35
CAPEX	M USD	-	-	(13.16)	-	-	-	-	-
Investment Cash Flow	M USD	-	-	(13.16)	-	-	-	-	-
Pre-Tax Free Cash Flow	**M USD**	**-**	**-**	**(13.01)**	**(0.13)**	**0.36**	**0.77**	**1.83**	**2.35**

20.3.4 Economic Feasibility

For the PVQ improvement project, the following economic benefits and costs are foreseen:

- Costs
  - Incremental CAPEX
  - Incremental OPEX
- Benefits
  - Incremental Revenues
  - Transport Cost Savings

It can be noted that the economic cash flows for the PVQ improvement project are similar to the financial cash flows; however, the financial cash flows need to be converted to economic cash flows to assess the economic feasibility of the project. To that end, conversion and allocation factors are applied to each of the identified cash flows. It is assumed that all cash flows can be attributed to Sri Lanka's economy; as such, all allocation factors are set to 1.0. The table below presents the assumed conversion factors for each of the economic cash flow conversions.

Table 20-17 PVQ - Economic Conversion Factors

Item	Conversion Factor	Justification
Incremental CAPEX	0.9	It is expected that a substantial part of inputs will be imported. As such, potential import duties and other additional costs should be subtracted from the market prices to arrive at the economic prices. For the CAPEX, a conservative conversion factor of 0.9 is applied.
Incremental OPEX	1.0	Maintenance is the largest incremental OPEX item, representing approximately 80% of the costs. As no market distortion is apparent for this item, the conversion factor is set to 1.0.
Incremental Revenues*	1.0	No market distortions are apparent.
Transport Cost Savings	1.0	No market distortions are apparent.

*Incremental revenues do not include the concession fees / royalties that are paid by the client due to the transport cost savings, as the transport cost savings are already included separately. Also including the concession fees / royalties would result in double-counting of benefits.

The table below summarizes the converted economic cash flows. To calculate the Economic NPV (ENPV), a social discount rate of 7.83% is applied. This results in the following economic viability indicators:

- ENPV (@ 7.83%): USD -2.38 M
- ERR: 6.11%

Hence, it is concluded that the project is not economically viable.

Item	Unit	2017	2018	2019	2020	2025	2030	2040	2050
Benefits									
Incremental Revenues*	M USD	-	-	(0.29)	-	(0.05)	(0.08)	(0.14)	(0.14)
Cost Savings	M USD	-	-	0.29	-	0.52	0.94	2.03	2.55
Costs									
Incremental CAPEX	M USD	-	-	(11.84)	-	-	-	-	-
Incremental OPEX	M USD	-	-	(0.15)	0.13	0.11	0.09	0.06	0.06
Pre-Tax Free Cash Flow	**M USD**	**-**	**-**	**(11.70)**	**(0.13)**	**0.36**	**0.77**	**1.83**	**2.35**

*Incremental revenues do not include the concession fees / royalties that are paid by the client due to the transport cost savings, as the transport cost savings are already included separately. Also including the concession fees / royalties would result in double-counting of benefits.

20.3.5 Potential for Private Financing and PPP

Currently, SLPA is a landlord authority for the activities at PVQ; SLPA is the owner of the PVQ infrastructure, while operations and superstructure investments are carried out by private parties.

The investments envisaged under the PVQ upgrade plan comprise dredging and quay wall construction works. These investments are typically allocated to the (landlord) port authority. However, as these investments benefit the private operators, concession fees paid by the operators may be increased; in this pre-feasibility, it is assumed that the private operators increase the concession fee payments with the level of their cost savings from the increased water depth.

20.4 Environmental Impact Assessment

Potential impacts are identical as those listed for the BQ Warehousing Relocation Plan.

Environmental Risks

- Risk of demolishing archaeological interesting structures (national heritage)
- Risks associated with the demolition of structures on, and infrastructure of the quay; emissions (Noise, dust, gaseous), unprofessional handling and indiscriminate disposal of hazardous waste (asbestos, polluted soil). Same as for JCT Modernisation.
- Risks related to dredging (similar to JCT modernisation Plan)
- Occupational health risk associated with demolition and construction works.

Mitigation Measures

- Archaeological Impact Assessment to be done with Archaeological Department (AD). As per the Antiquity Ordinance of Sri Lanka, it is essential to get the clearance from the AD in order to ensure that no heritage building, or archaeological artefact be destroyed or disturbed. This department will usually decide whether to sacrifice or preserve such an artefact if found.
- As mentioned for the JCT modernization plan, demolition plan needs to be worked out and approval from CEA will have to be obtained prior to the demolition work begins.
- Material transfer plan for hazardous material to be prepared and approval to be obtained from CEA; this could be taken to be a part of demolition plan as well. All adverse impacts that are very likely need to be addressed.
- Dredging plan and dredge material disposal to be done as per USEPA protocol; this is the same as for the JCT modernization.
- Safety plan for demolition work to be prepared; as explained for JCT modernization health and safety plan needs to be worked out.
- EIA/IEE or environmental clearance is to be prepared for the relocation and environmental clearance for the new location to be obtained; it is not yet clear whether either IEE or EIA is required for this activity; it is decided based on the anticipated impacts and their magnitudes as well.

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Appendix I Detailed Forecasts of Commodities

General

This section contains the detailed forecasts for Colombo port for the period 2016 – 2050. Each Colombo port forecast is derived from a national forecast, the details of which and the assumptions can be reviewed in the National Port Directions document. The forecasts table contain:

- Colombo share – The Colombo share is the percentage of national throughput flowing through Colombo port. This share is based on national allocation assumptions. The Colombo share for gateway containers for example, sees a decrease to 88% on the basis that Hambantota and Trincomalee will see some container throughputs.
- High, base and low scenarios – These are derived from the national high base and low scenarios differing by economic assumptions multiplied by the Colombo Share.
- Difference 2016 – 2050 – This is the absolute difference between the 2016 historic throughput and the 2050 forecast.
- CAGR – Average growth rate for the years 2016 – 2050.

Summary Colombo Forecasts

	Demand 2016	Demand 2020	Demand 2025	Demand 2030	Demand 2050	Difference 2016 - 2050	CAGR
Gateway Containers							
Colombo Share	100.0%	99.0%	98.0%	95.0%	88.0%		
High	1,300	1,643	2,207	2,713	4,003	2,703	3.36%
Base	1,300	1,643	2,153	2,498	3,289	1,989	2.77%
Low	1,300	1,643	2,098	2,283	2,585	1,286	2.04%
Transhipment Containers							
Colombo Share	100.0%	100.0%	100.0%	100.0%	100.0%		
Base	4,355	5,775	5,873	6,433	12,671	8,316	3.19%
High	4,355	6,304	7,311	8,473	20,996	16,641	4.74%
Wheat / Maize / Corn							
Colombo Share	18.0%	16.7%	15.0%	15.0%	15.0%		
High	2,179	3,057	3,279	3,070	2,968	789	0.91%
Base	2,179	2,866	2,871	2,560	2,334	156	0.20%
Low	2,179	2,675	2,463	2,049	1,701	(477)	-0.72%
Cement / Clinker / Gypsum							
Colombo Share	56.0%	53.3%	50.0%	40.0%	30.0%		
High	190	211	257	315	380	190	2.06%

	Demand 2016	Demand 2020	Demand 2025	Demand 2030	Demand 2050	Difference 2016 - 2050	CAGR
Base	190	211	257	302	342	152	1.74%
Low	190	211	257	289	304	114	1.39%
Fertilizer							
Colombo Share	100.0%	55.6%	-	-	-		
High	314	160	-	-	-	(314)	-100.00%
Base	314	160	-	-	-	(314)	-100.00%
Low	314	160	-	-	-	(314)	-100.00%
Crude Oil							
Colombo Share	100.0%	100.0%	100.0%	33.3%	33.3%		
High	1,685	2,512	2,512	2,512	2,512	826	1.18%
Base	1,685	2,512	2,512	2,512	2,512	826	1.18%
Low	1,685	2,512	2,512	2,512	2,512	826	1.18%
Refined Oil							
Colombo Share	90.3%	76.9%	60.0%	50.0%	50.0%		
High	2,778	3,568	3,966	1,744	3,840	1,063	0.96%
Base	2,778	3,010	3,193	845	2,264	(514)	-0.60%
Low	2,778	2,451	2,420	-	687	(2,090)	-4.02%
LNG							
Colombo Share	-	100.0%	50.0%	50.0%	50.0%		
High	-	359	857	1,146	2,713	2,713	
Base	-	343	781	995	1,994	1,994	
Low	-	333	723	879	1,475	1,475	
Non-containerised General Cargo							
Colombo Share	66.5%	63.6%	60.0%	40.0%	20.0%		
High	855	949	1,054	757	555	(300)	-1.26%
Base	855	949	1,046	734	509	(346)	-1.51%
Low	855	949	1,038	711	465	(390)	-1.78%
RoRo Domestic							
Colombo Share	50.3%	36.8%	20.0%	15.0%	10.0%		
High	32	109	167	240	400	368	7.72%
Base	32	109	131	145	236	204	6.06%
Low	32	109	95	65	87	56	3.01%
RoRo Transhipment							

	Demand 2016	Demand 2020	Demand 2025	Demand 2030	Demand 2050	Difference 2016 - 2050	CAGR
Colombo Share	-	-	-	-	-		
High	1	-	-	-	-	(1)	-100.00%
Base	1	-	-	-	-	(1)	-100.00%
Low	1	-	-	-	-	(1)	-100.00%

ADB

Technical Assistance Consultant's Report

Project Number: 50184-001
February 2020

Democratic Socialist Republic of Sri Lanka: National Port Master Plan

(Financed by the Japan Fund for Poverty Reduction)

The Colombo Port Development Plan – Volume 2 (Part 6)

Prepared by

Maritime & Transport Business Solutions B.V. (MTBS)

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Appendix II Container Transhipment Forecasting Methodology

Forecast Methodology & Process

Transhipment is an ever-growing business for the port Colombo and the main source of this container traffic in the port outperforming gateway cargo as can be seen in Figure 20-5. Colombo's strategic and timely expansion and geographically position for transhipment towards East-India, Bangladesh, Myanmar, Maldives and for relay to West India, Pakistan and East Africa contributes to this growth. Growth in the past year has picked up significantly to 12% in 2016 with total transhipment throughput of 4.4 M TEU in that year. This is mainly due to the capacity upgrades of the port Colombo lying conveniently near the main East-West maritime trade route.

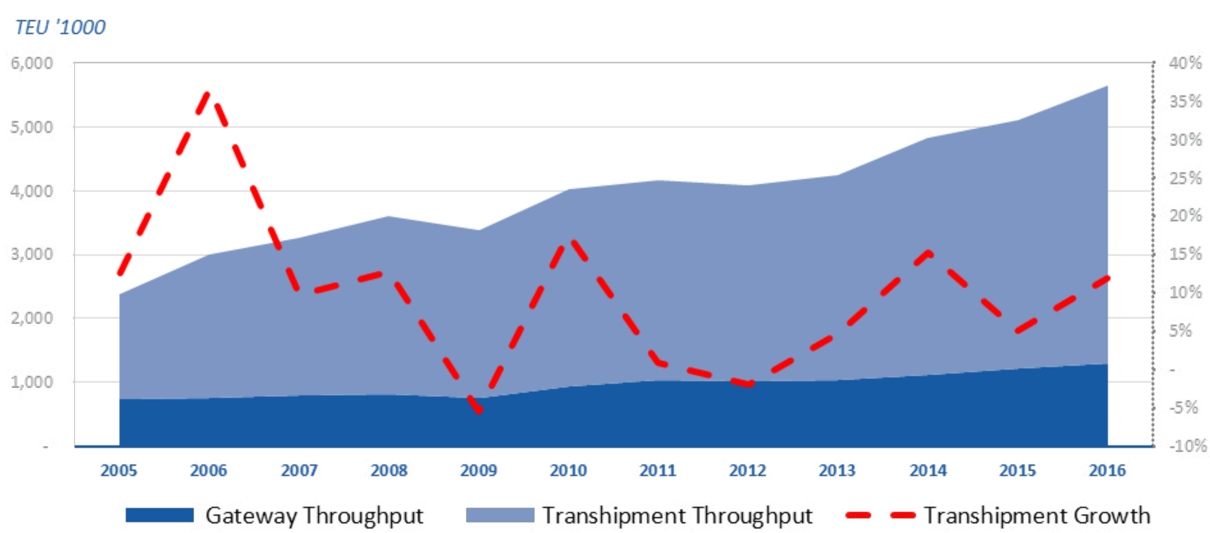
Colombo used to be dominant in transhipment to West India and the Middle East. The transhipment to west India has been reduced due to newly developed port facilities and the development of direct trades to this area. However, some relay transport has remained to these destinations. East India is still the traditional transhipment market contributing to most of the transhipment growth today.

Figure 20-5 also displays the volatile nature of the transhipment business though the trend has been positive with a CAGR of 4.9% in the past decade (2007 to 2016), the growth has fluctuated significantly with the global economy and trade. An important feature of the transhipment trade is the fact that it is "footloose". This means that shipping lines can easily redirect transhipment to other port along the transportation chain. Where they choose to perform their transhipment is driven by;

- suitability to handle Ultra Large Container Ships (ULCS);
- cost price of box handling;
- geographical location;
- quality of services rendered.

Competition is significant in this market with large transhipment ports like Singapore and Tanjung Pelepas along the same east-west corridors. The port of Colombo can maintain its position once cost price, and service levels (efficiency) remain competitive.

Figure 20-5: Throughput and Growth Transhipment Containers



Source: SLPA

Demand Driver & Proxy

Sri Lanka's transhipment trade mainly focuses on India, Bangladesh, the Maldives, and the Seychelles. Hence, the trade is mainly driven by (i) economic development and (ii) port development in these regions. Economic development of those regions drives the container consumption volumes, whereas (the lack of) port development drives the need for transhipment. Besides transhipment to feeder regions, transhipment at Colombo takes place because of Relay. The latter is the transhipment between two main vessels which connect at the transhipment hub to optimise the distribution to the end destinations.

Forecast Methodology & Process

Due to the importance of transhipment cargo for Sri Lanka's port volumes, the following detailed 8-step methodology has been applied for the forecast.

- Step 1 – Identification of relevant shipping loops: For each of Sri Lanka's transhipment areas, shipping loops are identified.
- Step 2 – Shipping loop data gathering and assessment: for each identified shipping loop, data regarding port rotation, weekly TEU capacity, number of loading and discharge ports, the type of loop, and the inclusion or exclusion of Colombo is gathered.
- Step 3 – Shipping loop volume estimation: based on the assessed data, each shipping loop's annual TEU volumes are estimated for the identified ports.
- Step 4 – Port throughput data gathering: actual 2015 TEU throughput data is obtained for ports in Sri Lanka's key transhipment regions.
- Step 5 – Shipping loop model calibration (country-level): there may be discrepancies between the estimated total shipping loop TEU volumes for a port (step 3) and the actual throughput at the port (step 4); such discrepancies may be caused by multiple factors, such as low utilization rates of some shipping loops. To control for such discrepancies, estimated TEU volumes of shipping loops are calibrated.
- Step 6 – Estimating Colombo market shares: given the adjusted shipping loop capacities (step 5), Colombo's volume share is estimated for each shipping loop.
- Step 7 – Shipping loop model calibration (overall): once Colombo's capacity share has been estimated for each of the identified transhipment regions (step 6), Colombo's total estimated capacity should equal Colombo's total actual transhipment volumes (2015: 3,888,321 TEU). If this is not the case, Colombo's forecast will be underestimated (if estimated volumes are lower than actual volumes) or overestimated (if estimated volumes are higher than actual volumes). As such, the total model is calibrated.

After step 7, Sri Lanka's current volumes for each of its transhipment markets can be derived. The table below provides an overview of the estimated 2015 volumes for each of the transhipment markets. Subsequently, assumptions concerning the transhipment markets are applied, in order to forecast Sri Lanka's future transhipment volumes towards these markets.

Table 20-18 Sri Lanka - Estimated Transhipment Volume Breakdown

Region	Port	Colombo Trade est. Volume (TEU)	Colombo est. Handlings (TEU)*
East India	Chennai	277,027	554,055
	Chidambaranar	411,576	823,153
	Visakhapatnam	119,940	239,880

Region	Port	Colombo Trade est. Volume (TEU)	Colombo est. Handlings (TEU)*
	Paradip	-	-
	Haldia	52,850	105,700
	Calcutta	76,536	153,073
	Total – East India	*937,930***	*1,875,860*
West India	Cochin	64,449	128,898
	Nhava Sheva (JNPT)	197,326	394,653
	Total – West India	*261,775***	*523,551*
Bangladesh	Chittagong	471,297	942,593
	Mongla	-	-
	Total - Bangladesh	*471,297*	*942,593*
Maldives	Male	*59,529*	*119,059*
Seychelles	Port Victoria	*1,966*	*3,932*
East & South Africa		*78,603*	*157,206*
Middle East, Mediterranean & U.S. East Coast		*113,087*	*226,175*
Total Estimated Colombo Transhipment			**3,848,375**
Total Actual Colombo Transhipment			3,888,321
Discrepancy (Allocated to "Other Markets")			39,946

Assumptions

In order to forecast Colombo's transhipment volumes, assumptions need to be made regarding economic development in Sri Lanka's transhipment markets, as well as regarding port development in Sri Lanka, its transhipment markets, and other regional hubs. The sections below provide an overview of the key assumptions applied to forecast transhipment container demand for each of the regions.

India

- Economic / Demographic Development Assumptions
  - World Bank population forecast up to 2050 has been employed.
  - IMF GDP forecast up to 2021 has been employed; MTBS has further projected GDP growth.
  - It is assumed that the Eastern regions of India will become increasingly important; as such, share of container consumption is assumed to partially shift towards East India over the forecast period.
- Transhipment Share Assumptions

- East India: currently, a majority of containers handled at East Indian ports is transhipped. It is assumed that deep sea ports will be developed in East India, thus decreasing the need for transhipment. Specifically, it is assumed that the transhipment share will decrease to 25% of total East Indian container demand by 2050.
- West India: currently, approximately 25% of containers handled at West Indian ports is transhipped. It is assumed that (new) deep sea ports will be developed in West India (e.g., Vizhinjam and Enayam / Colachel), thus decreasing the need for transhipment. Specifically, it is assumed that the transhipment share will decrease to 10% of total West Indian container demand by 2050.

- Sri Lanka Share of Transhipment Assumptions
  - East India: currently, over 40% of East India's transhipment containers is handled by Colombo port. It is expected that this market share will initially grow to 50% by 2030, due to Sri Lanka's favourable geographic location for this market and the expected implementation of the East Terminal and Hambantota Container Terminal. Subsequently, Sri Lanka's market share is assumed to decline to 40% by 2050, due to substantial development projects of other major regional hubs (e.g., the new Tuas Terminal in Singapore).
  - West India: currently, approximately 20% of West India's transhipment containers is handled by Colombo port. It is expected that this market share will not grow due to the implementation of the new terminals, as competition for transhipment to the West Indian market is more severe and Sri Lanka is less favourably positioned to serve the market. Subsequently, it is assumed that Sri Lanka's market share will decline from 2025 onwards, to a market share of 10% in 2050.

Bangladesh

- Economic / Demographic Development Assumptions
  - World Bank population forecast up to 2050 has been employed.
  - IMF GDP forecast up to 2021 has been employed; MTBS has further projected GDP growth.
- Transhipment Share Assumptions
  - Currently, more than 80% of container traffic towards/from Bangladesh is transhipped. This dependence on transhipment is assumed to decline from 2026 onwards, when several deep-sea port projects, such as Payra port and the less likely Sonadia port project, are expected to become operational. It is assumed that, by 2050, transhipped containers will comprise 40% of total container traffic.
- Sri Lanka Share of Transhipment Assumptions
  - Sri Lanka currently handles approximately 30% of transhipped containers to/from Bangladesh. This is expected to increase in the short term, due to the implementation of the East Terminal and Hambantota Container Terminal. Subsequently, Sri Lanka's market share is assumed to decrease due to development projects of other regional transhipment hubs. Specifically, Sri Lanka's transhipment market share is assumed to decrease to 25% by 2050.

Maldives

- Economic / Demographic Development Assumptions
  - World Bank population forecast up to 2050 has been employed.
  - IMF GDP forecast up to 2021 has been employed; MTBS has further projected GDP growth.
- Transhipment Share Assumptions
  - Currently, more than 70% of container traffic towards/from the Maldives is transhipped. This dependence on transhipment is assumed to remain over time, as no large port projects are planned.

As such, it is assumed that, by 2050, transhipped containers will comprise 74% of total container traffic.

- Sri Lanka Share of Transhipment Assumptions
  - Sri Lanka currently handles all of the transhipped containers to/from the Maldives. Sri Lanka's market share is assumed to remain constant over the forecasting period, due to its proximity to the Maldives.

Seychelles

- Economic / Demographic Development Assumptions
  - World Bank population forecast up to 2050 has been employed.
  - IMF GDP forecast up to 2021 has been employed; MTBS has further projected GDP growth.
- Transhipment Share Assumptions
  - Currently, approximately 65% of container traffic towards/from the Seychelles is transhipped. This dependence on transhipment is assumed to remain over time, as no large port projects are planned. As such, it is assumed that, by 2050, transhipped containers will comprise 64% of total container traffic.
- Sri Lanka Share of Transhipment Assumptions
  - Sri Lanka currently handles 6% of the transhipped containers to/from the Seychelles. Sri Lanka's market share is assumed to remain constant over the forecasting period.

Other Markets – Relay Services

- Demand Growth
  - Relay transhipment activities are carried out by shipping lines to shift cargo from one main service to another main service. As this trade exists purely due to the strategic considerations of the shipping lines, it does not fully follow the economic development of cargo destinations. Additionally, as it is expected that shipping lines will aim to minimize the amount of handlings in the shipping chain, it is assumed that the volumes of the relay services will grow slowly. Specifically, it is assumed that the relay to non-key markets of Sri Lanka will grow at a rate of 2% p.a.

Due to the importance of transhipment cargo for Sri Lanka's port volumes, the following detailed 8-step methodology has been applied for the forecast:

Step 1 – Identification of Relevant Shipping Loops

For each of Sri Lanka's transhipment areas, shipping loops are identified. Specifically, the following shipping loops are identified:

- East India – All shipping loops to major ports (Calcutta, Haldia, Paradip, Visakaphatnam, Chennai, and Chidambaranar (Tuticorin)).
- West India – All shipping loops to Nhava Sheva and Cochin, which accounted for >97% of West India port throughput in 2015.
- Bangladesh – All shipping loops to Chittagong port and Mongla port.
- Maldives – All shipping loops to Male port.
- Seychelles – All shipping loops to Port Victoria.
- East & South Africa – Shipping loops that call Colombo and either Mombasa (Kenya), Dar es Salaam (Tanzania), Djibouti (Djibouti) or Durban (South Africa).
- Middle East, Mediterranean & U.S. East Coast – Shipping loops that call Colombo, pass either Jebel Ali or Salalah, and move on to the Mediterranean or U.S. East Coast.

Example

Chidambaranar port (or Tuticorin) is called by the following 9 loops:

1) South India Feeder
2) Colombo-Goa-Mangalore shuttle (X-Press : GMX)
3) Colombo-Tuticorin shuttle (TUX) (KL : Swaco-P)
4) SCI Middle East India Liner Express service (SMILE)
5) Pan-India Express 1 (PIX 2)
6) Pan-India Express 1 (PIX 1)
7) Colombo-Cochin service (CCX) (KL : Swaco-H)
8) Colombo-Tuticorin service
9) Tuticorin Feeder

Step 2 – Shipping Loop Data Gathering and Assessment

For each of the identified shipping loops, the following data is assessed:

- Port rotation
- Weekly TEU capacity
- Number of loading ports / hub ports
- Number of discharge ports
- Focal port is a hub port or discharge port in the loop
- One-way or two-way cargo
- Colombo called in the loop or not
- Direct service or feeder loop

Example

The table below provides an overview of relevant data regarding the 9 identified loops that call Chidambaranar port.

Loop	Port Rotation	Weekly TEU Capacity	# Hub Ports	# Discharge Ports	Hub Port / Discharge Port	One-way / Two-way	Colombo called	Direct Service / Feeder Loop
1	Colombo, Cochin, Colombo, Tuticorin (DBGT), Colombo	1,145	2	2	Discharge Port	Two-Way	Yes	Feeder Loop
2	Colombo, Tuticorin, Goa (~Mormugao) (BTL only), Mangalore, Colombo	1,680	1	3	Discharge Port	Two-Way	Yes	Feeder Loop
3	Colombo, Tuticorin, Colombo	3,400	1	1	Discharge Port	Two-Way	Yes	Feeder Loop
4	Mundra, Jebel Ali, Mundra, Pipavav, Cochin, Tuticorin, Chennai, Katupalli, Krishnapatnam, Mundra	1,401	4	5	Discharge Port	Two-Way	No	Feeder Loop
5	Mundra, Kattupalli, Visakhapatnam, Kakinada, Tuticorin, Cochin, Jebel Ali, Mundra	1,977	4	3	Discharge Port	Two-Way	No	Feeder Loop
6	Mundra, Hazira, Cochin, Tuticorin, Cochin, Mangalore, Mundra	1,669	5	1	Discharge Port	Two-Way	No	Feeder Loop
7	Colombo, Cochin, Colombo, Tuticorin, Colombo	1,000	2	2	Discharge Port	Two-Way	Yes	Feeder Loop
8	Colombo, Tuticorin, Colombo	1,000	1	1	Discharge Port	Two-Way	Yes	Feeder Loop
9	Colombo, Tuticorin, Colombo	1,200	1	1	Discharge Port	Two-Way	Yes	Feeder Loop

Step 3 – Shipping Loop Volume Estimation

Based on the assessed data, each shipping loop's annual TEU volumes are estimated for the identified ports.

Example

The Chidambaranar feeder loop (shipping loop 9 in the previous table) is a simple feeder loop that shuttles between Colombo (the only hub port in the loop) and Chidambaranar (the only discharge port in the loop). As Chidambaranar is the only discharge port, it is assumed to absorb the full weekly capacity of 1,200 TEU (correction for the loading factor is done later). As it is assumed that the feeder vessels will also take empty containers, the weekly TEU capacity is doubled to 2,400 (two-way cargo flow). Hence, given a 52-week year, estimated annual capacity to Chadambaranar amounts to 124,800 TEU for this shipping loop.

In a similar fashion, the following estimated annual capacities have been determined for the 9 shipping loops that call Chidambaranar:

Loop	Port Rotation	Annual TEU
1	Colombo, Cochin, Colombo, Tuticorin (DBGT), Colombo	59,540
2	Colombo, Tuticorin, Goa (~Mormugao) (BTL only), Mangalore, Colombo	58,240
3	Colombo, Tuticorin, Colombo	353,600
4	Mundra, Jebel Ali, Mundra, Pipavav, Cochin, Tuticorin, Chennai, Katupalli,	29,141
5	Mundra, Kattupalli, Visakhapatnam, Kakinada, Tuticorin, Cochin, Jebel Ali,	68,536
6	Mundra, Hazira, Cochin, Tuticorin, Cochin, Mangalore, Mundra	173,576
7	Colombo, Cochin, Colombo, Tuticorin, Colombo	52,000
8	Colombo, Tuticorin, Colombo	104,000
9	Colombo, Tuticorin, Colombo	124,800
Total		**1,023,433**

**Note that these capacities only comprise the estimated annual capacity towards Chidambaranar, not the total capacity of the shipping loops.*

Step 4 – Port Throughput Data Gathering

Actual 2015 TEU throughput data is obtained for Sri Lanka's key transhipment regions. This data is shown in the table below.

Region	Port	2015 Throughput (x1,000 TEU)
East India	Calcutta	528
	Haldia	102
	Paradip	4
	Visakhapatnam	248
	Chennai	1,552
	Chidambaranar	560
West India	Cochin	366
	Nhava Sheva (JNPT)	4,467
	Other West India Ports	133
Bangladesh	Chittagong	1,867
	Mongla	42

Region	Port	2015 Throughput (x1,000 TEU)
Maldives	Male	80
Seychelles	Port Victoria	49

Step 5 – Shipping Loop Model Calibration (Country-Level)

There may be discrepancies between the estimated total shipping loop TEU volumes for a port (step 3) and the actual throughput at the port (step 4); such discrepancies may be caused by multiple factors, such as low utilization rates of some shipping loops. In order to control for such discrepancies, estimated TEU volumes of shipping loops are calibrated through applying the following restriction:

$$\sum_{j=1}^{n} Estimated\ Volume_{jk} = Actual\ Volume_{k}$$

Item	Description
Estimated Volume$_{jk}$	Estimated TEU volume from shipping loop *j* to port *k*
∑Estimated Volume$_{jk}$	The sum of estimated TEU volumes from all shipping loops to port *k*
Actual Volume$_{k}$	2015 Throughput for port *k*

This restriction is intuitive, as total TEU volumes transported by shipping loops to a certain port have to be equal to that port's total throughput.

Example

As can be observed from the step 3 example, the annual TEU capacity provided by shipping loops to Chidambaranar port amounts to 1,023,433 TEU. However, the table above shows that actual 2015 throughput at Chidambaranar port only amounted to 560,000 TEU. Consequently, the estimated TEU capacity needs to be adjusted downwards to more accurately reflect reality and to be in line with the restriction posed in step 5 (the sum of estimated shipping line volumes must equal actual throughput).

As Chidambaranar's actual throughput was 54.72% of the estimated throughput (560,000 / 1,023,433), a loading factor of 54.72% is applied to all shipping loop volumes for Chidambaranar port. Accordingly, the table on the next page shows the adjusted annual shipping loop capacities for Chidambaranar port.

Loop	Port Rotation	Annual TEU
1	Colombo, Cochin, Colombo, Tuticorin (DBGT), Colombo	32,579
2	Colombo, Tuticorin, Goa (~Mormugao) (BTL only), Mangalore, Colombo	31,868
3	Colombo, Tuticorin, Colombo	193,482
4	Mundra, Jebel Ali, Mundra, Pipavav, Cochin, Tuticorin, Chennai, Katupalli,	15,945
5	Mundra, Kattupalli, Visakhapatnam, Kakinada, Tuticorin, Cochin, Jebel Ali,	37,501
6	Mundra, Hazira, Cochin, Tuticorin, Cochin, Mangalore, Mundra	94,977
7	Colombo, Cochin, Colombo, Tuticorin, Colombo	28,453
8	Colombo, Tuticorin, Colombo	56,907
9	Colombo, Tuticorin, Colombo	68,288

Total	560,000

With these adjusted capacities, the sum of shipping loop volumes is equal to the port's actual throughput.

Step 6 – Estimating Colombo Market Shares

Given the adjusted shipping loop capacities (step 5), Colombo's volume share is estimated for each shipping loop. The share is impacted by the following 3 factors:

- Whether or not Colombo is called in the loop.
- Number of hub ports in the loop (higher number of hub ports results in a lower average share per hub port).
- Whether or not the loop is a direct service (in a direct service loop, Colombo and other hub ports may act as wayports; in this scenario, smaller shares of the capacity should be attributed to the way ports and higher shares should be attributed to the origin ports (e.g., ports in the Far East)).

Example

When looking at the 9th loop calling Chidambaranar port, the adjusted total capacity of 68,288 TEU is taken as the starting point. From the step 2 example, it can furthermore be observed that (i) Colombo is called in the loop; (ii) the loop has only 1 hub port (Colombo) and (iii) that the loop is classified as a feeder loop. As such, the following computations are carried out:

- The full capacity of 68,288 is attributed to Colombo, as Colombo is the only hub port in the feeder loop (68,288 / 1).
- As the loop is a feeder loop, Colombo is not seen as a wayport; as such, Colombo's share is not adjusted downwards.

Hence, Colombo's estimated share of the shipping loop volume to Chidambaranar port is 68,288 TEU. In a similar fashion, the following volumes are derived for Colombo's contribution to each of the shipping loops to Chidambaranar:

Loop	Adjusted Annual TEU Capacity	# Hub Calls	Colombo calls	Direct Service / Feeder Loop	Colombo TEU Capacity
1	32,579	2	2	Feeder Loop	32,579
2	31,868	1	1	Feeder Loop	31,868
3	193,482	1	1	Feeder Loop	193,482
4	15,945	4	-	Feeder Loop	-
5	37,501	4	-	Feeder Loop	-
6	94,977	5	-	Feeder Loop	-
7	28,453	2	2	Feeder Loop	28,453
8	56,907	1	1	Feeder Loop	56,907
9	68,288	1	1	Feeder Loop	68,288
Total Colombo Capacity					**411,576**
Colombo Share					*73.50%*

Step 7 – Shipping Loop Model Calibration (Overall)

Once Colombo's capacity share has been estimated for each of the identified transhipment regions (step 6), Colombo's total estimated capacity should equal Colombo's total actual transhipment volumes (2015: 3,888,321 TEU). If this is not the case, Colombo's foreacast will be underestimated (if estimated volumes are lower than actual volumes) or overestimated (if estimated volumes are higher than actual volumes). As such, the following restriction is applied:

$$\sum_{j=1}^{n} Estimated\ Volume_j = Actual\ Volume_{Colombo}$$

Item	Description
Estimated $Volume_j$	Colombo's estimated TEU volume for transhipment region *j*
∑Estimated $Volume_j$	The sum of Colombo's estimated TEU volumes for all transhipment regions
Actual $Volume_{Colombo}$	Actual total 2015 transhipment volumes for Colombo port

Example

Following the assessment of all of Colombo's identified transhipment services (comprising both end-feeder loops and relay services), the following volumes are estimated for the transhipment regions:

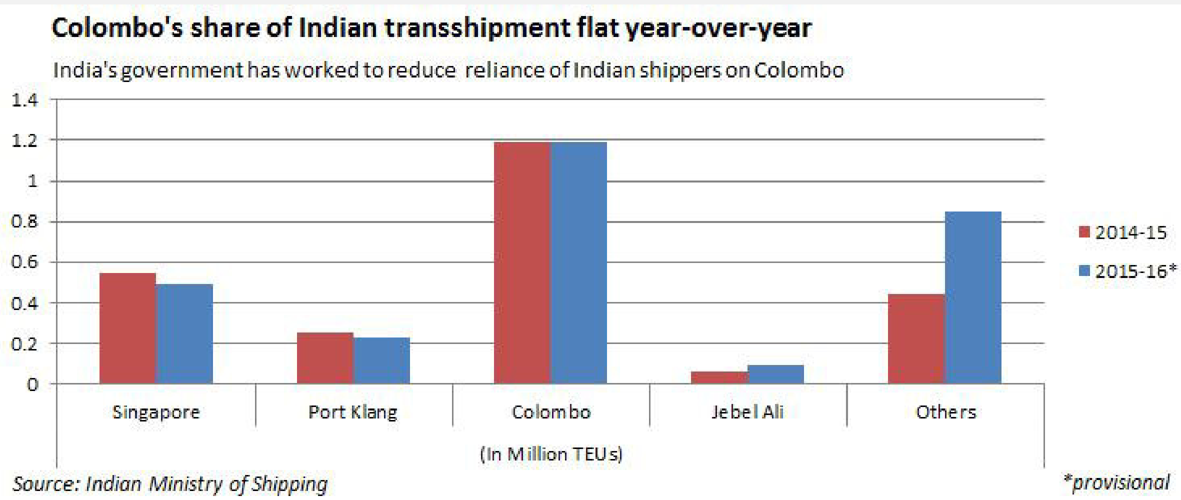
Region	Port	Colombo Trade est. Volume (TEU)	Colombo est. Handlings (TEU)*
East India	Chennai	277,027	554,055
	Chidambaranar	411,576	823,153
	Visakhapatnam	119,940	239,880
	Paradip	-	-
	Haldia	52,850	105,700
	Calcutta	76,536	153,073
	Total – East India	*937,930***	*1,875,860*
West India	Cochin	64,449	128,898
	Nhava Sheva (JNPT)	197,326	394,653
	Total – West India	*261,775***	*523,551*
Bangladesh	Chittagong	471,297	942,593
	Mongla	-	-
	Total - Bangladesh	*471,297*	*942,593*
Maldives	Male	*59,529*	*119,059*
Seychelles	Port Victoria	*1,966*	*3,932*
East & South Africa		*78,603*	*157,206*
Middle East, Mediterranean & U.S. East Coast		*113,087*	*226,175*

Total Estimated Colombo Transhipment	**3,848,375**
Total Actual Colombo Transhipment	3,888,321
Discrepancy	39,946

As each transhipped container to/from a transhipment market results in 2 handlings at the transhipment port (e.g., discharged from mother vessel and loaded onto feeder vessel), the estimated transhipment trade volumes need to be multiplier by 2 in order to arrive at the TEUs handled at Colombo.

***Colombo's total estimated transhipment trade to India amounts to 1,199,705 TEU. This is in line with figures made available by the Indian Ministry of Shipping (see figure on the next page).*

In order to account for the 39,946 TEU discrepancy, a transhipment category "other regions" has been added. The 39,946 TEUs have been allocated to this category.



Step 8 – Assumptions and Forecasting

In order to forecast Colombo's transhipment volumes, assumptions need to be made regarding economic development in Sri Lanka's transhipment markets, as well as regarding port development in Sri Lanka, its transhipment markets, and other regional hubs. The sections below provide an overview of the key assumptions used to forecast transhipment container demand for each of the regions. Subsequently, summarized forecast volumes are provided.

<u>8a TEU Demand Growth in Transhipment Markets</u>

First, the overall TEU demand growth of the transhipment markets is assessed, based on projected economic development of the markets. For the economic development projections, IMF World Economic Outlook (2017) growth projections have been applied for the period from 2017 to 2021. After 2021, MTBS has further projected economic development until 2050. The table below summarizes the estimated Base Case GDP growth figures for Sri Lanka's main feeder transhipment markets.

Item	Unit	2017	2018	2019	2020	2025	2030	2040	2050
India GDP Growth	% (constant prices)	6.72	7.37	7.80	7.93	7.50	5.50	4.67	3.00
Bangladesh GDP Growth	% (constant prices)	6.90	7.00	7.00	6.74	5.50	4.75	3.00	2.00
Maldives	% (constant prices)	4.06	4.72	4.72	4.78	4.40	4.00	3.00	3.00
Seychelles	% (constant prices)	3.50	3.41	3.31	3.33	3.41	3.50	3.00	3.00

Additionally, TEU-GDP growth multipliers have been projected for each of the feeder transhipment markets. The table below summarizes the projected multipliers.

Item	Unit	Actual	2017	2018	2019	2020	2030	2040	2050
India TEU-GDP Growth Multiplier	Factor	1.25*	1.20	1.20	1.20	1.20	1.10	1.00	1.00
Bangladesh TEU-GDP Growth Multiplier	Factor	1.03**	1.46	1.43	1.39	1.35	1.15	1.05	1.00
Maldives TEU-GDP Growth Multiplier	Factor	1.99***	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Seychelles TEU-GDP Growth Multiplier	Factor	-1.46****	1.00	1.00	1.00	1.00	1.00	1.00	1.00

*Average calculated over the period from 2006 to 2015. **Average calculated over the period from 2012 to 2015. ***Average calculated over the period from 2004 to 2015. However, due to substantial volatility in the period, a multiplier of 1.0 has been applied for the projection. ****Average calculated over the period from 2008 to 2015. However, due to substantial volatility in the period, a multiplier of 1.0 has been applied for the projection.

The table below summarizes the TEU trade demand forecasts for the feeder transhipment markets, which result from the historic demand and economic development projections.

Item	Unit	2015	2017	2018	2019	2020	2030	2040	2050
India TEU Demand	'000 TEU	12,392*	14,838	15,939	17,048	18,156	31,529	46,216	58,871
West India Share	*%*	*75.00*	*74.00*	*73.50*	*73.00*	*72.50*	*70.00*	*60.00*	*60.00*
East India Share	*%*	*25.00*	*26.00*	*26.50*	*27.00*	*27.50*	*30.00*	*40.00*	*40.00*
West India TEU Demand	*'000 TEU*	*9,294*	*10,980*	*11,715*	*12,445*	*13,163*	*20,494*	*27,730*	*35,332*
East India TEU Demand	*'000 TEU*	*3,098*	*3,858*	*4,224*	*4,603*	*4,993*	*11,035*	*18,487*	*23,548*
Bangladesh TEU Demand	'000 TEU	1,909	2,320	2,551	2,799	3,054	5,862	8,870	11,054
Maldives TEU Demand	'000 TEU	80	86	90	94	99	152	213	286
Seychelles TEU Demand	'000 TEU	49	54	55	57	59	83	114	153

*Including throughput at minor ports.

As relay transhipment is driven by other factors than economic development of the market, the relay market forecast is not based on economic development. Rather, a 2% annual growth rate is applied for the relay markets. The table below summarizes the resulting development of relay demand, in terms of TEU handlings at Sri Lanka's ports.

Item	Unit	2015	2017	2018	2019	2020	2030	2040	2050
East & South Africa Relay	'000 TEU	157	164	167	170	174	212	258	314
ME, MED & USEC Relay	'000 TEU	226	235	240	245	250	304	371	452
Other Markets Relay	'000 TEU	40	42	42	43	44	54	66	80
Total Relay	**'000 TEU**	**423**	**440**	**449**	**458**	**467**	**570**	**695**	**847**

8b Direct Trade vs Transhipment in Feeder Markets

In a second step, the development of direct trades in Sri Lanka's feeder markets is projected, based on expected port developments in these markets. The table below summarizes identified deep sea port capacity development plans in the key feeder markets that are foreseen to accommodate increasing direct trade volumes in the future – East India, West India, and Bangladesh.

Port	Initial Capacity		Expansion Capacity	
	TEU	Year	TEU	Year
East India				
Ennore	800,000	2017	600,000	2025
Visakhapatnam	360,000	2015	1,640,000	2020
Krishnakapatnam	1,200,000	2015	3,000,000	2025
Chennai	2,500,000	2015	4,000,000	2035
Kattupalli	1,200,000	2015	1,200,000	2020
Vizhinjam*	225,000	2019	193,750	2030
Colachel*	400,000	2020	1,600,000	2030
West India				
Mundra	3,300,000	2015	3,300,000	2018
JNPT	5,000,000	2015	4,800,000	2020
Cochin	1,000,000	2015	3,000,000	2025
Pipapav	850,000	2015	500,000	2016
Vizhinjam**	225,000	2019	193,750	2030
Colachel**	400,000	2020	1,600,000	2030
Bangladesh				
Chittagong	2,000,000	2015	3,570,000	2025
Payra	6,000,000	2023	-	-

*Assumed share of capacity that will be used for gateway cargo for East India; **Assumed share of capacity that will be used for gateway cargo for West India

Additionally, it is expected that deep-sea capacity in these regions will continue to expand after completion of the currently identified projects. As such, capacity growth beyond 2030 is estimated based on the identified capacity development plans between 2021 and 2030. The table below summarizes total expected capacity development for each of the regions.

Item	Unit	Value
East India		
Deep Sea Capacity Development Growth 2021 – 2030*	%	64.79
Estimated Deep Sea Capacity Development Growth 2031 – 2040**	%	50.00
Estimated Deep Sea Capacity Development Growth 2041 – 2050***	%	30.00
2015 Deep Sea Capacity	M TEU	5.3
2050 Deep Sea Capacity	M TEU	33.2
West India		
Deep Sea Capacity Development Growth 2021 – 2030*	%	24.74
Estimated Deep Sea Capacity Development Growth 2031 – 2040**	%	25.00
Estimated Deep Sea Capacity Development Growth 2041 – 2050***	%	25.00
2015 Deep Sea Capacity	M TEU	10.2
2050 Deep Sea Capacity	M TEU	37.8
Bangladesh		
Deep Sea Capacity Development Growth 2021 – 2030*	%	479.00
Estimated Deep Sea Capacity Development Growth 2031 – 2040**	%	0.00
Estimated Deep Sea Capacity Development Growth 2041 – 2050***	%	0.00
2015 Deep Sea Capacity	M TEU	2.0
2050 Deep Sea Capacity	M TEU	11.6

*Vis-à-vis 2020 capacity, fully based on identified projects; **Vis-à-vis 2030 capacity, based on identified projects and expected new projects; ***Vis-à-vis 2040 capacity, based on expected new projects.

It is noted that it is not expected that the full deep sea port capacity will be used for direct trade. The table below presents the expected share of deep sea capacity that will be used for direct trade over time, based on calculated 2015 base figures and an expected gradual increase in direct trades. Note that these figures concern the share of deep sea capacity that is used for direct trades, not the share of total demand that is served through direct trades.

Item	Unit	2015*	2050
East India (% of Deep Sea Capacity used for Direct Trade)	%	17.11	40.00
West India (% of Deep Sea Capacity used for Direct Trade)	%	78.81	85.00
Bangladesh (% of Deep Sea Capacity used for Direct Trade)	%	16.63	30.00

*Calculated based on shipping line analysis in steps 1 – 7 and identified current deep sea capacity.

The assumptions posited above result in the following development of direct trade and feeder transhipment demand in the regions over time.

Item	Unit	2015	2017	2018	2019	2020	2030	2040	2050
East India									
Direct Trade	'000 TEU	890	1,116	1,156	1,240	1,478	4,016	8,625	13,261
Transhipment Trade	'000 TEU	2,198	2,742	3,068	3,363	3,515	7,019	9,861	10,288
Direct Trade Share of Total Trade	%	29.05%	28.93%	27.36%	26.93%	29.60%	36.39%	46.66%	56.31%
Transhipment Handlings*	'000 TEU	4,396	5,484	6,136	6,726	7,030	14,038	19,723	20,575
West India									
Direct Trade	'000 TEU	7,999	8,193	8,814	9,617	11,328	19,688	25,145	32,099
Transhipment Trade	'000 TEU	1,295	2,787	2,901	2,828	1,835	806	2,585	3,223
Direct Trade Share of Total Trade	%	86.06%	74.62%	75.24%	77.28%	86.06%	96.07%	90.68%	90.87%
Transhipment Handlings*	'000 TEU	2,590	5,575	5,801	5,655	3,670	1,611	5,170	6,446
Bangladesh									
Direct Trade	'000 TEU	333	348	355	363	371	2,587	3,029	3,471
Transhipment Trade	'000 TEU	1,576	1,972	2,196	2,436	2,683	3,276	5,841	7,583
Direct Trade Share of Total Trade	%	17.42%	14.99%	13.93%	12.97%	12.14%	44.13%	34.15%	31.40%
Transhipment Handlings*	'000 TEU	3,153	3,944	4,392	4,872	5,366	6,551	11,683	15,167

*For transhipment hubs, each import/export container to/from the feeder port is handled twice.

8c Inter Hub Group Competition

The next step comprises an assessment of the competitive positions of the major transhipment hub groups. The following hub groups have been identified:

- South Asia Hub – Colombo, Hambantota, Vizhinjam, and Colachel
- South East Asia Hub – Singapore, Tanjung Pelepas, and Port Klang
- Middle East Hub – Jebel Ali, Khalifa, and Salalah

Given the locations of the hub groups, each hub group has its own focus market. The table below presents the assumed Base Case hub group market shares for each of the key feeder regions.

Item	Unit	East India		West India		Bangladesh	
		2015	2050	2015	2050	2015	2050
South Asia Market Share	%	42.67%*	42.67%	20.21%*	20.21%	29.90%*	29.90%
South East Asia Market Share	%	47.33%	47.33%	49.79%	49.79%	-	-
Middle East Market Share	%	10.00%	10.00%	30.00%	30.00%	70.10%	70.10%

*Based on shipping line analysis in steps 1 - 7

8d Intra Hub Group Competition

In a final step, the market share of Sri Lankan ports within the South Asia Hub needs to be determined. Thereto, the following Base Case assumptions have been applied:

- No transhipment cargo is allocated to Hambantota as Colombo remains the dominant port in Sri Lanka.
- Transhipment capacity at Vizhinjam and Colachel is calculated by subtracting the direct trade capacity (as presented in step 8b) from total capacity. Due to a dominant competitive position of Colombo vis-à-vis these ports, it is assumed that transhipment demand will be restricted at Vizhinjam and Colachel. The following restrictions are assumed to reflect the dominance of Colombo:
  - For East India transhipment cargo, utilization of the combined East India transhipment capacity at Vizhinjam and Colachel will not exceed 50%.
  - For East India transhipment cargo, combined throughput at Vizhinjam and Colachel will not exceed 50% of total East India South Asia Hub transhipment demand.
  - For West India transhipment cargo, utilization of the combined West India transhipment capacity at Vizhinjam and Colachel will not exceed 60%.
  - For West India transhipment cargo, combined throughput at Vizhinjam and Colachel will not exceed 60% of total West India South Asia Hub transhipment demand.
  - For Bangladesh transhipment cargo, utilization of the combined Bangladesh transhipment capacity at Vizhinjam and Colachel will not exceed 50%.
  - For Bangladesh transhipment cargo, combined throughput at Vizhinjam and Colachel will not exceed 50% of total Bangladesh South Asia Hub transhipment demand.

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Appendix III Economic Scenarios

GDP per Capita Developments

Sri Lanka's economy is transitioning and the country is facing financial challenges. The significant trade deficit causes an outflow of international monetary reserves, leading to lower exchange rates. Government finances are negatively impacted by this development; as external debt is in foreign currency. Government debt to GDP is currently at 75%, but several successful measures have been taken by the government.

For the purpose of the traffic forecast three scenarios for the Sri Lankan economy are identified by the consultant:

- "Accelerated growth" (High) - Sri Lanka develops fast and outpaces its regional competitors. In 2050 Sri Lanka is strong regional maritime and trading hub including new industrial complexes.
- "Developed Nation" (Base) - Sri Lanka is a developed nation in 2050 with its entire population out of poverty. It has become a net exporter and a medium regional player.
- "Slow Growth" (Low) - Sri Lanka has a slow economic growth. In 2050 its export industry has not fully developed.

The most likely population forecast is used for each scenario to reduce complexity. The following assumptions underlie the three scenarios:

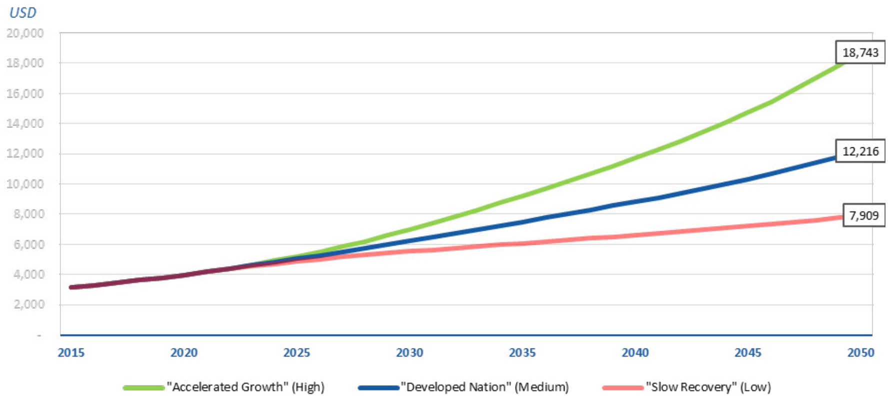
Table 20-19: GDP Growth Scenarios Overview

Scenario	GDP / Capita 2015 (USD Constant 2010)	Population Forecast	GDP Growth Rate 2010 – 2015 (IMF)	GDP Growth Rate 2015 – 2021 (IMF)	GDP Growth Rate 2021-2030	GDP Growth Rate 2031-2040	GDP Growth Rate 2041-2050	GDP / Capita 2050 (USD Constant 2010)	Economy Comparable to
"Accelerated growth"	3,156	Most Likely	6.4%	5.18%	5.92%	5.25%	4.50%	18,743	Czech Republic & Saudi Arabia 2015
"Developed Nation"	3,156	Most Likely	6.4%	5.18%	4.81%	3.50%	3.00%	12,216	Croatia & Russia 2015
"Slow Growth"	3,156	Most Likely	6.4%	5.18%	3.70%	1.75%	1.50%	7,909	Colombia 2015

Source: MTBS

Based on the Base population Figure 20-6 presents the GDP per capita forecast which will be used in the commodity forecasts.

Figure 20-6: GDP per Capita Forecasts



Source: MTBS

Appendix IV Land Use Plan Colombo

The Colombo land use plan highlights the intended function of port lands. The colours represent different classification in the port. The zonal plan does not make an assumption about land ownership, although most areas in the port are owned by SLPA. The table below outlines the legend and classification of lands.

Legend and Explanation Port Land Use Map

Legend	Classification	Explanation
	Area Reserved for Connectivity	The Port Access Elevate Highway has access ramps near SAGT and CICT which is reserved.
	Auxiliary Port Function	Auxiliary port functions include marine services, water supply, bunkering etc.
	Commercial / Industrial Development	Commercial and industrial lands are used by private parties for non-water bound activities.
	Logistics and Warehousing	Logistics and warehousing areas in and outside the port.
	Special Study Area	Special study areas lack the
	Port Support	Port support functions are labelled for Customs and Navy.
	SLPA owned Facilities	SLPA owned facilities and
	Rail Reservation	A reservation for potential future rail line heading to South Port.
	Port Road and PAEH	Port roads and Port Access Elevated Highway.

The following page contains the overall land use plan of South Port, the old port basin and the areas around Bloumendhal Hill. These areas each have a separate paragraph with details.

Colombo Land Use Map

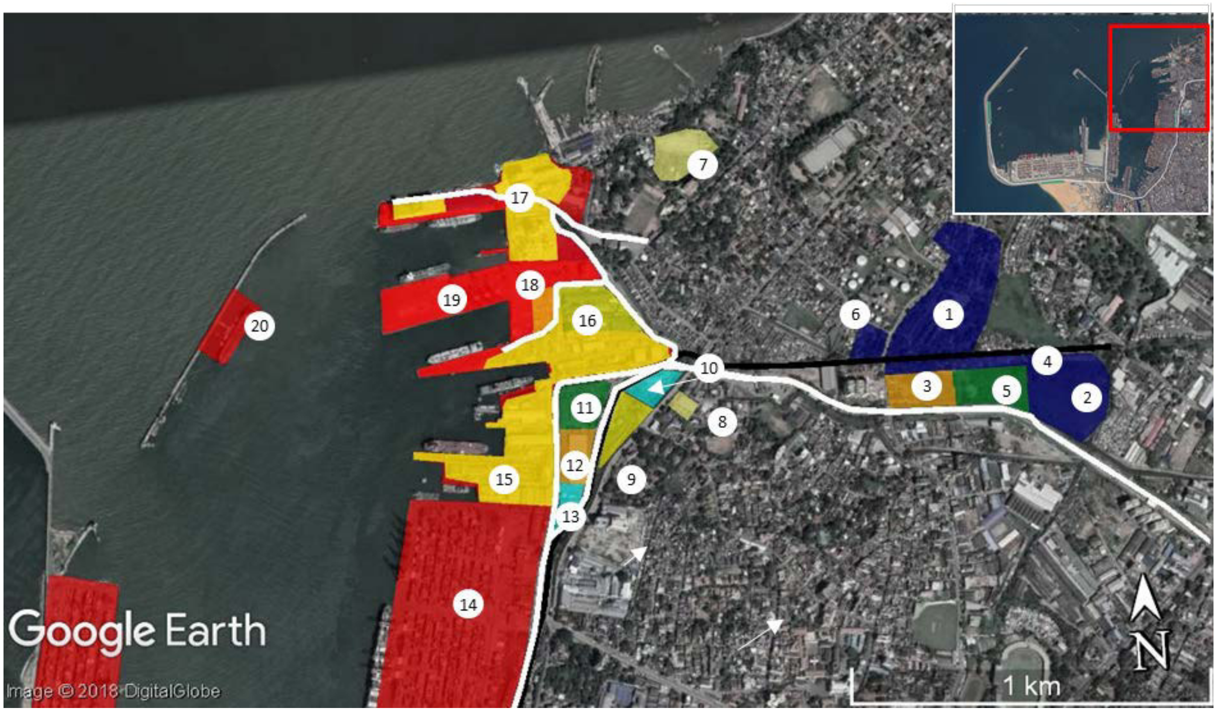
South Port Land Use Plan

1	CICT
2	Study Area South Port Corner
3	Special Study Area “Triangle
4	Harbour Master and Tugs
5	Special Study Area LNG
6	Rail Reservation
7	Port Roads and PAEH
8	ECT

BQ and Surrounding Area Land Use Plan

1	Port Terminal – Passenger Terminal	7	Customs Building
2	Special Study Area	8	SLPA Facility
3	Navy	9	Special Study Area "Triangle
4	SLPA administration Facility	10	PAEH Ramp Reservation
5	Marine Services	11	PAEH
6	Marine Services	12	SAGT

Bloumendhal Hill, PVQ and UCT Land Use Plan



1	Special Study Area – SLPA expansion	11	Customs
2	Special Study Area – SLPA expansion	12	Warehousing & Logistics
3	Warehousing & Logistics	13	Fire Department
4	Special Study Area – Rail Reservation	14	Port Terminal – JCT
5	Customs	15	Colombo Dockyards
6	Special Study Area	16	Commercial Warehouses
7	Training Institute	17	Dry Bulk Industries
8	SLPA Housing	18	Warehousing & Logistics
9	Commercial Use -	19	Port Terminal
10	Auxiliary Function	20	Port Terminal

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Appendix V Regulations for Social Safeguards

A1.1 Land Acquisition Act (LAA) No.09 of 1950 as amended and Regulations

The Land Acquisition Act of 1950 is the principal Act which governs the acquisition of private land for public purposes. The Act is based on the principal of Eminent Domain, though it was amended several times, last amendment being in 1986, there was no attempt to change the principles outlined in the Act on compensation, The people who lose, in fact sacrifice, their property for development projects that benefits the larger society had been treated unfairly in most places including Sri Lanka but they have been often viewed as development refugees and the payment of compensation has been characterized by delay and under valuation. The land acquisition act of Sri Lanka did not address the issues mentioned above and the compensation procedure that existed did not provide provisions to restore the socio-economic conditions of the affected people at least to the pre-project level until regulations pertaining to payment of compensation passed in Parliament in 2008 and made public by the Government Gazette No.1956/12 dated 07th April 2009.

NGOs and other pressure groups played a significant role to influence the legislators to pass these regulations though it fell short of amending the relevant clauses of the Act. Nevertheless, regulations are part of the Act and recognized by law. The main features of the regulation are that the provisions have been made for the payment of Market Value for the portion of the land that is acquired if the acquired land as an entity realize a value lower than the Market Value of the land, if it is sold as a whole parcel. Replacement cost for structures is another salient feature of the approved regulations. Payment of disturbances and other expenses are categorized under 12 sub headings. The operational procedures of the LAA are laid down in detail and under it claimants are paid only the depreciated value for structures which often lead to difficulties in resettling affected people. Under LAA, any aggrieved party on the valuation determined by the Department of Valuation could appeal to the Land Acquisition Review Board (LARB). If not satisfied with the decision of the LARB an appeal could be made to the Supreme Court (SC). But experience reveals that the procedures adopted by the LARB and the litigation is time-consuming, and the quantum of increase received by the appellants have been very much not to the satisfaction of the affected. With the introduction of Land Acquisition and Resettlement Committee System (LARC) introduced in 2001 after the adoption of NIRP by the government provided a friendly and less time-consuming platform for the affected to seek redress for compensation issues. LARC was replaced by 2008 regulations and re-introduced in 2013 for 18 designated road projects and subsequently extended to a few other projects within and outside the road sector. With the promulgation of 2008 and 2013 regulations the compensation is now computed by the Valuation Department based on the provisions of the relevant regulations and ex-gratia payment is decided by the LARC. Yet compensation for loss of income for formal businesses is subject to provisions of LAA.

It is assumed that compensation for the acquisition of land for the projects under National Port Master Plan will be based on 2008 regulations which allow the APs to receive compensation for:

i. land at market value and for
ii. structures at replacement cost (market value)

iii. when the date of intention to acquire was published, if the building is used for occupation or business purpose or intended to be used for such purposes, the difference between cost of re-construction and the value of building should be paid as an additional compensation.

iv. damage caused by any severance should be paid in full in addition to the compensation for land and structures. There are 12 categories of payments for disturbances and other expenses.

If the National Port Master Plan is included by the cabinet of ministers of the GOSL as a designated project under the 2013 rules, the affected will benefit more as the compensation scheme approved under 2013 rules provide more benefits to the affected. There is an inbuilt appeal procedure if the affected person (AP) is not satisfied with the compensation offered to him. The appeal committee is designated as Land Acquisition and Resettlement Committee (LARC) chaired by the relevant Divisional Secretary of the area where the land is located, assisted by representatives of Valuation and Survey Department, and from the project. Any AP who is aggrieved by the decision of the LARC could appeal to a forum designated as Super LARC chaired by the Secretary to the line ministry which implement the project (details of the regulations are given in the Gazette notifications of 2008 and 2013).

The Act discourages the unnecessary acquisition and land acquired for one purpose cannot be used for any other purpose, if it is not required by the state after acquisition, it should be returned to the original owner subject to full filling following requirements:

1. No development had taken place in the acquired land
2. Even part of compensation not paid
3. It had not been used for a public purpose
4. After publishing the gazette notice for dispossession, the original owner has consented to accept the land back.

The valuation for the payment of compensation is based on the principles laid down in the National Policy on Involuntary Resettlement (NIRP) approved by the government of Sri Lanka in 2001.

A1.2 National Involuntary Resettlement Policy (NIRP)

The cardinal principles of the NIRP imply that the affected (persons) are compensated at replacement cost, incomes rehabilitated, and they are resettled if resettlement is triggered. The affected should not be impoverished and the project proponent should ensure that the APs at least should enjoy the pre-project level standard of living but try to ensure a better level of living than what they enjoyed prior to the project. The operational policies of the NIRP require that resettlement is avoided or minimized as far as possible by exploring viable alternatives at the project design stage. The project should be a development opportunity for the affected too.

Rationale of NIRP

In Sri Lanka, the Land Acquisition Act (LAA) and subsequent regulations enacted by parliament only provides for compensation for land and structure and loss of income of some categories. It does not require project executing agencies to address key resettlement issues such as exploring alternative project options that avoid or minimize impacts on people, compensating those who do not have title to, but are currently using and dependent on land, or implementation of income restoration measures aimed at the social and economic rehabilitation of displaced APs. It does not adequately deal with the impacts on those occupiers of lands who do not possess title to the land in occupation but whose lands are taken over for development purposes.

The policy aims to ensure that displaced affected persons are treated in a fair and equitable manner, and to particularly ensure that people are not impoverished or suffer unduly as a result of public or private project implementation. Sri Lanka has adopted a national policy to protect the rights of all people affected by development projects. To remedy the current gaps in the LAA in addressing key resettlement issues, the Cabinet of Ministers approved on 16th May 2001, the National Policy on Involuntary Resettlement (NIRP). And enunciated its adoption to all development induced resettlement. The Ministry of Land and Land Development has the institutional responsibility for implementing the NIRP. The newly adopted policy principled on human, ethical considerations entails the payment of resettlement value (replacement cost) and arranges for their resettlement and where necessary even their rehabilitation. Even though the NIRP is not in the statute book, the policy was adopted by the Government of Sri Lanka (GOSL) for the projects funded by Asian Development Bank (ADB), the World Bank (WB) and the Japanese Bank for international Cooperation (JBIC) after its adoption in 2001 and subsequently for all projects whether funded by donors or GOSL.

NIRP was first implemented to address the issues of APs of the Southern Transport Development Project (STDP). The rules enacted in parliament in 2008 and 2013 were to give legitimacy to the provisions of the NIRP. Any public official who contravenes the NIRP is subject to disciplinary actions by the heads of respective organizations. It is an issue that can be raised at Parliamentary select committee by a member of parliament on behalf of the APs or inquired by the Ombudsman of Parliament, Human Rights Commission or by courts of Law. In fact, the highest court of Sri Lanka has recognized the NIRP could be treated as an obligation of the state towards the affected. Case of RDA vs. Mundy is a good example. Land Acquisition Review Board which is the legal body under the LAA to review the appeals against compensation issues often referred the applicants back to LARC in the past as the LARC system is more beneficial and expeditious in arriving at a decision on compensation issues. As a result there were hardly any appeals directed to LARB by the Aps where LARC system was in operation. The practice had been in the past to follow the polices of ADB, WB, JBIC and other relevant donors when there exists an ambiguity between donor policy and NIRP/LAA. At close examination it appears that the NIRP and donors policies particularly that of ADB and WB are at congruent in most of the issues. Contravention of provisions of the RAP which is prepared based on NIRP and donor policies could invite sanctions from the donors too.

Objectives of the NIRP policy

To avoid, minimize and mitigate negative impacts of involuntary resettlement by facilitating the re-establishment of the displaced people on a productive and self-sustaining basis. The policy should also facilitate the development of the project displaced people and the project.

- To ensure that people adversely displaced by development projects are fully and promptly compensated and successfully resettled. The livelihoods of the displaced people in dealing with the psychological, cultural, social and other stresses caused by compulsory land acquisition.
- To ensure that no impoverishment of people shall result as a consequence of compulsory land acquisition for development purposes by the state.
- To assist adversely affected people in dealing with the psychological, cultural, social and other stresses caused by compulsory land acquisition.
- To make all displaced people aware of processes available for the redress of grievances that are easily accessible and immediately responsive.
- To have in place a consultative, transparent and accountable involuntary resettlement process with a time frame agreed to by the PMU and the affected people.

- To have in place a consultative transparent and accountable involuntary resettlement process with time frame agreed to by the PEA and the displaced people.

Scope of the NIRP Policy

The policy apply to all development projects, induced land acquisition or recovery of possession by the state.

- A comprehensive RAP (Resettlement Action Plan) will be required where 20 or more families are displaced.
- If less than 20 families are displaced the policy still applies but a RAP requires a lesser level of detail.
- The policy will apply to all projects regardless of source of funding.
- The policy will apply to all projects in the planning phase on the date this policy comes into effect, and all future projects.

Policy principles

- Involuntary resettlement should be avoided or reduced as much as possible by reviewing alternatives to the project as well as alternatives within the project.
- Where involuntary resettlement is unavoidable displaced people should be assisted to re-establish themselves and improve their quality of life.
- Gender equality and equity should be ensured and adhered to throughout the policy.
- Displaced people should be fully involved, in the selection of relocation sites, livelihood compensation and development options at the earliest opportunity.
- Replacement land should be an option for compensation in the case of loss of land if suitable state and is available, in the absence of replacement of land cash compensation should be an option for all displaced persons.
- Compensation for loss of land, structures, other assets and income should be based on full replacement cost and should be paid promptly by the project executing agency
- Resettlement should be planned and implemented with full participation of the provincial and local authorities.
- To assist those displaced to be economically and socially integrated into the host communities; participatory measures should be designed and implemented.
- Common property sources and community and public services should be provided to displaced people.
- Resettlement should be planned as a development opportunity for the displaced people.
- Displaced /affected persons should be identified and given appropriate assistance to substantially improve their living standards.
- Affected persons who do not have documented title to land should receive fair and just treatment.
- Vulnerable groups are to be identified and given appropriate assistance to substantially improve their living standards
- The adoption of NIRP in its entirety will make it possible to confirm fully to the bank policies, if the project is to be implemented with donor funding

A1.3 Women Charter of Sri Lanka

When displacement of people occurs due to implementation of projects by the state, the impact of such projects on the women and children should be considered in detail and mitigation measures should be implemented.

The State policy on women in Sri Lanka is clearly spelled in the Sri Lanka Women's Charter of 1993, which is based on United Nation Convention on the Elimination of all forms of Discrimination against Women (UNCEDAW) and was a collaborative effort of the state institutions and women's NGOs. Seven areas of issues, specific to women in Sri Lanka have been addressed.

- Civil and political rights,
- Right to education and training,
- Right to economic activity and benefits,
- Right to healthcare and nutrition,
- Right within the family,
- Right to protection from social discrimination
- Right to protection from gender based violence

The Charter provides for the establishment of the National Committee on Women (NCW) which comprises experts from fourteen sectors and a Chairperson, who are appointed by the Executive President. The NCW is mandated to monitor and ensure the implementation of the provisions of the Charter. Above policies should be adhered to by the project in dealing with women's issues.

Under the national Women's Charter every form of discrimination against women has been removed. The national charter is in conformity with the UN convention against any form of discrimination against women. Women in Sri Lanka were entitled to voting rights before their counterparts in Great Britain. Child labour is prohibited in the country, primary education is compulsory for all children and there are number of ordinances passed by the parliament to prevent abuse and discrimination against women. There are special government agencies to oversee the problems pertaining to children named as National Child Protection Authority (NCPA) and Department of Probation and Child Care Services. (DP&CS) In every police station there is a division to look into offences against women and children. This division is normally headed by a female inspector.

A1.4 Procedure to follow in retrenchment of employees

Retrenchment of employees is governed by the Labour Termination Act passed by the Parliament of Sri Lanka and in operation for the past few decades. This act comes under the Purview of the Labour Department, part of the Ministry of Labour and Trade Union Relations.

According to the Labour Termination Act, the organization, planning to retrench staff, should get the consent of individual employees to accept the package offered by the employer to leave the organization. The gratuity offered to the employee, identified for retrenchment, should commensurate with his/her period of service.

If the employee is not willing to accept the package and retire, the employer should apply to the Commissioner General of Labour (CGL) /Labour Tribunal (LT) giving reasons for the requirement for retrenchment and on receipt of the approval from the CGL or TL and on the conditions stipulated by the CGL or TL, the retrenchment could be effectuated.

The employees who are aggrieved by the action of the employer in respect of the compensation paid by the employer has the right to appeal to CGL or TL for redress.

A1.5 International Social Safe Guard Policies

The main multinational and bilateral donor agencies such as the Asian Development Bank (ADB), World Bank (WB) Japanese Bank for International Corporation (JBIC) etc. are very concerned of affected people due to acquisition of properties by the governments for development projects. The main concepts of the international lending agencies are that the affected should be treated in just and fair manner and compensation should be adequate to replace their lost assets. People should not be impoverished because of the acquisition and at least pre-project socio-economic status of the affected should be maintained but project should endeavour to achieve better. The people without legal titles to their land should be treated fairly. The project should be considered as a development opportunity for the affected and some benefits of the project should flow onto the affected people.

The current project needs to comply with the Asian Development Bank's Social Safeguard Statement of 2009. The main features of ADB's policies are:

a. Payment of Market Value for land
b. Replacement Cost for structures without deductions for salvage material
c. Payment of compensation for loss of income
d. Payment of compensation for loss of livelihood
e. Payment for all other losses resulting in acquisition
f. Income restoration mechanism to maintain at least pre-project level income but project should attempt to improve them above pre-project level standard.
g. Treat people without legal titles to land fairly and reasonably without discrimination
h Measures to improve the living standards of the vulnerable categories
i. Grievance Redress Mechanism to address the project related grievances of the affected
j. Takeover of land after payment of full compensation
k. Consultation and information dissemination process.
l. Rehabilitation and resettlement
m. Preparation of a comprehensive Resettlement Action Plan (RAP) if the number of displaced people is over 200
n. Implement resettlement component of the project as a stand-alone operation.

The usual steps to be taken to comply with ADB's policies include:

1. Screen the project early on to identify past, present, and future involuntary resettlement impacts and risks. Determine the scope of resettlement planning through a survey and/or census of displaced persons, including a gender analysis, specifically related to resettlement impacts and risks.
2. Improve the standards of living of the displaced poor and other vulnerable groups, including women, to at least national minimum standards. In rural areas provide them with legal and affordable access to land and resources, and in urban areas provide them with appropriate income sources and legal and affordable access to adequate housing.
3. Develop procedures in a transparent, consistent, and equitable manner if land acquisition is through negotiated settlement to ensure that those people who enter into negotiated settlements will maintain the same or better income and livelihood status.
4. Disclose a draft resettlement plan, including documentation of the consultation process in a timely manner, before project appraisal, in an accessible place and a form and language(s) understandable

to affected persons and other stakeholders. Disclose the final resettlement plan and its updates to affected persons and other stakeholders.

5. Conceive and execute involuntary resettlement as part of a development project or program. Include the full costs of resettlement in the presentation of project's costs and benefits. For a project with significant involuntary resettlement impacts, consider implementing the involuntary resettlement component of the project as a stand-alone operation.

At one point the NIRP is more stringent than ADB's policies; the NIRP requires a comprehensive RAP when more than 20 families are to be displaced, while ADB threshold is at more than 200 affected persons.

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Appendix VI Regulations for Environmental Assessment

The most relevant acts and regulations with a direct bearing on the proposed Master Plan, are:

- National Environmental Act No. 47 of 1980
- Coast Conservation Act No. 57 of 1981
- Mines and Minerals Act No. 33 of 1992
- Marine Pollution Prevention Act No 59 of 1981

A2.1 The National Environmental Act, No 47 of 1980

The National Environmental Act, No 47 of 1980 (NEA), is the basic national charter for protection and management of the environment. The NEA was amended by Act No 56 of 1988 to include a provision relating to Environmental Impact Assessment (EIA), contained in Part IV of the statute entitled "Approval of Projects". Under the provisions of section 23 Z of the NEA, the EIA process applies only to "Prescribed Projects" (PP), which have been specified by the Minister in charge of the subject of Environment in Gazette Extra-ordinary No 772/22 of 24th June 1993. The EIA process is implemented through designated Project Approving Agencies (PAA) as prescribed by the Minister under Section 23 Y of the NEA in Gazette Extra-ordinary No 859/14 of 23rd February 1995. Under Section 23 CC of the NEA, the Minister stating the procedures that should be followed to achieve the EIA requirement of the NEA has made regulations. The Central Environmental Authority (CEA) is the agency charged with the responsibility of implementing the above positions of the NEA. Since the enactment of the NEA, the environmental management activities in Sri Lanka are carried out by the CEA. The construction of ports and harbours is listed as a prescribed project under the National Environmental (approval of projects) regulations published in Gazette No. 722/22 dated 24.01.1993.

Detailed Environmental Impact Assessment (EAI) studies on the proposed developments must be carried out by the project developer, to get environmental clearance to carry out the project works under these regulations, after the acceptance of this general EIA. Further, the Sri Lankan Government under the provisions of the NEA has also gazetted several environmental regulations and orders of which National Environmental (Protection and Quality) Regulations, gazette No. 1534/18 of 01st February 2008, Regulations on Prescribed Activities for which Environmental Protection Licence is required, Gazette No. 1533/16 of 25th January 2008, National Environmental (Procedure for approval of projects) Regulation No. 1 of 1993, gazette No. 772/22 of 24th June 1993 and its subsequent amendments, National Environmental (Protection and Quality) Regulations, gazette No. 924/13 of 23rd May 1996, Regulations on hazardous waste management, Gazette No. 1533/16 of 25th January 2008, National Environmental (Ambient Air Quality) Regulations, gazette No. 1562/22 of 15th August 2008, National Environmental (Noise Control) Regulations, gazette No. 924/12 of 23rd May 1996 are imperative to be complied with. Furthermore, CEA has brought in interim standards for vibration control and emission control of air from industrial activities for which gazette notifications are yet to be prepared. However, such interim standards are in force and port developments need to comply with such standards.

A2.2 Coast Conservation Act No. 57 of 1981

The Coast Conservation and Coastal Resource Management Department (CCD), which operates under the Ministry of Fisheries and Aquatic Resources Development controls the development activities within the coastal zone. The CCD administers the Coast Conservation Act No. 57 of 1981 with subsequent amendments (CCA). The coastal zone, according to paragraph 42 of the CCA, is defined as 'the area lying within a limit of 300 m landward of the mean low water line and in the case of rivers, streams, lagoons or any other body of water connected to the sea, either permanently or periodically, the landward boundary shall extend to a limit of 2 km measured perpendicular to the straight base line between the natural entrance points defined by the mean low water line, thereof and includes the water of such rivers, streams and lagoons or any other body of water so connected to the sea'. The mean low water line is considered as 0.6 m below the mean sea level. Therefore, since the proposed development activities are located within the coastal zone, the approval of the CCD has also to be obtained. A width of shoreline known as the setback area, within which developments are prohibited or restricted has been defined by the CCD. This setback area always comprises a reservation area and a restricted area. The reservation area is the closest to the shoreline, and its point of reference is 0.6 m above the mean sea level. Usually, any construction activity is prohibited within the reservation area. However, the Director General of the CCD may issue permits if the projects do not cause permanent or significant impacts and are considered compatible with the integrity of the shore and the aquatic resources. Other restrictions, which apply to this setback area, are generally project specific. The width of the setback area is determined by the Director General of the CCD in relation to coastal stability and the presence of fauna and flora. The Director General of the CCD, as per the provisions of CCA, has the discretion of carrying out a separate EIA for the development projects that are proposed to be located within the coastal zone where, CCD could be the project-approving agency for EIAs or IEEEs.

A2.3 Mines and Minerals Act No. 33 of 1992 (MMA)

The Geological Survey and Mines Bureau (GSMB) shares the responsibilities with the CCD for granting permission for approving development projects within the coastal zone. The paragraph 66 (1) of the Mines and Minerals Act No. 33 of 1992 (MMA) states that "notwithstanding the provisions of other law, no person shall engage in any development activity other than a prescribed development activity within the coastal zone except under the authority of a permit issued on that behalf by the Director General (of the CCD) or of a license issued under the MMA". Paragraph 66 (2) of the MMA reads as "the Minister (in-charge of CCD) may having regarded the effect of those development activities on the long-term stability, productivity and environmental quality of the coastal zone prescribe the categories of development activities, which may be engaged in within the coastal zone without a permit under subsection 14 (1) of the CCA or a license issued under the MMA". Paragraph 66 (3) of the MMA states that "Notwithstanding anything in the preceding provisions of the paragraph 66, the holder of a license issued under the MMA shall not be required to obtain a permit from the Director General (of the CCD) or any other officer authorized by him for the occupation of any part of the foreshore or bed of the sea lying within the coastal zone". Therefore, it appears that there is some overlap of regulatory authority between the CCD and GSMB. It may be required to get the approval of the GSMB also for the proposed development Project.

A2.4 Marine Pollution Prevention Act No. 59 of 1981

The Marine Environmental Prevention Authority (MPPA) has been established under the provisions of the Marine Pollution Prevention Act No. 59 of 1981. As per the requirements of this act, all ships that enter the territorial waters of Sri Lanka should comply with appropriate measures for preventing and controlling pollution of the sea from garbage, sewage, organic and inorganic compounds, organic liquids, oils, and petrochemicals. This act enables carrying out the requirements and conditions stipulated in the international convention for the prevention of pollution from ships (The Marpol Convention) to which Sri Lanka is a signatory. Thus, the ships and barges, which supply the equipment and machinery for the project and also those who use the port, should comply with the provisions of Marine Pollution Prevention Act No. 59 of 1981. As per the MPPA Act, for bunkering of ships licenses should be obtained as per the regulations, Gazette No. 02 of 2011. The Marine Pollution Prevention Act No 35 of 2008, Section 39 and section 51 give necessary provisions to prepare oil spill contingency plan, as per regulations, Gazette No. 02 of 2012. Accordingly, all port and harbours shall prepare contingency plan as per guideline given by the MEPA to handle oil spills. MEPA will also issue licenses or permit for any material or waste being dumped arising from development activities as per Marine Environmental Protection (Issuance of Permits for Dumping at Sea) Regulations No. 01 of 2013 under the provisions of Marine Pollution Prevention Act No. 35 of 2008.

A2.5 Other relevant regulations

If the development project adversely affects the agricultural lands or minor irrigation reservoirs, the permission of the Agrarian Services Department as per Agrarian Development Act No. 46 of 2000 has to be obtained. The Department of Agriculture as per the ***Soil Conservation Act No. 24 of 1996*** may grant permission to the development projects proposed to be established in erodible lands. Further, the Department of Agriculture as per the powers vested in them by the Botanic Gardens Ordinance No. 32 of 1973 will grant permission for development projects that are proposed to be located within 1 km radius from the boundary of Botanic Gardens.

The Forest Department has the power to grant permission for any development activity within any land declared, proposed or defined under the ***Forest Ordinance No. 16 of 1907*** or within 1 km radius from the boundary of such lands. These lands include forest reserves, village forests and state forests. The Department of Irrigation as per ***the Irrigation Ordinance*** has the controlling powers over flood areas and medium-sized & major irrigation reservoirs. They have the authority to grant approvals for the development activities in the areas that affect these reservoirs and flood areas.

The Land Commissioner's Department as per the Land Acquisition Act handles the land acquisition and land alienation for development projects. Further, this Department has the authority to grant permission for the development projects, including the activities associated with port development within crown reservations, 200 m from banks of public streams which are more than 25 m in width at any place of their course and within 200 m from the public reservoirs.

The Department of Fisheries and Aquatic Resources deals with the development projects concerned with fisheries and aquaculture. This Department usually does not involve in granting or refusing approval for construction of ports. However, if fisher folk and fisheries are affected due to the construction of ports, the concurrence and approval of this Department may have to be obtained.

The approval of the Road Development Authority as per the ***Road Development Authority Act No. 73 of 1981*** has to be obtained if the project developers have to upgrade the roads especially when transporting heavy equipment for the development activities or if RDA-belonging roads are to be affected.

The Urban Development Authority as per the ***Urban Development Authority Act*** usually does not involve in approving port development projects. However, if such development activities impact on the inundation areas declared under UDA Act, the UDA has a regulatory power on such projects. Also, land use development in terms of zoning will be done as per the UDA Act.

Another agency that has regulatory powers on the development activities is the Water Resources Board. They are, under ***Water Resources Board Act No. 29 of 1964***, concerned with the impacts on groundwater and surface water resources. To approve the development projects, the Water Resources Board should approve that sufficient amount of groundwater and/or surface water is available during construction and operational phases and no pollution of groundwater and/or surface water takes place due to the project.

The Department of Wildlife Conservation under ***Flora and Fauna Protection Ordinance*** has the authority to grant permission to development projects, which are proposed to be located within a national reserve, sanctuary or any area declared under the Fauna and Flora Protection ordinance, or within 1 km from the boundary of such area.

The Archaeological Department under ***Antiquity Ordinance*** has the regulatory powers on development projects that will be proposed in areas with archaeological value. It will grant permission to development projects within 500 m from the boundary of any archaeological reserve, ancient monument or protected monument.

The permission of the Local Authority in the area where the development project is located should also be obtained for the construction of buildings, and such infrastructure should comply with the requirement of such agencies.

Appendix VII Steps in the Land Acquisition Process

In case land is required for a public purpose of any Ministry, Department, Corporation, Statutory Board, Provincial Council or a Local Government Institution, the Head of the relevant Department forwards an acquisition proposal to the Secretary, Ministry of Lands through the Secretary to the Ministry of which the particular institution fallen under the purview. After confirming accuracy of the proposal, the acquisition procedure is commenced on the approval of the Minister of Lands. The lands are acquired under the provisions of the Land Acquisition Act and regulations imposed thereto and compensation and interests are paid to the land owners in respect of the lands acquired.

Acquisition Application Form 01, Form 02 Form 03, Form 04	Applicant Institution - Forward the application through the respective Ministry
Section 2 Direction	Ministry of Lands – Grant authority to enter the land and the decision of Hon. Minister that the particular land is needed for a public purpose.
Section 2 Notice Sinhala, English, Tamil	Divisional Secretary - Publish the notice in the surrounding area.
Advance Tracing	Superintendent of Surveys
Section 4 Direction	Lands - Inviting objections from the land owners and decision of the Hon. Minister for investigation
Section 4 Notice Sinhala, English, Tamil	Divisional Secretary - Publish the notice inviting objections
Objection Inquiry	Applicant Ministry - Forward recommendations after conducting investigations on objections
Section 5 Declaration	Ministry of Lands - Decision of the Hon. Minister of Lands that the land is to be acquired
Section 5 Notice Sinhala, English,Tamil	Divisional Secretary/Government Printer - Publish a gazette notice that Hon. Minister of Land decided that the land is to be acquired
Final plan	Superintendent of Survey
Section 7 Gazette Notice Sinhala, English,Tamil	Divisional Secretary/Government Printer - Invitation notice to investigate the title of the land.
Section 9- Inquiry into Title Form 01, Form 0	Divisional Secretary – Investigating title
Section 15 Notice Sinhala, English, Tamil	Divisional Secretary - Publish the notice in the surrounding area.
Section 10- Decision on Title Sinhala,English,	Divisional Secretary – Determine the title
Valuation	Valuation Department

Section 17 – Awarding Compensation Sinhala	Divisional Secretary
Payment of Compensation	Divisional Secretary - Allocate financial provisions from the Ministry of Lands or the relevant Institution and make payments to the land owner
Gazetting 38 Order Sinhala, Sinhala	Ministry of Lands - Take over the land's possession to the Government
Taking undisturbed possession	Divisional Secretary – Take over the procession and hand it over to the applicant institution
Section 44 Vesting Certificate/Registration of State Ownership Sinhala	Divisional Secretary/Registrar General - Issue vesting certificate to the Institution concerned, after payment of compensations to the land owners

Appendix VIII Mitigation Measures for Land Acquisition and Resettlements

Mitigation measures to cope with significant Impacts from proposed priority projects at the Ports of Colombo and Trincomalee

A4.1 Loss of assets and employment

When a project results in the involuntary relocation of people the flowing steps should be taken:

1 Screen the project early on to identify past, present, and future involuntary resettlement impacts and risks. Determine the scope of resettlement planning through a survey and/or census of displaced persons, including a gender analysis, specifically related to resettlement impacts and risks.
2 Minimize human displacement and resettlement wherever possible
3 Identify all project impacts and record all losses properly
4 Pay compensation as per the NIRP and to comply with the safe guard requirements of the World Bank
5 Improve the standards of living of the displaced poor and other vulnerable groups, including women, to at least national minimum standards. Provide them with appropriate income sources and legal and affordable access to adequate housing.
6 Develop procedures in a transparent, consistent, and equitable manner if land acquisition is through negotiated settlement to ensure that those people who enter into negotiated settlements will maintain the same or better income and livelihood status.
7 Disclose a draft resettlement plan, including documentation of the consultation process in a timely manner, before project appraisal, in an accessible place and a form and language(s) understandable to affected persons and other stakeholders. Disclose the final resettlement plan and its updates to affected persons and other stakeholders.
8 Conceive and execute involuntary resettlement as part of a development project or program. Include the full costs of resettlement in the presentation of project's costs and benefits. For a project with significant involuntary resettlement impacts, consider implementing the involuntary resettlement component of the project as a stand-alone operation.
9 Encroachers could be provided with land for land, since SLPA has adequate land resource to allocate to the displaced encroachers.
10 Permit holders equivalent to free holds if willing also could be given land for land with compensation for the structures at replacement cost.
11 Water, electricity and other facilities which they enjoyed prior to displacement should be provided as part of the project cost.
12 Income restoration programme should be implemented to restore the income of affected people to enjoy a life equal or better than what they had prior to the displacement.
13 Implement a programme to empower women.
14 Liaise with the educational authorities to find schools of equal standard or better for children who had to seek new schools due to displacement (if the affected are accommodated with in the port premises this requirement does not arise)
15 Settlement planning will take account of the local socio-economic development context
16 Maintain a continuous consultations and dialogue with the affected before, during and some period after resettlement to create trust, and built confidence to avoid conflicts and misunderstanding with the project implementers.

A4.2 Relocation and Rehabilitation

The occupants of land within the port premises who need to be evacuated to build facilities for the improvement of the Trincomalee Port need to be relocated without disruption to their day to day activities. The suggested mechanism is to:

1 Offer them alternate land plots within the port area and pay compensation for the improvements made on the land at replacement cost without taking into consideration the depreciation and salvage material. Infrastructure facilities and services should be available to them at the same service level as they experienced before or higher.
2 Offer the grant permit holders cash compensation if they are willing and allow them to settle elsewhere.
3 If the port authorities prefer to preserve as much as land possible owned by them, and if the affected people wish to live in condominiums construct a condominium and allocate housing units in the condominium to the displaced people. If the value of the assets lost by an affected person, is more than the cost of the housing unit allocated to him, the affected person is entitled to receive the balance due to him.

A detailed plan for relocation and rehabilitation has to be prepared by the project's proponent in a so-called Resettlement Action Plan (RAP). A proposal for the 'Organizational Arrangements for the Implementation of RAP' is presented in 0.

A4.3 Income Rehabilitation

If any AP, due to land acquisition, loses his/her income fully or partially, the project should implement a plan to restore the income of APs, as the NIRP and ADB social safeguard statement of 2009 specifically mentioned that the affected people should not be impoverished, and their socio-economic standard should not fall below the pre-project standards they enjoyed.

A detailed plan for relocation and rehabilitation and the other issues listed in 3.3.1 to 3.3.3 must be prepared by the project's proponent in a so-called Resettlement Action Plan (RAP). A proposal for the 'Organizational Arrangements for the Implementation of RAP' is presented in 0.

A4.4 Cost Estimates for the Resettlement of APs at the Port of Trincomalee

Any development project involving land acquisition triggers resettlement due to displacement of people. For the works related to the extension of the Ashroff Jetty (access of railway), land will be required between the jetty and the existing China Bay railway station.

There are two sets of regulations in operation for the payment of compensation for the acquired assets under the Land Acquisition Act (LAA) approved by the parliament of Sri Lanka namely 2008 and 2013 regulations; the 2013 regulations are applicable to designated projects. Initially, this regulation covered 16 road projects, but it has been extended to projects implemented by the Ministry of Western Development and Megapolis. If compensation to the Aps is to be made under the 2013 regulations, the approval of the Cabinet of Ministers is a prerequisite. The National Port Master Plan may or may not fall within the 2013 regulations as the project has not yet reached the implementation stage. In this stage we have based our computations of the cost of land acquisition and resettlement for the extension of the railway to the Ashroff Jetty on the 2008 regulations.

Cost of Land

The compensation is payable only for private lands. The encroachers who occupy the state land (SLPA land) are not entitled to receive compensation except for any improvement(s) made on the land. Those who are in possession of land with grants received from the government (Jayabhoomi Grants) are entitled for compensation since such holdings are considered as free holds. And the holders of grants can sell such lands with the permission of the relevant authorities (Divisional Secretary /District Secretary).

According to the plans prepared by the Department of Surveys in 2011, the extent of land with grants belonging to 14 households is 0.98 ha (381 perches). The compensation payment of this extent of land may well occur after 2-3 years from now. Any estimate for the payment of compensation for the land to be acquired should consider the time factor.

It is reasonable to value a perch of land at Rs.500,000 as the land value in the area will rise with the planned development of the port. Therefore, the cost of the land could be assessed as:
381 * Rs.500,000 = **Rs. 190,500,000 or US$ 1,245,098** (1 US$ = Rs.153)

Cost of Structures

Currently, there is no information on the extent of buildings (floor area) to be demolished. It is deemed reasonable to adopt the amount spent by the Ministry of Western Development and Mega polis for a housing unit to resettle a family displaced due to the implementation of the projects under their purview.

Number of buildings to be displaced is 52. The estimated cost amounts:
52 * Rs 3,500,000 = **Rs. 182,000,000 or US$ 1,189,542** (1 US$ = Rs.153).

Sub Total of compensation payable for land and structures is **Rs. 372, 500, 000 or USD=2,434,640**

Other entitlements

In addition, there are other entitlements payable to the affected depending on the types of expenses and disturbances each may face; no details for such entitlements are currently available. It is prudent to allocate 10% of the above subtotal to cater for such payments.

On this basis, the total cost estimate amounts to **Rs.409, 750,000 or USD=2,678,104**

A4.5 Grievance Redress Mechanism in resettlement programmes

Well formulated mechanism should be in place for the resolution of grievances of APs in development induced resettlement projects. They are institutions, instruments, methods and processes by which a resolution to a grievance of an AP could be sought and provided. Project implementing authorities should take adequate care to minimize grievances through careful designs and good participatory management. Problems do occur, and grievances are inevitable even under extremely efficient planning and expert management due to unforeseen circumstances. A built in institutional mechanism to redress grievances would be an ideal forum to listen to the grievances of the APs and find solution to their problems. The suggested system would help to alleviate suspicions and misunderstanding between the APs and the project management. It helps APs easy access without incurring much expense to seek timey solutions to their problems. It facilitates to achieve project objectives without many hiccups.

The RAP should identify the potential social and economic impacts associated with land acquisition and relocation and illustrate the measures and procedures needed to redress or mitigate grievances. Some of the inadequacies of compensation, delay in payment of compensation significant social impacts would be severance or disruption of relationship, marginalization, disruption of children's education and access to facilities within easy reach Increase in violence and sexually transmitted diseases due to influx of construction labour from areas outside the project, whose tenure is temporary, and not subject to peer pressure and lack of concern to observe the accepted social norms.

The main purpose of the measures of redresses should be recommended in RAP to avoid economic and social hardships to people resulting from the construction effects of the project. A suggested draft for the grievance redress measures, steps and procedures to be adopted by the PMU is described in 0.

A4.6 Institutional Arrangement to Attend to Gender Concerns

The PMU should recruit a female officer with experience in gender issues to deal with the concerns of women. Alternatively, the PMU could obtain the services of relevant officers attached to the Divisional Secretariat to handle such issues.

Appendix IX Organisational Arrangements for the Implementation of RAP

A5.1 Role of PMU

The PMU will be responsible for the implementation of the RAP. The eligible APs to receive compensation will be decided by the Acquiring Officer (Divisional Secretary) after the completion of the inquiries under the Sec.09 of the LAA. He/she will submit the list to the PMU(SLPA) for the payment of compensation which was awarded by the DS based on the report on compensation calculated by the valuation Department on eligible entitlements of each AP. The valuation report will be prepared based on replacement cost and the compensation package approved by parliament and published by the government gazette no. 1596/12 dated 07th April 2009. The Legal procedure is for the PMU to prepare the cheques for individual APs and submit them to relevant DS to hand them over to APs after completing documentations and obtaining their signatures on the payment vouchers but to make the procedure expedited, DSs consent to allow the PMU to pay the APs direct and submit a report for his records. Under the LAA the DS is the Acquiring Officer and the Paying officer.

SLPA falls within the administration of the Ministry of Ports and Shipping. The PMU will function under the direction of the Chairman/Managing Director of SLPA. The PMU should be staffed with the following officers before the implementation process commence.

- Head of the PIMU (An Experienced Engineer)
- Land Officer attached to SLPA
- Resettlement Specialist
- Sociologist of PMU
- Technical Officers
- Administrative Staff - Accounts Staff

A field office of the PMU should be established within the Trincomalee Port for facilitating the land acquisition and resettlement process. A Resettlement Assistant should be stationed at this office with supportive staff to attend to the problems of APs and take necessary actions to solve them under the guidance of Head of PMU. An implementation schedule should carry the time frame of accomplishment for each activity of the plan. Resettlement activities, with the deployment of relevant staff by the PMU.

A5.2 Review of Mandate and Capacity of Resettlement Agencies

In implementing the RAP, the collaboration of several related agencies is vital for achieving the outcomes. Statutory powers for land acquisition are vested in the Divisional Secretary and he is responsible for the entire process with the collaboration of the Departments of Valuation, Government Printer, the CEA and the SLPA. It is specifically the task of the PMU to assist the DS in technical matters if and when required.

The following are the key state agencies that will have direct involvement with resettlement interventions:

- Ministry of Ports and Shipping
- Ministry of Land and Land Development
- Divisional Secretary - Trincomalee and staff, including
- Grama Niladaris / other community level officers.
- Consultants on land acquisition and ressettlement
- Survey Department
- Valuation Department
- Government Printer
- Central Environmental Authority
- Local Government Institutions of the project area.
- Ceylon Electricity Board
- Water Supply and Drainage Board
- Sri Lanka Telecom Ltd.

In implementing the RAP, the PMU carries out the following activities. The Resettlement Specialist, attached to the PMU, has a major role to play in those activities.

- Conduct awareness meetings with stakeholders to disseminate and update Information and also receive feedback from stakeholders.
- Establish Public Information Centres (PIC) and develop and distribute informative bulletins and relevant materials to ensure transparency.
- Conduct Land Acquisition and Resettlement Surveys (LARS) and Social and Economic Surveys (SES) to collect necessary data for resettlement planning.
- Coordinate and assist the land acquisition process with the DS, Survey Valuation departments and other relevant government agencies and APs. Formulate project cells
- Prepare Resettlement Plans and implement them with the aim of restoring/improving the lives of the APs at least to the pre-project level or beyond.
- Ensure the execution of the entitled compensation package and realize the objectives of the NIRP and expedite payment of compensation by assisting the DS and the APs.
- Assist/ and coordinate with relevant agencies to restore/improve the income of the APs.
- Identify resettlement sites in consultation with the APs and host communities when necessary and develop them with all services and assist APs to resettle.
- Coordinate with community based organizations to assist the APs in resettlement.
- Coordinate/monitor the activities of GRCs.
- Assist vulnerable groups including women and the poor.
- Develop a plan to address gender concerns.
- Implement the construction program through contractors and supervision consultants and monitor the construction program.
- Prepare/submit required periodic reports to the relevant stakeholders including donors if the project is financed by external donors.
- Ensure flow of funds to maintain a healthy cash flow.
- Maintain MIS for the project through networking with relevant agencies.
- Monitor the resettlement plan with measurable indicators internally and externally.
- Issue a certificate to each household head indicating the list of compensation paid.

A5.3 The role of the Divisional Secretary (DS)

The Divisional Secretary is responsible for civil administration of the division and hence empowered with statutory provisions to acquire land within the division and vest them with the agencies that required land under LAA. The DS has the coordinating responsibility of all development work, in addition to planning and implementation of its own development projects/ programs in the division. Although, formally all land acquisition work has to be done by the DS office, for accelerating the process, the PMU assists the DS for various activities in the acquisition process, including arranging with APs and other stakeholders, preparation of paper work and other gazette notification if requested by the DS to expedite the work. This type of assistance is given by other organizations also to the DS to accelerate the land acquisition work for their projects.

A5.4 The Role of NGOs, and Organizations of APs in Resettlement Planning and Management

Contractors and consultants employed by the PMU, Community Based Organizations of APs, NGOs and other civic organizations also play a significant role in the implementation process of the RAP. The government agencies involved have sufficient capacity and experience to efficiently and effectively contribute to the implementation of the RAP. Their contribution is well within their respective mandates. The PMU coordinates the efforts and whenever required supports them with technical assistance.

The PMU/ provides for capacity building, including technical assistance, when required or when new types of interventions and procedures are called for like in the case of public protests and other contentious issues.

Civil Society Organizations, including religious leaders have lent their cooperation in the past in the implementation of a RAP and are found to be effective in representing the APs as they usually have confidence in the clergy. Their main role has been advocacy on behalf of the APs and has also contributed at times to business development efforts of the APs.

A5.5 Responsibility of the PMU for payment of compensation

For accelerating the acquisition process and ensuring justice for APs, the PMU support APs with following services:

- Advise the APs regarding the list of documents to be submitted at the title determination inquiries conducted under Section 9 of the LAA
- Ensure timely cash flows to assist DSs to pay the statutory payments as they are due
- Prepare individual cheques and hand them over to DS to effect payments
- Assist DS to inform the APs in advance regarding the payment of compensation
- Prepare the list of AP s with categories of compensation they are entitled to
- Document grievances if any made by the APs
- Make arrangement to pay the interest due on the statutory payment through the DS
- Arrange to distribute a certificate with details of the compensation paid to each
- Allow a period of 4-6 weeks after the payment of statutory compensation and other assistance for the AP to hand over vacant possession of the property
- PMU should pay the incentive payment of 10% of the replacement cost due to the APs immediately after the handover of the vacant possession within the prescribed period to the DS/PMU if this amount had not been included in the calculation of replacement cost.
- Store all data in respect of compensation in a pre-prepared database.

- Maintain a file for each AP.
- Provide a card for each AP to record the compensation paid, since all compensation is not paid by one payment, the visits of resettlement staff to meet APs could be marked in the card kept with the AP.

A5.6 Responsibilities of APs for Compensation Payment

- Produce all relevant documents at the Section 9 inquiries to establish the rights and ownership of the APs, including title deeds, government grant certificates, lease permits, rental agreements, documents on tenancy rights, registration extracts etc, as relevant to each AP.
- Ensure AP present personally to receive compensation as far as possible. If due to an unavoidable reason the AP is unable to collect the payment cheque personally, a proxy could collect the payment upon written authorization by the AP.
- It is the responsibility of the AP to request the DS within 14 days after the receipt of the determination on ownership (title) to refer the matter to the appropriate court of law, if he is not satisfied with the determination of the DS.
- The DS is expected to issue the order under Sec17 of LAA, as soon as possible indicating persons who are entitled to receive compensation for the land or servitude which is to be acquired.
- The interest that the persons possess on the land or servitude to be acquired.
- Total compensation entitled for the land or servitude to be acquired. AP could appeal to the LARB within 21 days from the date of the order if he /she is not satisfied on the quantum of compensation.
- The AP should hand over the property in vacant position within the prescribed period.

Table: Example of implementation time frame of Resettlement Action Plan

No.	Activity	Date from start	Year 1												Year 2											
			1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
1	Recruitment of Consultants to prepare Social Assessment Report and RAP	Month 1																								
2	Conduct Census & SES and input of data &analysis	Month 2																								
3	Preparation of RP and submission to M/LLD & WB	Month 2																								
4	Land Acquisition -Process	Month 3 -12																								
5	Consultations and awareness creation during land acquisition and resettlement process																									
6	Payment of Compensation	Month 9 -13																								
7	Relocate houses, shops, businesses	Month 9 -14																								
8	Clear the area required for port work	Month 9- 15																								
9	Issue notice for commencement of civil workers	Month 9																								
10	Income Restoration	Month 10 – 15																								
11	Management Information system	Month 1 - end																								
12	Grievance Redressing	Month 5 - end																								
13	Consultations with APs	Full project cycle																								
14	Internal Monitoring	Month 03 - end																								
15	External Monitoring	Month 09 - 21																								

The table on the previous page shows an example of the time frame for major resettlement activities. Resettlement activities should be commenced from the date of appointment of the consultants (if needed) to prepare the RAP. It is advisable to allow a period of about 21 months for the implementation of the RAP, as the experience in Sri Lanka indicates that land acquisition of a plot of land takes an average of 52 weeks

A5.7 Creation of Awareness of the Grievance Redress Mechanism (GRC)

The GRC is required in the PMU of the Trincomalee Port as the land acquisition for port improvement is a major activity in the programme.

Wide publicity should be given by the PMU of the SLPA regarding the establishment of GRCs to the APs and closely related officials to the GRC mechanism for e.g. Grama Niladharis, Local Samurdhi Officers and Social Development officers of the Divisional Secretariats and Pradeshiya Sabhas of the areas concerned.

- PMU should prepare flyers indicating
  - Project brief including the benefits of the improvement of Ports to the community and the country.
- Procedures for registering a complaint
- Categories of persons, institutions and property/assets affected that can claim
- Compensation

Explanation of those who would not be considered as an affected person, property etc. The address of the authority to receive and register the application with the name of the officer in-charge, address, and telephone/fax numbers to contact.

Receiving Application for Redress

The applications regarding grievances for redresses can be submitted to the PMU on week days during office hours. The PMU can place a secured box at the office with a label marked complaint box to drop the complaints of the APs

Maintaining of Complaint Register

As a first step, a complaint register should be maintained at the office of the PMU of SLPA to register applications received from the APs on their grievances. On receiving a complaint, it will be registered at the office /sub office of the PMU and complaint will be given a reference number. These applications are registered in the office with all details such as names of the person, type of grievances etc. And inform the applicant the receipt of the complaint with the reference number given to him.

Forum to Redress Grievances

Three tier Committee system is proposed to solve the grievances of the affected people which remains unsolved at the level of the Sociologist.

(a) Local Resettlement Committee (LRC)
(b) Grievance Redress Committee (GRC)
(c) Independent Group of Eminent Persons (IGP)

Resolution of Grievance by the Sociologist/Resettlement Specialist

He/she discuss the issue with relevant AP and attempt to solve it at his level. If he/she is successful in solving the grievance at his level, he/she should provide proof of APs acceptance of his solution and inform the AP with copy to the immediate senior officer and the issue ends. If he is unsuccessful, refer

it to the Local Resettlement Committee (LRC) without delay with his observations and solution offered by him with copy to the applicant. If the grievance is a matter of breach of peace, he should refer it to the GramaNiladhari of the area or police.
Members to be appointed to the above committees should be decided by the management of the SLPA.

A5.8 Institutional Arrangements for land Acquisition and Resettlement

The lead role in implementing the resettlement action plan rests with the Sri Lanka Ports Authority. The implementation responsibility will be shared with the Project Management Unit (PMU) established at the SLPA to coordinate and monitor the construction of proposed improvements to Colombo and Trincomalee Ports. The PMU is headed by a senior engineer who is designated as the Director PMU.
PMU will be supported by relevant experts in technical, social, land administration, and financial disciplines. In the implementation of the RAP the Sociologist attached to the SLPA will act as the link among the institutions involved in implementing the resettlement plan He has a major role to play

Matrix of roles and responsibilities of government agencies and other organizations involved in resettlement planning and implementation (for port project)

Agency / Unit	**Roles and Responsibilities**
PMU/SLPA	Preparation of land acquisition proposals, staffing, coordination with other relevant agencies, consultation with stake holders, dissemination of information, secure funds, identify lands for resettlement with APs, procure land for resettlement sites when necessary, develop infrastructure at resettlement sites, arrange to construct auxiliary structures, arrange IRP. Implement the Gender Action Plan; attend to internal monitoring, progress review, Project MIS and documentation.
Ministry of Ports and Shipping (M/P&S)	Provide necessary policy guidelines, provide funds, coordinate with the SLPA and give directions to the PMU on implementation issues.
Ministry of Ports and Shipping (M/P&S)	Submit proposals forwarded by the PMU of SLPA/M/P&S to M/land and Land Development, arrange for funds including reimbursement responsibility.
Ministry of Land and Land Development	Approvals of the publications of relevant orders under LAA. Monitor the progress of land acquisition and liaise with the DSS at different stages of acquisition process.
Divisional Secretary – Trincomalee Town & Gravets	Acquisition of land, payment of statutory compensation, payment of interest, consultation, information dissemination, GRC, and vesting of acquired land with the SLPA. PMU provide technical assistance on request. Support implementation of RAP when necessary on PMUs' request. Support rehabilitation and improvement of public utilities disturbed by land acquisition and construction program.
Grama Niladari	Delivery of notices under LAA to the APs, consultation, facilitation of acquisition of alternate lands, during preparation of advance tracing and final plan by assisting the surveyors to identify the claimants.
Valuation Department	Preparation of properties to be acquired, preparation of valuation reports.

Agency / Unit	Roles and Responsibilities
Government Printer	Publication of gazette notifications relevant to land acquisition.
Local Authority	Approval of resettlement sites, housing plans if required.
NGO	Consultations, dissemination of information, assist APs at the title determination inquiries (Sec.09), GRC, secure alternate land, eternal monitoring.
Affected People	Help in planning of resettlement sites if sites are required ,IR, Monitoring
Construction Supervision Consultants	Plan and monitor construction of resettlement sites if sites are required.
Contractor	Construct resettlement sites with infrastructure facilities if required; construct auxiliary structures of the affected on the instructions of the PMU/if the APs prefer replacement of structures in lieu of compensation
Donors (if funding the project)	Review Missions (external monitoring)

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Appendix X Tasks for Health, Safety and Environment Department

Currently, SLPA operates a HSE management plan, in effect for a longer period already. However, this plan mainly focusses on the operation and manoeuvring of ships within the harbour basin and just outside the basin. This plan does not cover all port activities. Hence, with the idea of greening the port of Colombo, it is essential to develop a comprehensive HSE plan to be implemented on par with the international guidelines. In Sri Lanka, it is the Labour Department (Occupational Health and Safety Division) which is legally responsible for these such aspects but when it comes to ports it is not properly implemented.

Preparation of proper HSE plan is of utmost importance and it should comply with norms stipulated in international guidelines. For this purpose, we refer to the HSE guidelines as proposed by IFC (2017).[8]

The following section provides a summary of HSE issues in relation to port and terminal construction and operations, along with recommendations for their management as part of a comprehensive environmental and social management system for a given project. A HSE management plan in general encompasses three major areas as follows:

1 Environment
- Terrestrial and aquatic habitat alteration and biodiversity
- Climate change resilience
- Water quality
- Air emissions
- Waste management
- Hazardous materials and oil management
- Noise and vibration (including underwater)

2 Occupational health and safety
- Physical hazards
- Chemical hazards
- Confined spaces
- Exposure to organic and inorganic dust
- Exposure to noise

3 Community health and safety
- Port marine safety
- Port security
- Visual impacts

It therefore important that each sub category receives equal attention, in order to establish an internationally recognised HSE management system. Table A6.1 presents salient features to be included in a sound HSE plan.

[8] ENVIRONMENTAL, HEALTH, AND SAFETY GUIDELINES FOR PORTS, HARBORS, AND TERMINALS (https://www.ifc.org/wps/wcm/connect/d2f2cf88-ce22-4a48-86fc-45ee3b8e9e45/ 20170201-FINAL_EHS+Guidelines+for+Ports+Harbors+and+Terminals.pdf?MOD =AJPERES

Table A6.1 Salient features and tasks to be considered in a HSE plan

Number	Attribute	Salient HSE features and tasks related construction and operations of ports
1.0	**Environment**	
1.1	Terrestrial and aquatic habitat alteration and biodiversity	Terrestrial, brackish and marine habitats with impacts related to flora and fauna related biodiversity, habitat alteration, fragmentation, alteration of coastal processes, water courses, hydrological impacts, sedimentation and coastal erosion, alteration of aquatic habitat, sea bed changes, dredging impacts, smothering of benthic fauna, potential impacts to shoreline vegetation, wetlands, coral reefs, fisheries, avifauna and other sensitive aquatic and near-shore habitats, shoreline morphology, coastal inundation
1.2	Climate change resilience	Water level changes, inundation areas, increased intensity of rainfall, flash floods, heat waves, storms and storm surges and high wind speeds, natural disasters such as tsunamis, droughts, sea level rise,
1.3	Water quality	All possible water, sediment quality parameters and tests for different port activities; It should include phsico-chemical, physical, biological monitoring on regular intervals and emergency occasions; ship waste need to be monitored, hazardous material need to be verified; storm water laden pollutants need to be checked; oily wastewater generated from workshops should also be checked; parameter such as BOD, COD, total suspended solids, and coliform bacteria, pH, DO, total P and Total N, oil and grease, TSS etc. need to be monitored
1.4	Air emissions	All land-based and sea-based sources need to be checked; emission and ambient levels need to be monitored. Parameters such as NO_x, SO_x, CO, PM, VOC, need to be monitored
1.5	Waste management	Both municipal and hazardous components need to be separated; composition, quantities, rate of aggregation need to be estimated; Nature of hazardous material such as flammability, etc. need to be explored; All aspects of MARPOL convention for ship waste need to be worked out
1.6	Hazardous materials and oil management	Quantification of hazardous cargo needs to be done; fuels, solvents, lubricants, chemicals that are prone for fire should be treated with extreme care; hazardous materials at ports typically include large volumes of hazardous cargo, as well as oil, fuels, solvents, lubricants and other hazardous substances used in port activities including vessel, vehicle, equipment and grounds maintenance. Spills may occur due to accidents (e.g., collisions, groundings, fires), equipment failure (e.g., pipelines, hoses, flanges), or improper operating procedures during cargo transfer or fueling, and involve crude oils, refined products or residual fuels, liquid substances, and substances in packaged form. Such occurrences should be monitored on a regular basis; dangerous good handling and spill control planning are too managed well under the HSE plan
1.7	Noise and vibration (including underwater)	Noise sources need to be placed so as to get the minimum disturbances to the port activities; setback distances for noisy machinery or operations must be maintained; noise attenuation efforts must be practised; Noise levels as per the local regulations must be carried out. Vibration levels need to be monitored in terms of PPV levels and checked with permissible levels. Vibration cut-

		off efforts must be practices if necessary. Impact on structural integrity and human inconvenience should be looked into.
2.0	**Occupational health and safety**	
2.1	Physical hazards	Port operation activities should be conducted in accordance with applicable international regulations and standards, including: • International Labour Organization (ILO) Code of Practice for Safety and Health in Ports (2005); • General Conference of the International ILO Convention concerning Occupational Safety and Health in Dock Work, C-152, (1979); • General Conference of the ILO Recommendation concerning Occupational Safety and Health in Dock Work, R-160; • IMO Code of Practice for Solid Bulk Cargo (BC Code); • International Code for the Construction and Equipment of Ships carrying Dangerous Chemicals in Bulk (IBC Code); • International Code for the Safe Carriage of Grain in Bulk (International Grain Code); • Code of Practice for the Safe Loading and Unloading of Bulk Carriers (BLU Code); and • International Maritime Dangerous Goods Code (IMDG Code). Additional prevention, minimization, and control techniques specific to ports and the implementation of applicable recommendations from the above-referenced international codes of practice, include the following; • Separate people from areas of vehicle traffic and make vehicle passageways one-way, to the extent practical; • Design materials handling operations to allow for a simple, linear layout and reduce the need for multiple transfer points, which can increase the potential for accidents/injuries; • To the extent practical, locate access and transit routes to avoid situations where suspended loads pass overhead; • Construct the surface of port areas to be of adequate strength to support the heaviest expected loads. The surface should be level or only slightly sloped; free from holes, cracks, depressions, unnecessary curbs, or other raised objects; continuous; and skid resistant; • Consider, when determining the method by which the goods are stacked, the maximum permissible loadings of quays or floors; the shape and mechanical strength of the goods and containers (including allowable stacking mass and stack height); the natural angle of repose of bulk material; and the possible effects of high winds; • Provide safe access arrangements suitable for the size and type of vessels calling at port facilities, such as guard rails and/or properly secured safety nets between ships and the adjacent quay; • Install and use guarding arrangements (e.g., rails, etc.) for

		weatherdeck and 'tween-deck' hatchways when open; • Avoid placing cargo on, or allowing passage of vehicles over, any hatch cover that is not of adequate strength for that purpose; • As far as is reasonably practicable, prevent workers from working in the part of a hold where a trimming machine or grab is operational; • Minimize the risk of free fall of materials by installing telescoping arm loaders and conveyors; inspect all slings before use; • Equip lifting appliances with means of emergency escape from the driver's cabin and a safe means for the removal of an injured or ill driver; and • Inspect disposable pallets and similar reusable devices before use and avoid re-use of such devices if the integrity of the device has been weakened or otherwise compromised.
2.2	Chemical hazards	Port workers may be exposed to chemical hazards, especially if their work entails direct contact with fuels or chemicals (including pesticides and fumigants), or depending on the nature of bulk and packaged products transferred in port activities. Work with fuels may present a risk of exposure to VOC via inhalation or skin contact during normal use or in the case of spills. Fuels, flammable liquid cargo, and combustible dust (e.g. from grain or coal) may also present a risk of fire and explosions. Recommended measures to prevent, minimize, and control risk of exposure to chemical hazards are provided in the general HSE guidelines.
2.3	Confined spaces	As in any industry sector, confined space hazards can be potentially fatal. The potential for accidents among port workers varies among port facilities and activities: confined space hazards may arise in ship cargo holds, silos, sewage tanks, and water tanks. Port operators should implement confined space entry procedures as described in the general HES guidelines. With specific reference to access to cargo holds, confined space entry programs should include procedures that prevent or minimize the use of combustion equipment, including fuelling activities, in the interior of cargo holds and in spaces that do not provide an alternative means of egress.
2.4	Exposure to organic and inorganic dust	Potential exposure to fine particulates is associated with handling dry cargo (depending on type of cargo handled, e.g., china clay, grain, and coal) and from roads. Occupational health and safety impacts associated with nuisance dust in ports are similar to those for other industries, and their prevention and control are discussed in the general HSE guidelines. Specific recommendations for prevention, minimization, and control of dust generation are identified in this document under "Air Emissions."
2.5	Exposure to noise	Noise sources in ports may include cargo handling, vehicular traffic, and loading/unloading containers and ships. Occupational exposures should be managed as described in the general HSE

		guidelines.
3.0	**Community health and safety**	
3.1	Port marine safety	Port operators have certain key responsibilities for the safe operation of ships, ranging from passenger safety to the safe access and manoeuvring of chemicals and oil transporting ships inside the harbor and port areas. Port operators should therefore implement a Safety Management System (SMS) able to effectively identify and correct unsafe conditions. The SMS should be informed by initial risk and hazard assessments, and should include consideration of alterations to coastal processes and seabed and coastal geomorphology that may impact navigational and vessel-berthing activities. The SMS should be adapted as needed based on regular operational hazard assessments of port activities. The SMS should include procedures to regulate the safe movement of vessels within the harbour (including pilotage procedures, port control and vessel traffic services, navigational aids, and hydrography surveys), protect the general public and communities from dangers arising from offshore activities at the harbor, and prevent events that may result in injury to workers and the public, including fishers and recreational users. The SMS should also include comprehensive emergency preparedness and response plans that provide a coordinated response based on government, port authority, port users, and community resources required to manage the nature and severity of the emergency event.
3.2	Port security	Port operators should have a clear understanding of their responsibilities, including international legal and technical obligations to provide security to passengers, crews, and personnel in port. In accordance with applicable international legal requirements, port security arrangements (e.g., access control) may be established through the completion of a Port Facility Security Assessment of port operations followed by the appointment of a Port Facility Security Officer and the preparation of a Port Facility Security Plan, depending on the outcome of the risk assessment. (see also section 6.4)
3.3	Visual impacts	Permanent and temporary installations and ships can make visual changes to the landscape. One of the most significant changes attributable to ports is nighttime illumination, depending on the proximity of the port and associated bulk storage facilities to sensitive land uses such as residential or tourist areas, Excessive illumination may also result in changes to invertebrate flight paths and settlement/breeding patterns. Visual impacts, including excessive background illumination, should be prevented during the port planning process or managed during operations through the installation of natural visual barriers such as vegetation or light shades, as applicable. The location and color of bulk storage facilities also should be selected with consideration of visual impacts.

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Appendix XI Review on IT Systems

This annex holds the examples on existing systems at port operators in the Port of Colombo.

In paragraph 1.1 the existing systems at the container terminals are shown.
In paragraph 1.2 the way forward on IT is elaborated.

Existing systems at container terminal operators in the Port of Colombo

The following tables illustrate the existing systems at the three main users in the port, SAGT, CICT and SLPA.
It should be noted that the first two only focus on container terminals whilst SLPA has a wider scope of work and acts as Authority and port operators at the same time.

SAGT systems

Systems present at SAGT	Systems under development	Major concerns
Terminal Management System Navis N4	ePortal Internet, provides electronic billing and real-time information	Updates of databases
Maintenance management System	CCTV	Hardware upgrades
HRIS & Payroll	Remote data management	Navis upgardes
Psion Teklogix radio	Document management system	Upgrade of mobile apps
Safety & Security management system	Intelligent website with authenticated access (portal)	CAPEX versus Terminal lease expiry
GPS based container position detection system		Improvement costs versus productivity and traffic congestion
		Systems versus people (union issues)
		Integration to national public information data sharing architecture (lack of single maritime window)

CICT systems

Systems present at CICT	Systems under development	Major concerns
Terminal management system CTOS PACS & DIS	Automatic gate control integrated to billing	Improvement costs versus productivity and traffic congestion
GDPS & GPS & RF enabled	Online payment gateway (paperless business processing)	Systems versus People influences of external unions
Hi frequency remote communication	Ready to integrate & associate with national data exchange	Why still hardcopies for a container discharge?

Systems present at CICT	Systems under development	Major concerns
HRIS & Payrol	Linked to terminals managed by group to provide an excellent service standard	Update of mobile apps
Radio data server WIFI and & ethernet links		Integration to national public information data sharing architecture (lack of single maritime window)
Laser technology		
Civil engineering & property management		
CCTV Birdseye view		

SLPA systems

Systems present at SLPA	Systems under development	Major concerns
Terminal Management system Navis sparcs	Port permit issuing system (approved)	Civil engineering and property management system.
Finance & procurement system – Oracle E-business	CCTV (approved)	Public information portal, Interactive website, social media, business marketing and publicity drive.
HRIS & Payroll	HRIS System & Payroll (approved)	Business planning, performance monitoring, productivity measuring, financial planning, Management Information Sytem (MIS).
Port access permits	Document management system (approved)	WIFI coverage, Fiber Optic backbone
Import / export FCL Container Management System		Engineering and Technical workshop planning and management system
Registration system at Warehouses (CFS/LCL)		Process flow & procedures manuals and audit system
		CRM, Strategic marketing Modelling, Digital Document management system
		Port security and digital birdseye view system
		Harbour master services management system
		Virus & cyber protected electronic data exchange, email spam protection, remote redundancy, data warehouse

Systems present at SLPA	Systems under development	Major concerns
		Warehouse logistics management system
		Mobile based app integration
		Integration to national public Information data sharing architecture (lack of single window)

The above tables illustrate the following main points:

- Each of the terminals have various stages of IT developments and different systems.
- Manual processes are to be reduced in order to create efficiency and reduce administration.
- Terminals work on gate automation, CCTV, and ePortals for electronic billing.
- Cybersecurity is a important topic for all port users.
- Each of the terminals face challenges related to sharing with national public information data sharing architecture or the lack of a single window.
- Mobile app integration is next step of development.

It can also be noted that SLPA has the largest back load with respect to upgrading IT systems.

Way forward on IT systems

The following points are SLPA currently main target issues related to IT systems

- CCTV – The camera system throughout the terminals should improve safety
- Port permit issuing system – this system organises the issuing of port permits
- Document management system has been approved, this mainly related to the digital filling of documents. E-signing is however not yet part of this.
- HRIS – the human resource information system an organising payroll is very important. It has to link with the human resource attendance system.

The following systems are highlighted as areas in which systems need to be implemented in the future. Some of them are related to hardware and network issues whilst the majority is related to business segments such as operations, management, marketing, harbour master and engineering.

- Civil engineering and property management system.

  This system would allow civil engineering to plan their maintenance and resources whilst, digitally keeping track of important drawings. Port development planning is an important element in the future of the port and process can be complex and time consuming. Hence such system would allow civil engineering to plan forward, understand the phase of a development project and the steps to be taken (procurement, tender, ESIA etc.)
- Public information portal, Interactive website, social media, business marketing and publicity drive. The corporate imaging of SLPA should be addressed including to boost of the public information portal and interactive website.

  Business planning, performance monitoring, productivity measuring, financial planning, Management Information System (MIS). A MIS system is lacking which pulls real-time information from the system and presents this into management dashboards.
- WIFI coverage and Fiber Optic backbone

The hardware infrastructure in the port is poor including the fibre backbone which often is an issue during construction works. The WIFI coverage is poor at many sites within the port. (Port users like to obtain access as well)

- Engineering and Technical workshop planning and management system

  The engineering and technical workshops have only manual systems for planning and administration. There is no business software in place to set tasks and to monitor progress.

- Process flow & procedures manuals and audit system

  Generally speaking the port lacks a central point in which procedures are clearly addressed and explained by flow charts. This will help personnel to do their tasks (internal) and shall help port users (external) to understand the main Q&A for the port and will increase transparency.

- CRM, Strategic marketing Modelling, Digital Document management system.

  A customer relation management system is lacking at SLPA. This would enhance the marketing function of the port.

  Strategic marketing modelling would ensure that strategic clients are highlighted to support strategic decision making.

  Digital document system with e-signatures and authorisation. In order to become paperless a digital document system should be implemented supported by e-signatures and authorisations. This system would ensure that managers can approve the documents digitally and can authorize according to their responsibilities.

- Port security through digital birds-eye view system

  Port security can be improved by digital birds-eye view system. Also drones can be used by authorized institutes and should be legally prohibited for non-authorised institutions and privates.

- Harbour master services management system

  The harbour master services should be supported by a system in which berthing planning, pilot and tug times can be processed for billing. The system should be integrated with a vessel classification system.

- Virus & cyber protected electronic data exchange, email spam protection, remote redundancy, data warehouse

  Virus and cyber protection of the networks and for electronic data-exchange should be guaranteed.

- Warehouse logistics management system

  Warehouses run by SLPA require a business software solution for their warehouses. The pick & place order and delivery should ensure that the warehouse logistics is improved and secured.

- Mobile based app integration

  Once information is shared on the internet, mobile devices would like to use that information as well. On the other hand mobile applications can be specifically used for a purpose, like for example: Truck appointment and container tracking and tracing.

- Integration to national public Information data sharing architecture (lack of single maritime window)

  The ports users share the same information multiple times at different moments in the logistical chain. To share information is key to reduce administration, safe time and communications costs. A single maritime window or port community system is a way to re-used information, receive notifications and approvals digitally. In this way the port logistics will become more efficient, more transparent at reduced costs.

Appendix XII Bunker hub ports and markets

This annex holds the examples on bunker hub ports and markets.

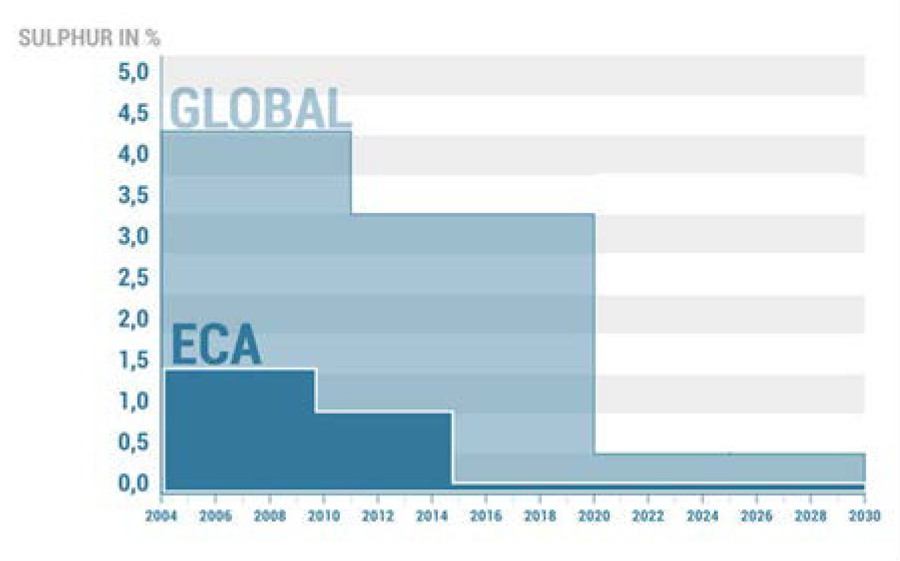
Bunker Hub ports

The world bunker markets are dominated by major centres like Singapore, Rotterdam and Houston. Vessel owners trading on the main East West trades tend to purschase their fuels in these nodal spots. Singapore has the advantage to have calm waters around the port suited for anchorage and has a large refinery industry with numerous storage facilities which supply the bunker industry. Singapore has also build tank storage on a centrally located island from which bunker barges can be loaded. The port of Rotterdam has the advantage of being a main hub port in Europe where a large volume of ships are unloaded. For shipowners it is advantagous to buy fuel whilst the ship is being unloaded or when next voyage is a ballast leg as bunkers on board reduce the capacity for cargo on board. Next to this Rotterdam has a large refinery industry able to supply the bunker markets. Houston, like Rotterdam and Sinpagore is also an oil centre with large refineries.

Regulations change the market demand

MARPOL Annex VI "Regulations for the Prevention of Air Pollution from Ships" stipulate that Heavy Fuel Oil (HFO) combustion is not permitted during port stay and in specific areas at sea.
By January 1st, 2020, the IMO specifies that global sulphur rule for marine fuels requires ships to burn 0.5% sulphur limit bunker fuels worldwide, instead of the 3.5% sulphur limit currently.
Since 2015, in so-called Emmission controlled areas (ECA's) the sulphur limit is even further reduced to 0.1% . This is today applicable to the Baltic sea, the North Sea and the US coastal waters. There are talks to increase the ECA zoning in 2030 also between Japan and Singapore and even along the Indian sub-continent. Decisions on these matters have however not yet been reached.

Outside an ECA established to limit Sox and particulate matter emissions	Inside an ECA established to limit SOx and particulate matter emissions
4.50% m/m prior to 1 January 2012	1.50% m/m prior to 1 July 2010
3.50% m/m on and after 1 January 2012	1.00% m/m on and after 1 July 2010
0.50% m/m on and after 1 January 2020*	0.10% m/m on and after 1 January 2015



Shipowners have the choice either to invest into scrubbers or burn low sulphur fuels, MGOs or convert to alternative fuels like LNG. While alternative fuels including LNG are also an option, their widespread adoption is limited, at least initially, because of retrofit costs and infrastructure bottlenecks worldwide. After 2020 marine gasoil is expected to gain considerably in marketshare under the assumption that the uptake of scrubbers is likely to remain slow globally. The IMO regulation is expected to increase the demand for distillates in shipping which has also an strong effect on the bunker supply industry. More MGO bunker vessels will be required in future. This trend is already noticed as new bunker barges for MGO are ordered by many ports including Singapore.

Bunker Hubs

With ample refinery capacity in the Middle East as well as in China these sectors have also grown in the bunker markets. Recently more and more bunker hubs are developed as trading hubs (Port of Fujairah and Gibraltar) rather than as selling points near refineries. A good example is Port of Fujairah in United Arab Emirates which is strategically located outside the Straits of Hormuz and has become a bunker hub only with a relative small refinery (80,000 barrel per day). The facility has 52 tanks with a combined 1.6 million m3 tank storage and has 11 jetties able to handle ships from barges to mainline vessels at 16.5m draughts and upto 300m in length.

Type of Fuels

Marine fuels (ISO 8217), also called bunker fuels, are generally divided into two different classes:

- Residual fuels (a blend of Heavy fuel oil (HFO), and
- Distillates

The first group, the heavy fuel oils, also includes other products such as LSFO, ULSFO and HSFO. The blends of heavy fuel oil and distillates frequently used in practice are described as marine diesel oil (MDO) or intermediate fuel oils (IFO). In the narrower sense of the term, “marine diesel oil” refers specifically to blends with a very low proportion of heavy fuel oil. This type of marine diesel oil is therefore also categorized as a distillate in some of the literature. The group distillates are colloquially known as marine gasoil (MGO).

Marine fuels are quoted on the international bunker markets with their maximum viscosity (which is set by the ISO 8217 standard, which is further detailed in the annex) due to the fact that marine engines are designed to use different viscosities of fuel. The unit of viscosity used is the centistoke and the fuels most frequently quoted are listed below:

Samples of residual fuels:

- IFO 380 - Intermediate fuel oil with a maximum viscosity of 380 Centistokes (<3.5% sulphur)
- IFO 180 - Intermediate fuel oil with a maximum viscosity of 180 Centistokes (<3.5% sulphur)
- LS 380 - Low-sulphur (<1.0%) intermediate fuel oil with a maximum viscosity of 380 Centistokes
- LS 180 - Low-sulphur (<1.0%) intermediate fuel oil with a maximum viscosity of 180 Centistokes
- MDO - Marine diesel oil (a blend of HFO and distillates).
- Samples of distillate fuels:
- MGO - Marine gasoil
- LSMGO - Low-sulphur (<0.1%) Marine Gas Oil - The fuel is to be used in EU community Ports and Anchorages. EU Sulphur directive 2005/33/EC
- ULSMGO - Ultra Low Sulphur Marine Gas Oil - referred to as Ultra Low Sulfur Diesel (sulphur 0.0015% max) in the US and Auto Gas Oil (sulphur 0.001% max) in the EU. Maximum sulphur allowable in US territories and territorial waters (inland, marine and automotive) and in the EU for inland use.

The bunkers delivered to ships vary a lot and is depending on the fuel for the main engines and the fuel for the auxiliary engines. Large ships can run on heavy fuel oil (mostly IFO) as well as marine diesel oil. For the auxiliary engines often MDO or MGO are used. Smaller vessels such as barges are not designed to run on heavy fuel oil but run on MDO.

Type of Bunker supply

Bunker supplies is dominantly organised by bunker supply vessels which supply vessels during their stay at the port or at anchorage. At very small ports sometimes bunkers are organised by truck transport especially for the distillate fuels. Barge transport is the common supplier at ports also because heavy fuel oil needs to be heated before it can be pumped.

The figure shows a bunker barge active near Singpaore with a typical length of 68.4m (LOA) and a beam of 12.8m and DWT of 1993 ton.

LNG an upcoming fuel.

LNG is a new marine fuel which is slowly gaining ground. Especially due to the limited emissions from LNG and elimination of NOx this fuel is introduced by shipowners with a high greening agenda. The first Ultra Large Container Ships have been equipped with LNG, a trial by CMA CGM. LNG is however mostly noted into the dedicated trades such as RoRo ferries and in the cruise industry. For LNG bunkering special bunker barges are required. The port of Rotterdam has recently welcomed the first LNG bunker barge, with 3,000 m3 capacity. By 2020 the port expects to operate 10 LNG bunker barges. By end of 2018 Rotterdam expects the first cruise vessel to be fuelled by LNG[9]. Also the MV Cardissa, operated by Shell to distribute LNG along European coastal waters, started to use the LNG Gate Terminal in Rotterdam last year. The vessel can carry 6,500 m3 LNG, has 5,320 DWT, a length of 120m

[9] Port of Rotterdam Authority

and a beam of 19.4m and is intended to supply LNG to various smaller European ports. As such Port of Rotterdam become also a hub port in LNG next to containers!

Sample Rotterdam

In 2017 Rotterdam handled about 9,9 million m3 of bunker fuels, down from 10.1 million m3 in 2016. The bunker fuels sold consists of various fuel type between heavy fuel oil to Ultra low Sulphur fuel oil, Marine diesel oil (MDO), marine gas oil (MGO) and LNG. The volume of bunkered LNG surged in 2017 from less than 100 tonnes to 1,500 tonnes. The increase in LNG bunkers was mainly due to the world's first container ship, the Wes Amelie, that was converted to LNG propulsion. The vessel regularly bunkers at the City Terminal at the Prins Willem Alexanderhaven. Last year, oil major Shell also put the ocean-going vessel Cardissa into use. The ship, which has Rotterdam as its work location, will supply customers throughout Europe with LNG from the new LNG "Gate terminal" in Rotterdam. The LNG "gate terminal" in Rotterdam features three storage tanks, each with a storage capacity of 180,000 m3, which make it possible to unload large amounts of LNG at once. The liquefied natural gas is either regasified at Gate Terminal to be transported through an underground pipeline to the European gas distribution network, or it is loaded into (short sea) vessels, bunker barges, smaller tankers for inland shipping or trucks.

Around 1 to 1.5 million m3 of bunkered fuel oil sold in Port of Rotterdam consists of so-called 'ultra-low sulfur fuel oil' with a sulfur content lower than 0.1% (ULFSO). Ultra-low sulfur fuel oil has been used since 2015. At that time, the permissible sulfur content in fuel oil went from 1.0 to 0.1% in the ECAs (emission control areas) of the North Sea, the Baltic Sea and the coasts along the United States.

Sample Singapore

In 2017, marine fuel sales in the city-port hit a record 50.6 million tons, rising 4.2% year on year. Currently, there are about 213 registered bunker tankers in Singapore of which 130 are for fuel oil, 71 are for marine gasoil and 11 are dual-fueled, and 1 is for ultra-low sulfur fuel oil, according to Port Authority data. After 2020, many industry sources expect the number of MGO bunker barges in Singapore to increase significantly, with some expecting the ratio of MGO:MFO bunker tankers to reach as high as 2:1. As a result Port of Singapore is implementing new mass flow meter regulations in order to keep transparency across fuel deliveries. To re-calibrate existing fuel barges estimated investments of 100,000 S.USD are expected including re-certification (30,000 S. USD), downtime and tank cleaning. The company Sentec recently bought two marine gasoil bunker barges.

Appendix XIII Sample LNG hub terminal

The following information illustratively describes the LNG Gate terminal in Rotterdam, located on 42 hectares of land at Maasvlakte 1 in the Port of Rotterdam, the Netherlands.

The terminal (in red marked on the picture), has a throughput capacity of 12 billion m³ (BCM) per annum and consist of three storage tanks, a regassification plant, two conventional ship berths and one small scale berth for inland barges.

The terminal is designed to unload LNG vessels, load LNG to vessels and to road trucks and to perform transhipments. The Gate terminal is the main import terminal of gas into the local and international gas pipeline grids.

LNG Gate terminal in Rotterdam

The Gate terminal facilities consist of:

- Total land area 42 hectares;
- Two jetties to unload LNG Carriers of sizes between 65,000 m3 and 267,000 m3
    - Jetty 1,2 – max vessel LOA is 350m (and minimum lengths of 90m) for the accomodation of approximately between 6,500 m³ and 267,000 m3.
    - Jetty 3 – max vessel LOA 180m is design for inland barges and ships upto about 20,000m³ (40,000m³ in future).
- Three (3) storage tanks (full containment tanks) with a net capacity of 180,000m3 each and total working capacity of 540,000 m³;
- Eight Open Rack Vaporisers (ORV), for which the warm cooling water of the local power plant is used for vaporisation of the LNG to enable a firm daily redelivery capacity equivalent to 12 billion m³ of gas per annum (12 BCMA), equivalent to approximately 1,67m (n) m3 per hour (~40m (n) m3 per day);
- The minimum delivery rate of the terminal is 139,000 m3(n)/h;
- The depth alongside jetty 1,2 is CD – 14.5m. With maximum loaded draft for vessels of 12.5m;
- The depth alongside the jetty 3 is CD - 10m. Maximum loaded draft of 7.5m;

Other details of jetty 1,2

- Maximum vessel beam at jetty 1,2 is 55m;
- Maximum approach speed to fenders at jetty 1,2 is 12cm/s, accidential 15cm/s;
- Maximum docking angle 5 degrees;
- Jetty 1,2 are equipped with cargo SVT arms of 20 inch. (three unloading and one vapour return);
- Jetty 1,2 connectors for quick connect 16 inch type hydraulic couplers;
- Working design pressure 100mLC;
- Usual working terminal pressure 50 to 250mbar;
- Terminal design maximum unloading rate is 14,5000 m^3/h for jetty 1 and 12,500 m^3/h for jetty 2;
- Return vapour temperature -130celsius after 1 hour at full rate vapour return;
- Heel to be maintained in the terminal is 30,000 m^3 for 3 tanks (10,000m^3 per tank);
- LNG density range 440-480 kg/m^3.

ADB

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Democratic Socialist Republic of Sri Lanka: National Port Master Plan

(Financed by the Japan Fund for Poverty Reduction)
The Colombo Port Development Plan – Volume 2 (Part 7)

Prepared by

Maritime & Transport Business Solutions B.V. (MTBS)

Rotterdam, The Netherlands

For Sri Lanka Ports Authority

Asian Development Bank

Appendix XIV Preliminary North Port options explained

Development of North Port – options explained

To develop the North Port, three development options can be considered.

- Energy Hub concept
- JICA North Port recommendation
- SLPA North Port concept

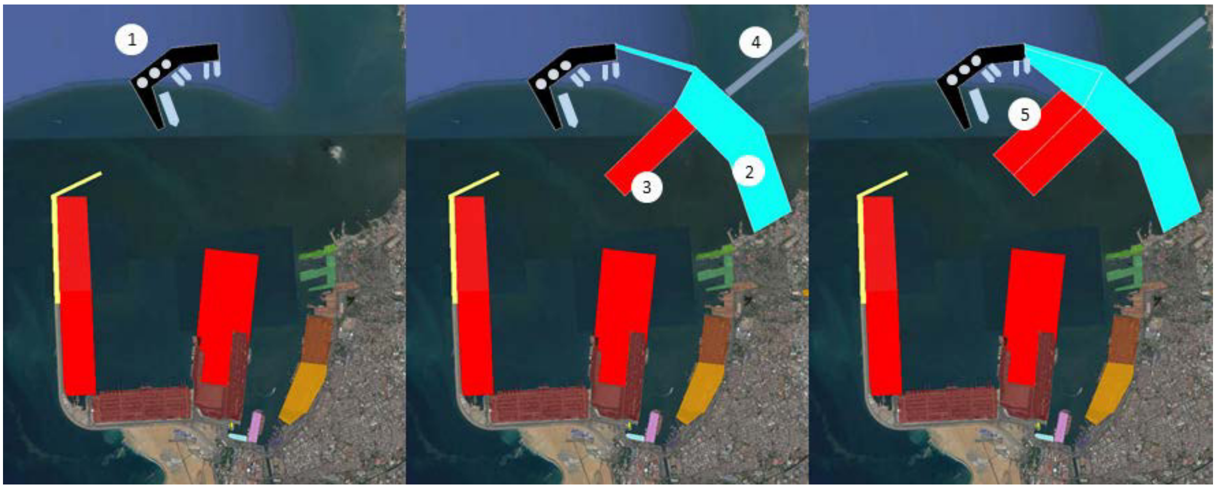
These options will be briefly stated here with benefits and challenges for development. The decision for development should be taken considering demand developments. This demand may also be triggered by other types of commodities than Containers, for example Liquid bulk, RoRo or General cargo. Planning should be considered at minimum 10-15 years in advance.

North Port – Energy Hub Concept

The Energy Hub Concept fulfils the nation's demand for a centralised energy import hub. The development can be phased in three stages where the first stage is the offshore energy hub development (nr. 1). To further fill the basin land can be created (nr. 2) for terminal and logistics development. A northern container terminal with 1,400 m quay on both sides can be phased in two or more stages (nrs. 3 and 5).

The designs below are a conceptual drawing subject to further studies. Size and orientation may still change, its purpose is to give a high-level overview of potential development. The main issues to be mitigated with this design are the environmental and ecological studies; the river sediment flow; the access bridge; and the safety and nautical assessment of the main channel.

Figure 20-7: Energy Hub Concept



Source: MTBS

The main features of the energy hub (conceptual phase) are:

LNG berth: For FRSU berth at 15.5m (vessels upto 300m with 260,000m3 capacity) able to receive LNG vessels featuring 300m LOA at 14.5m draught.

Two jetties: one jetty for imports of refined fuels (two berths at 15.5m depths for max LR2 (120,000 DWT or upto 300m)

one jetty for bunker barges (two berths) at 10.0m for indicative 3,000 - 8,000 dwt vessels or upto 100m

Tank storage 45 ha
Container terminal 1st phase: 1,400m with 420m in widths, depths at 18m, vessels upto 450m, 58ha
Container terminal 2nd phase:1,400m with 420m in widths, depths at 18m, vessel upto 450m, 58ha
The total container capacity is around 5.5 – 6 million TEU.
Turning base: Container vessels 900m, tankers 600m.
Bridge: Connecting to shore above Kelani river and the towards highway.
Rail: Connectivity to national grid and south basin via bridge and via existing port.
Roads: The North port should make connectivity with South basin, the main port access road and the Highway North of Kelani river through the new bridge.
Logistics area: Large 150 - 250ha

Possible additional terminals within the concept:
General cargo: 1st phase berth 300m at 15.5m, 2nd phase 250m
Bulk terminal: 1st phase berth 300m at 15.5m, 2nd phase 250m
RoRo terminal: 1st phase berth for 280m at 10m, 2nd phase 220m

The main benefits to this concept are:

- The liquid hub can be independently developed within South port Max concept.
- The liquid bulk and LNG vessels can be accommodated in deeper waters which saves dredging compared to a solution north of PVQ.
- LNG vessels and liquid bulk vessels have a high risk profile from a nautical perspective. In this concept they do not have to cross the port basin leading to optimisation of vessel traffic flows and minimisation of risks.
- The Liquid hub island is at a safe distance from the city which is important for LNG, relatively low impact to port and city.
- The liquid hub provides option to connect by pipeline for the power plant, and provides save berthing for liquid bulk and LNG vessels whilst at the same time creates optimal bunker supply options by barge to main line vessels at the port.
- The island can be integrated into further north port development.
- The shore impact to access north port is relatively low compared to North Port option 2 development.

The main challenges to this concept are:

- Having a masterplan with the option to integrate the island at a later stage in the overall development needs careful planning (and simulations) well in advance of north port development.
- The shape and angle of the north port development towards the liquid bulk island interferes with the river outlet. River sedimentation flow simulations as well as water level piling need to be researched. Basically the research should investigate the angle at which north port breakwater is designed in order to find the levels of impact and the options for remediation.

North Port – JICA Recommendation

The JICA logistics study 2017 presented an island design for the North Port which is connected by bridges to the old port and towards the North. JICA has proposed mitigation measures for the main disadvantage of this design regarding the outflow of the river.

Figure 20-8: JICA North Port Concept

Item	Value (M TEU)
Long Term Container Handling Capacity	21.7

Source: JICA – Draft Final "Data Collection Survey on Logistics Sector in Sri Lanka" – May 2017

The main benefits to this concept are:

- Land creation for the logistics and energy imports.
- Relatively low hindrance to city and population.

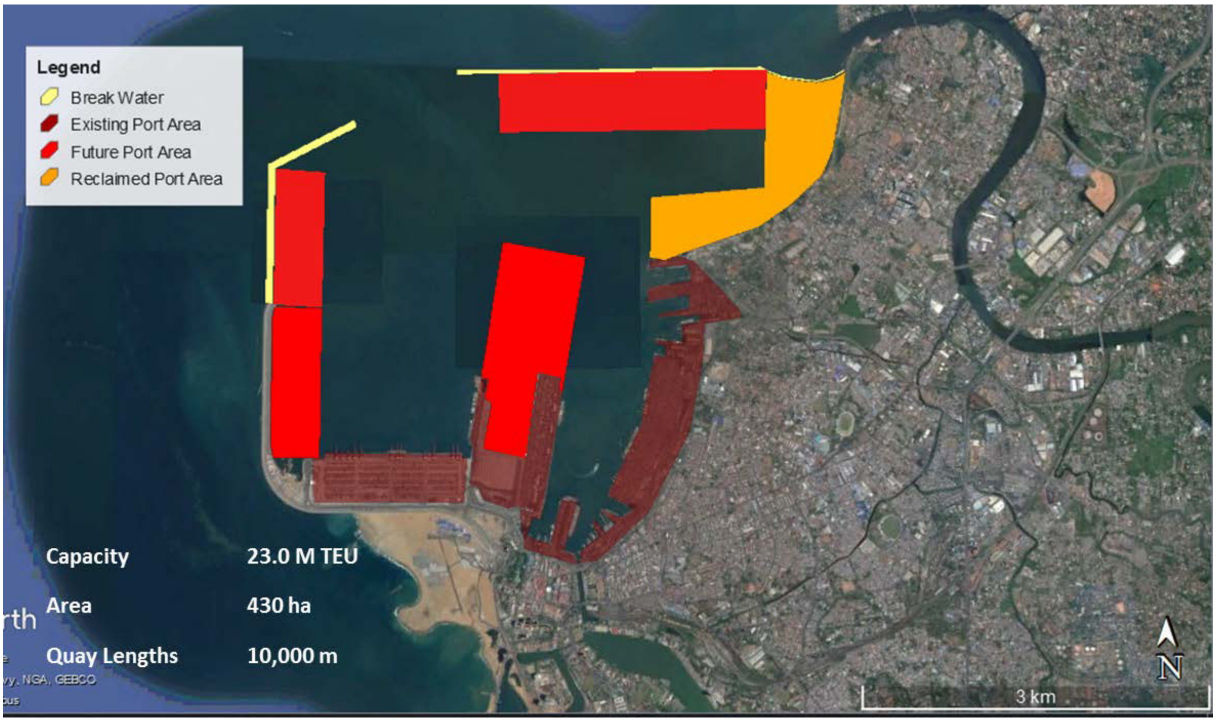
The main challenges to this concept are:

- Mitigating the outflow of the river Kelani. Possibly sediment might reach the old basin directly.
- Nautical accessibility is a concern. The navigation area between the new port and the main breakwater is expected to be subject for revision.
- The nautical safety is of concern. The navigation in the channel has to accommodate container vessels and liquid bulk vessels this may create future navigational bottlenecks.
- It remains questionable whether the logistics centre (blue area) is indeed created in future as many residents are still living there.
- North breakwater is expensive as it is located in deeper waters compared to the other North port development options.

North Port – SLPA Concept

The figure below presents the SLPA envisaged North Port Design with a break water under Kelani river heading westwards. The land created could then serve as a container terminal with possibilities for dry bulk, liquid bulk and break bulk terminals. A liquid hub is projected north of PVQ in this concept.

Figure 20-9: SLPA North Port Concept



The main benefits to this concept are:

- Relatively low displacement due creation of port land into sea. The housing near the coast will be affected, though not as much as a similar scale development on land.
- The North port breakwater can be located on top of the rubble defence as mentioned in South Port Max concept.
- There is ample space for logistics on the reclaimed port area.

The main challenges to this concept are:

- As land is created in front of the shoreline, many residents are effected, more than in energy hub concept or JICA concept
- The river sedimentation flow needs to be researched and river flow guidance may be required
- The land accessibility is poor, a bridge towards the North will also be required to facilitate the growth of the terminals.

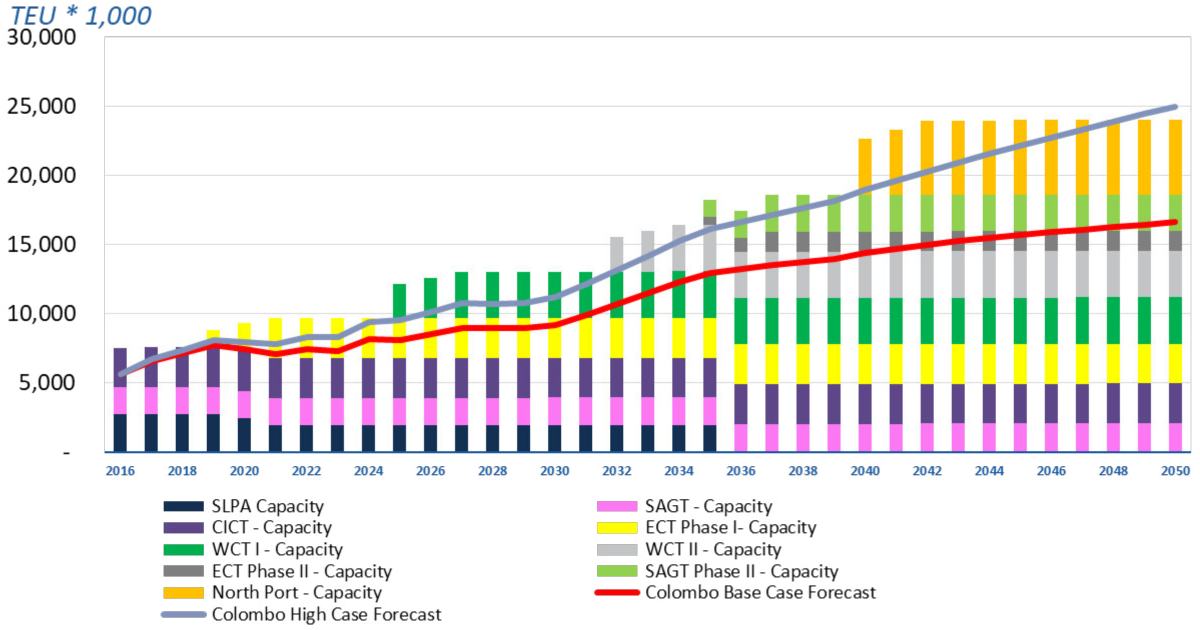
Phasing of container terminals in case of demands go beyond Base Case

In case container demand grows beyond the Base Case, there will be need for North Port development for containers (it is noted that the need for a north port development may also be triggered by other cargo segments, as stated in section 10.6). In that case, the expansion path includes:

- 2019 start East Container Terminal Phase I operations
- 2025 start West Container Terminal Phase I operations
- 2032 start West Container Terminal Phase II operations
- 2035 start SAGT Phase II operations
- 2035 start East Container Terminal Phase II operations
- 2035 phase out Jaya Container Terminal operations
- 2040 start of North Port operations

The phased container terminal development outlook is projected in the figure below.

Figure 20-10: Phasing Container Terminals – High Case



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Appendix XV Implementation Plan

This section contains the proposed timelines for the implementation of the various plans. The section details:

- Timeline for major recommendation (grouped by activities).
- Implementation plan Short Term Priority projects including detailed timeline
- Long term development plan including timeline.

The overview of the implementation plan follows the detailing below.

Implementation Plan - Recommendations

ECT development:

- Tender start in 1st half 2018 – 6 months
- Construction - 18 months
- Operational – begin 2020

Logistics & warehousing:

- Activities on logistics 2018 – 2020 (till gates are improved)
- Activities on warehousing - 2018 till begin 2021 (when warehouse Bloemandhal hill opens)

Nautical access and navigation

VTMS, existing cruise berth lengthening

- Upgrade VTMS till second half 2018
- Existing cruise berth by new dolphin, until end 2018

Roads

Port Access road, PAEH ramps, JCT entrance

- Till after PAEH development - expected by end 2020

Rail and Multimodality

Reservation of rail in the port:

- RDA involvement due to PAEH: 1st half 2018 – 2 months
- Execution 1 month
- Ready by end 1st quarter 2018

Environment

The project consists of measuring and monitoring, guidelines, HSSE department, green policy, ISO certificates and international conventions

- Activities to start by begin 2019
- Reorganisation departments to run till end 2020.
- Compliance issues till end 2020
- Green policy till end 2020
- ISO 14001 certificate by end 2022

IT and port

The IT project are widespread from systems to purchase to hardware and networks. The most important IT work is the TOS system upgrade.
TOS upgrade:

- Tender – first half 2018
- Design and implementation – 12 months
- Operational – mid 2019

Other IT systems

- Ongoing tenders – up till mid 2019
- Implementation – 12 months
- Operational – by mid-2020

Customs efficiency reforms

- Customs single window – up till end 2018
- Inspection and scanning facilities up till end 2020
- Custom inspection with small patrol vessels

Navy

- New mooring places – up till end 2018

Direct auxiliary functions

- New tug purchase up till 1st half 2020
- Bunker barges (LNG) up till 2021
- BWM systems by end 2019
- VGM up till 1st half 2018

Indirect auxiliary functions

- Maintenance and repair to be restructured – up till end 2020
- Fleet databases / ship classification – 1st half 2018
- Licenses digitalised – up till begin 2020
- Emergency plan update up till 1st half 2019
- Medical centre to be outsourced by end 2022

Trade facilitation and logistic hubs

- Logistics centres / cargo villages / FTZ – up till end 2020
- Trade facilitation (ease of doing business, tax incentives, trade agreements) – ongoing till 2025
- Airport to sea function – up till end 2020

Implementation Plan – Short term priority projects

The time planning for the short term priority projects are displayed in this paragraph.

JCT Modernisation
The project has the following time line

- Tender phase second half 2018 – Jan 2019
- Construction 2019
- Operational 2020
- Continued improvements equipment till end 2021

PVQ upgrade plan SP2 & SP3

The project did not reach approval

- Tender phase second half 2018 – Jan 2019
- Construction 2019
- Operational 2020
- Continued improvements equipment till end 2021

Oil refinery upgrade

The expected refurbishment / new refinery is expected to encompass about 10 years

- Tender phase second half 2018 – Jan 2019
- Construction till end 2027
- Operational 2028

LNG storage facility

The project depends on the new LNG fuelled power station and conversion of the existing oil-fired power station.

- Tender phase second half 2018 – second half 2019
- Construction 2019 - 2022
- Operational 2023

UCT transformation plan

The project depends on the new LNG fuelled power station

- Cranes removed
- Warehouse – construction 2019
- Cement piping – construction 2019

Passenger terminal

The project consists of a new passenger terminal building on BQ area.

- Tender - 2018
- Construction – 18 months
- Operational – second half 2020

Port gate complex

The project consists of two variants:

Main gates

- Tender – second half 2018
- Construction – 12 months
- Operational – second half 2019

PAEH gates

- Tender – second half 2019
- Construction – 12 months
- Operational – second half 2021

BQ warehousing allocation plan

The project consists of relocating warehouses to Bloemandhal hill:

Warehouses can be made within one year but roads and connectivity will take time.

- Tender – first half 2018 – end 2019
- Construction – 24 months
- Operational – begin 2021

Mechanical and electrical workshops
The project consists of relocating workshops:

- Tender – start 2018 – second half 2018
- Construction – 6 months
- Operational – start of 2019

Resettlement of underutilised buildings
The project consists of demolishment of warehouses and buildings:

- Tender – second half 2018 – start of 2019
- Demolishment – 12 months
- Finished – start of 2020

Widening Port Access road
The project consists of widening the Port Access road after the finalisation of the PAEH, by end 2020:

- RDA: Beginning of 2021
- Construction 6 months
- Finished – second half 2021

Gate automation (JCT and main gate)
Gate automation JCT:

- Tender 2nd quarter – 6 months
- Construction 6 months
- Operational – second half 2019

Gate automation main gate, after customs efficiency upgrade:

- Tender begin of 2020 – 6 months
- Construction 6 months
- Operational – begin 2021

PAEH simulations
Simulations:

- Tender 1st half 2018 – 2 months
- Execution 2 months
- Ready by half 2018

PAEH Development
PAEH development:

- Tender start in 1st half 2018 – 6 months
- Construction 24 months
- Operational – begin 2021

Reservation Future Rail Development path
Reservation future rail development:

- RDA: 1st half 2018 – 2 months
- Execution 1 month
- Ready by end 1st quarter 2018

Port Community system

Port community system:

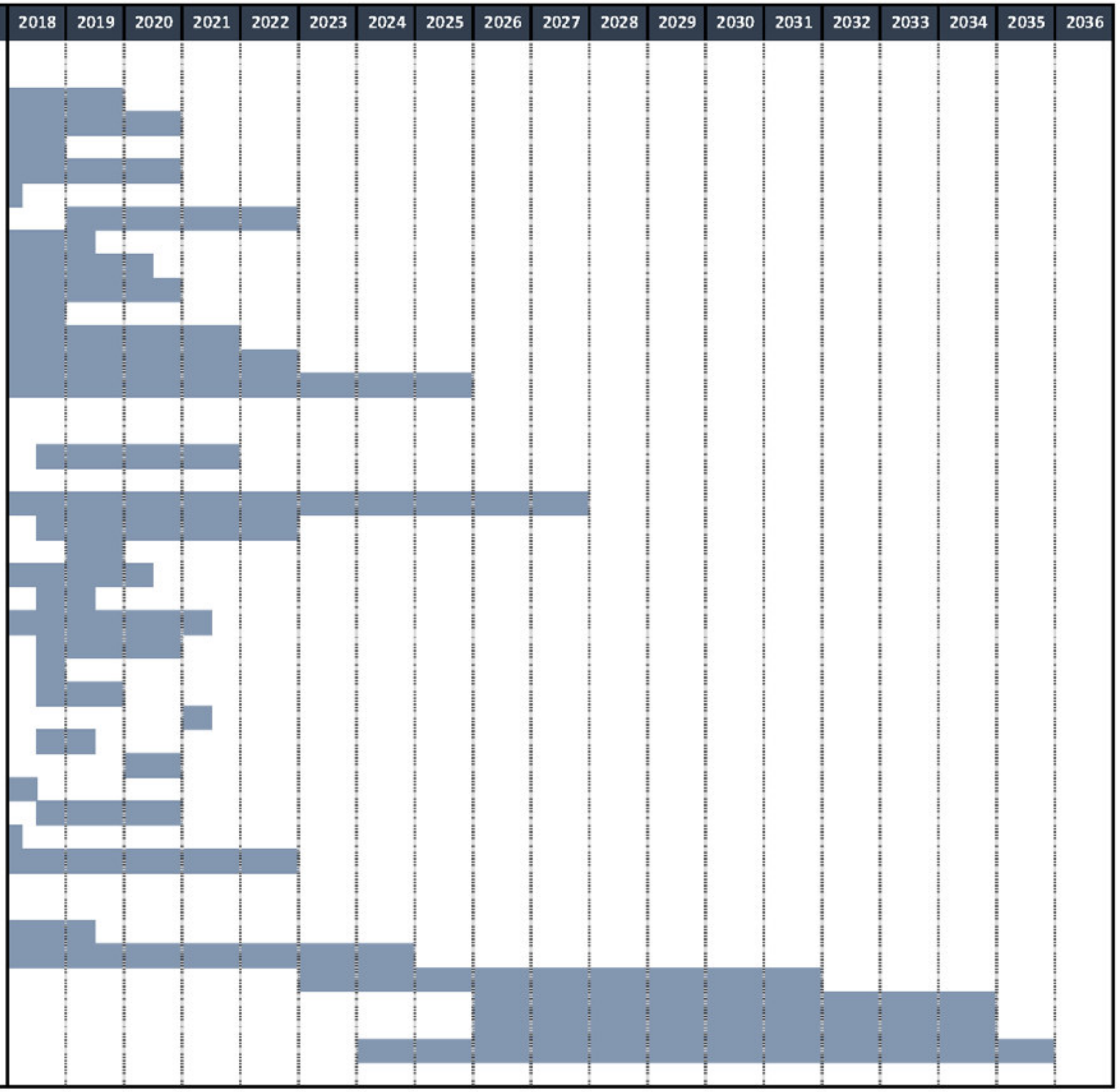
- Task force and orientation in till 1st half 2018
- Tender advisory service till 3rd quarter 2018
- Project start begin 2019
- Project end 2022, operational start 2023

Implementation Plan - Long term developments

The long-term developments of the port infrastructure are displayed in next overview.

- 2019 start East Container Terminal Phase I operations
  - Concession & tenders, buy cranes 18 months, start operations after mid 2019
- 2025 start West Container Terminal Phase I operations
  - Start project 2018, Planning and design(2yr), Reclamation (1yr), tender and construction (4yr), equipment (in parallel), operational by 2025.
- 2032 start West Container Terminal Phase II operations
  - Start project 2023, Planning and design(2yr), Breakwater development (2yr), Reclamation (1yr), tender and construction (4yr), equipment (in parallel), operational by 2032.
- 2035 start SAGT Phase II operations
  - Start project 2026, Planning and design(2yr),Breakwater development (2yr), Reclamation (1yr), tender and construction (4yr), equipment (in parallel), operational by 2035.
- 2035 start East Container Terminal Phase II operations
  - Start project 2026, Planning and design(2yr),Breakwater development (2yr), Reclamation (1yr), tender and construction (4yr), equipment (in parallel), operational by 2035.
- 2036 start of North Port operations
  - Start project 2022, Planning and design(4yr), Breakwater development (3yr), Reclamation (2yr), tender and construction (5yr), equipment (in parallel), operational by 2035.

Implementation plan	Start	Duration (# months)
Recommendations		
Cargo	01/01/2018	24
Logistics and Warehousing	01/01/2018	36
Nautical access and navigation	01/01/2018	12
Roads	01/01/2018	36
Rail and Multimodality	01/01/2018	3
Environmental Impact	01/01/2019	48
IT and the Port: a) TOS system	01/01/2018	18
IT and the Port: b) other IT systems	01/01/2018	30
Customs	01/01/2018	36
Navy	01/01/2018	12
Auxiliary Functions - Direct Supportive Functions	01/01/2018	48
Auxiliary Functions - Indirect Supportive Functions	01/01/2018	60
Auxiliary Functions - International Benchmark	01/01/2018	96
Short Term Priority Projects		
SP1-JCT Modernisation Plan	01/07/2018	42
SP2-SP3-PVQ Upgrade Plan	01/12/2017	0
SP4-Sapugaskanda oil refinery	01/01/2018	120
SP5-LNG Storage Facility	01/07/2018	54
SP6-UCT Transformation Plan	01/01/2019	12
SP7-Passenger Terminal	01/01/2018	30
SP8a-Port Gate Upgrade Plan-Main Gate	01/07/2018	12
SP8b-Port Gate Upgrade Plan-South Gate PAEH	01/01/2018	42
SP9-BQ Warehousing Relocation Plan	01/07/2018	28
SP10-Mechanical and electric workshops	01/07/2018	6
SP11-Resettlement underutilised buildings	01/07/2018	18
SP12-Widening of the port access road	01/01/2021	6
SP13a-Port Gate Automation JCT	01/07/2018	12
SP13b-Port Gate Automation Main Gate	01/01/2020	12
SP14-PAEH Simulations	01/01/2018	6
SP15-PAEH Development	01/07/2018	30
SP16-Securing Future Rail Development Path	01/01/2018	3
SP17-Port Community System	01/01/2018	60
Port Development Options		
ECT phase 1	01/01/2018	18
WCT phase 1	01/01/2018	84
WCT phase 2	01/01/2023	108
SAGT phase 2	01/01/2026	108
ECT phase 2	01/01/2026	108
North Port	01/01/2024	144



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Appendix XVI Environmental Sustainability, Monitoring and Reporting

This annex describes a common way to monitor and report the environmental conditions of a port. Commonly these reports are known as environmental sustainability reports. This report would refer to the sustainability targets as set by the Port Authority in their masterplan or annual report.

The task of such a report is to understand the increase or decrease of impacts on the environment, and to communicate to the general public what has been done or what is planned to be done to reduce emissions and to improve the climate in and near the port.

The report can have many forms but generally consists of an introduction and the following seven areas on which modern ports commonly monitor and report environmental conditions:

- A general description of the port and the logistics areas
- Energy, Air, Water, Waste, Noise, Nuisance and Nature.

Requirements for monitoring:

1. Description of the sustainability target (mission on environmental sustainability)
2. Description of activities
3. Definition of the port-zone
4. An institutional framework in which private companies and public companies within the port zone are required to measure or estimate their emissions (CO_2, NOx, SO_2, PM10 and sometimes PM2.5, Methane, Ammonia and Ethane[10]) and report this to an (independent) entity responsible to report annually on environmental sustainability. An electronic environment reporting system in which the companies make their annual environmental report is a handy tool in the data collection a can be made mandatory by local laws.
5. A set of environment monitoring stations in the port and near the port which are able to monitor air quality, noise, emissions wind force and wind directions and air-pressure on an hourly basis.
6. Key boundary levels of exhaust emissions, noise and air quality are specified as maximum values not to be exceeded. This is often stipulated in the environmental licences provided to companies in their licence to operate or concession contracts. The stipulation is often governed by national environmental / climate laws or by district / municipality laws and / or by applied international legislation on dangerous goods for example.

Sustainability targets

The port authority or the (local) government reports a sustainability target such as the following example:

To become more sustainable through energy transition and sustainable utilisation of sources to get to an energy neutral situation in 2030. This means that all energy will come through own generate energy without usage of fossil fuels or through purchase of sustainable energy. For this often an *energy program* has been formulated to come to more sustainable energy usage with targets like the following:

- 30% energy utilisation by sustainable sources (wind, solar, earth heating, use of industrial residual heat).
- A reduction of 10% CO_2 footprint in 2030 compared to 1999, and so on.

[10] A chemical cluster would typically have several additional reporting values.

It such be clear that such quantitative targets can only be set when a zero-level measurement have been under taken with a measurement system in place. That exercise would provide the as-is situation against which improvements can be measured.

In the next paragraphs the seven elements are further explained through the use of examples from the Port of Moerdijk. This Dutch port in the neighbourhood of Rotterdam contains all elements of a modern industrial port, in a concise manner, has dry and liquid bulks, container and general cargo and a petrochemical industry. Furthermore, it is located near villages and near nature reserve areas.

For example: The strategy of the Port of Moerdijk is based on the 'Triple P' principle of People, Planet and Profit. Reference is here also made to the UN sustainability development goals (SDGs). The idea behind this is that sustainable development requires a balanced development process, aimed at promoting the resilience and quality of nature (planet), the physical and mental wellbeing of the inhabitants (people) and healthy economic development (profit). Improvement of one may not be at the expense of the other. The right balance strengthens the total and not just the individual parts.

Description of activities
In the description the port and the port’s activities are described. The description includes the size (ha) and volume of throughputs and the amount of people working in the port.

For example: The port of Moerdijk is an industrial port located south of the port of Rotterdam with open access to sea and inland rivers. The port handled liquid bulk, dry bulk, general cargoes, containers and consists of a industrial parc and logistics parcs. The port is operated by the (privatised) Port Authority Moerdijk. In 2016 the total volume handled was 17 million tons of which 4.9 million ton in containers. In 2016 the industrial parc encompassed 432 companies totalling 8,835 employees. Combined with port suppliers a total direct employment of about 17,059 people.

Definition of the port zone

Here the port zone is stipulated and when relevant the zoning in the port is expressed. For example: The port encompasses 2.635 ha and is located near highways, rail and inland water ways. The port is zoned into five sections, an industrial parc, an eco-parc a seaport area, logistics area and a service area. There are four populated areas (located in red) in the proximity.

Logistics

The total seagoing vessels in 2016 numbered 1,900 and inland waterways mounted to 11,383 vessels. The total volume transported increased by 5.7% to 17.5 million tons, compared to previous year. In 2016 about 886,00 tons of products was transported by rail of which the majority was steel and chemical products.

The port has a lengthy network of pipelines connecting local industry to the ports of Rotterdam and Antwerp.

Institutional framework

An institutional framework should be in place in which responsibilities on environmental monitoring and reporting is clearly defined. For complicating matters, reference is often made to various institutes to which responsibilities are allocated.

In the case of Port of Moerdijk the collector of data and the reporting entity have been placed in a separate workgroup for which a *foundation* named "Sustainable Connections Moerdijk" was formed. The stakeholders in the foundation are the Port Authority, Government departments, municipalities, representatives from a cluster of local businesses, Water supplier and the local energy board. The target for this foundation is to formulate a program which contributes to the environmental missions of the stakeholders. With other words the foundation needs to formulate a plan which service the main sustainability ambitions of each stakeholder. Sustainability means that the Moerdijk port and industrial area has an optimal balance between ecological, economic and social aspects.

The port of Moerdijk has implemented an electronic environment reporting system which compiles the relevant data. As the foundation is independent data collected is secured.

Monitoring stations

A set of environment monitoring stations is required near the port to monitor air quality, noise, emissions, wind force and wind directions and air pressure on an hourly basis.

The main objective is to measure near the city or villages in order to understand the (negative-) effects on the population. Often ports start with one or two measurement stations but for a good coverage of the port a monitoring station can be placed in each compass quadrant.
In the case of Port of Moerdijk four measurement stations were established near the main villages surrounding the port.

Key boundary levels

Key boundary levels of exhaust emissions, noise and air quality are specified as maximum values not to be exceeded. Following key boundary levels are often applied in the air measurement stations:

Type	Unit	Hourly boundary level	Annual boundary average level	Day level
NO2	µg/m3	200	40	
PM10	µg/m3	50	40	
PM2.5	µg/m3	NA	25	
Benzeen	µg/m3	NA	5	
Noise (day)	Decibel (dB(A)			50
Noise (evening)	Decibel (dB(A)			45
Noise (night)	Decibel (dB(A)			40

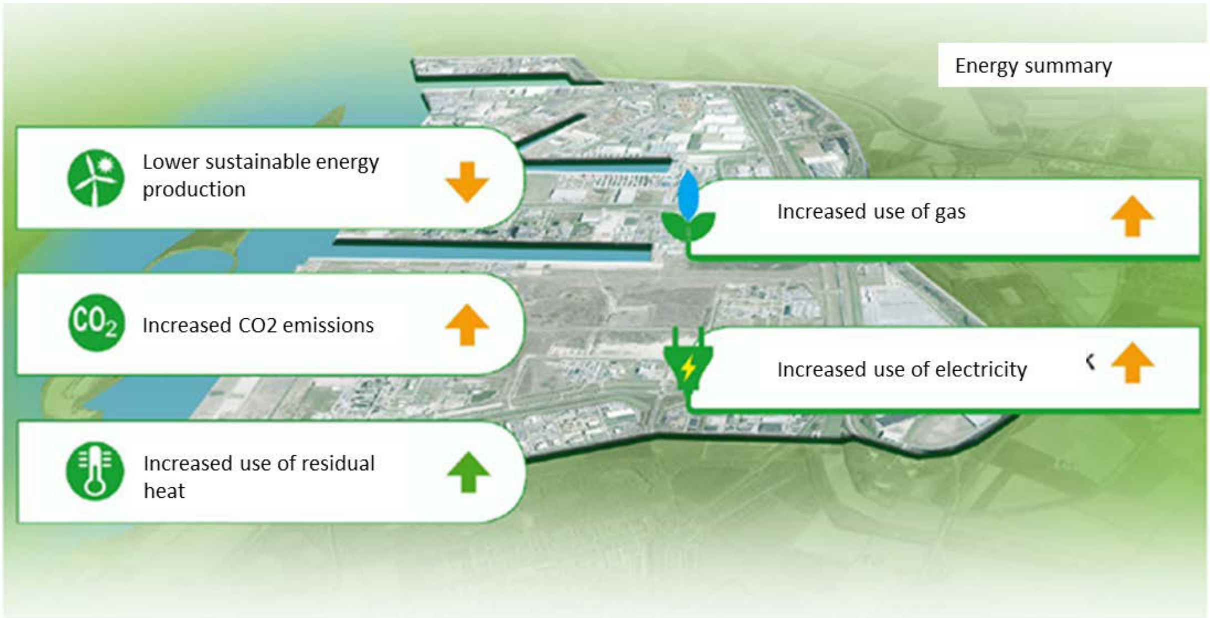
It should be noted that these levels relate to a specific area (the entire port) and not for specific companies. Through modelling with timing and wind directions, the contribution of specific zones can be illustrated.

For CO_2 and SO_2 the exhaust limits are often separately specified per company and its industrial activity. Each company needs to report its exhaust by enforced laws and when this is combined, it offers the entire CO_2 exhaust in the port in kg.

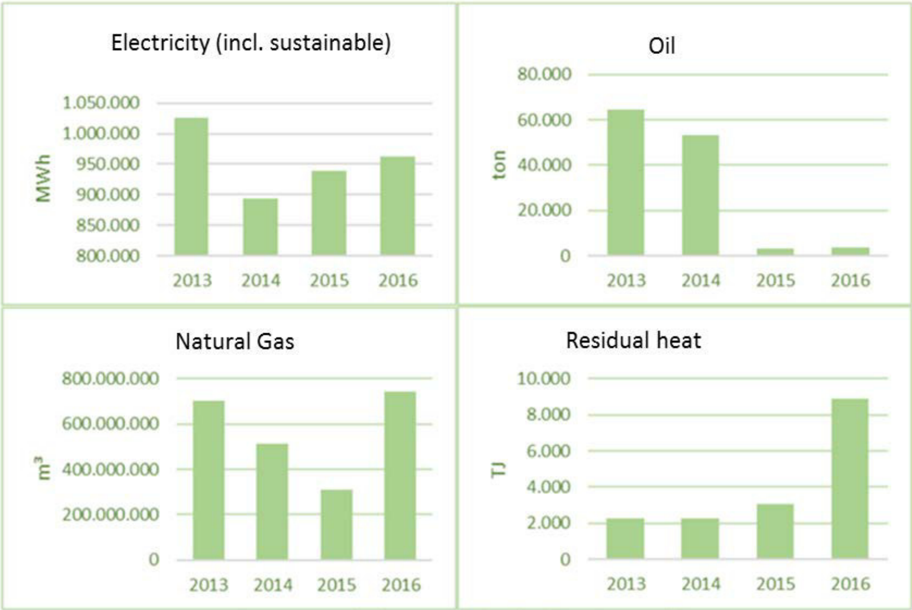
In the next paragraphs the seven themes are discussed these themes are Energy, Air, Water, Waste, Noise, Nuisance and Nature.

Energy

Under this section the energy utilisation is described. It displays the total consumption of energy bought and produced by the companies located in the port: electricity (Mwh), of Oil (tons), of natural gas (m^3) and industrial heat (in Terrajoule Tj). A sample of reporting the summary is illustrated in next figure.



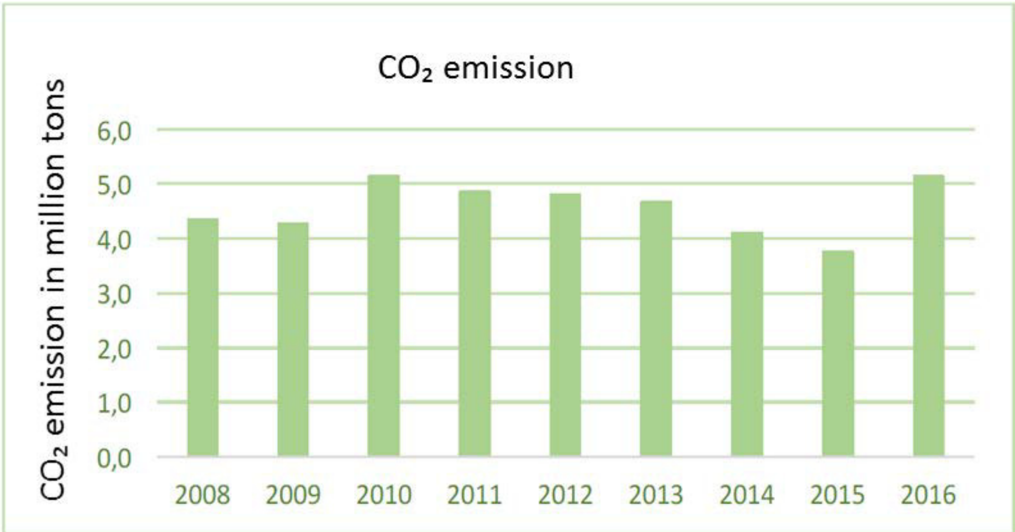
The performances illustrated in this figure refer to a yarer in which two new large industries started in the port. This had an increased effect on the energy usage and hence the emissions increased as well. Positive was the reuse of residual heat for which a specific project was executed. Each company is required to report its energy usage on an annual basis, this produces the following graphics.



Electricity purchased by companies within the port

The Port of Moerdijk showed that the energy production was 2.5 times as large as the energy consumption by local companies. The port as such is a net producer and exporter of energy. An element added in the port was the re-utilisation of residual heat from the industries by transferring this to other port companies.

The CO_2 footprint is measured through the electronic environmental annual reporting system in the port. Each company which has an environmental licence is required by law to report its CO_2 exhaust. This provides the following graphic. The target for reduction has not been met in 2016 due to a new large industry which started operations in the port. Next to residual heat, the port wants to increase the energy from wind, solar power and biomass to speed the energy transition and re-use the CO_2 for greenhouses.



What has been done :

- The port of Moerdijk started to a project for the re-utilisation of residual heat by a project with as purpose to transport residual heat from the industry towards the local energy firms. It has been estimated that this residual heat is similar to the consumption of 50,000 households. Further the project intends to transport CO_2 towards greenhouse horticulture which uses the CO_2 for the cultivation of cucumbers and peppers.
- The port has promoted the use of solar panels in the port. About 9 MW is planned to be installed by local companies.
- The port introduced LED lighting at all public places in the port including access roads. The LED lightning is also part of the sustainability vision of the port.

What are next steps:

- A start has been made with the environmental impact assessment to create a windmill parc on the west and south corner of the port.
- A new energy program for 2021 will be made.

Air quality

Under this paragraph the air quality measurement and reporting is shown. The port should have several monitoring stations which is able to measure the air quality. The air quality measurement by the port became mandatory through municipality laws.

At the port of Moerdijk four air quality stations where implemented since 2008. The stations are located near the major population centra Moerdijk, Zevenbergen, Zundert and Strijensas. At the stations the air quality is measured every hour.
The key boundary levels of air quality are specified as maximum values which should not to be exceeded.

Measure station Moerdijk	Criteria/ measurement	Value	Unit
NO2	Boundary level (hourly value)	200	µg/m3
	Measurement highest hourly concentration	105	µg/m3
	Boundary level (annual average)	40	µg/m3
	Measured annual average	21	µg/m3
PM10	Boundary level (day value)	50	µg/m3
	Measured highest day concentration	74	µg/m3
	Number of allowed trespassing of day value	35	number
	Number of measured trespassing	11	Number

	Boundary level (annual average)	40	µg/m3
	Measured annual concentration	20	µg/m3
PM2.5	Boundary level (annual average)	25	µg/m3
	Measured annual average	14	µg/m3
	Measured highest day concentration	49	µg/m3
Benzeen	Boundary level (annual average)	5	µg/m3
	Measured annual average	1.3	µg/m3
	Measured highest day concentration	58	µg/m3

What has been done:

- The measurement of the air quality is continuously followed. All measured value was within boundary limits except for PM10 which did exceed the boundary level but was still within allowed levels of trespassing.

What are next steps:

- The port started to measure also toluene, ethylbenzene, mp-xylene en o-xylene to understand the value developments. No boundary levels have been specified for these items sofar. The concentrations were declining despite increased industrial activities. The air quality as such improved.
- Through data modelling base on the wind directions and air quality measurements the contribution of port and the industrial terrain are specified.
- The target is that the air quality remains stable at the surrounding village Moerdijk despite planned expansion of industrial activities.
- The port likes to implement a real life “smell” system which will measure smell and can be used for tracing the source.
- The measurement of air quality will be continued and the results will be shared with the individual companies.

Water

Under this paragraph the utilisation of water is shown. The water supplier reports to the individual entity for reporting on environment, the water usage. This is either:

- drinking water. Used for drinking and general usage.
- industrial water. The latter is of a different water quality and used for industrial processes like cleaning, spooling and cooling.

Another two elements are measured:

- The indirect discharge of spoiled water and the rainfall discharge to the sewage system
- The use of cool water from the river and the discharge of cool water to the river.

The port of Moerdijk used 1.06 million m³ of drinking water, in 2016. Equivalent to the annual usage of 7,100 households. About 5.4 million m³ of industrial water is consumed.

Water discharge at the sewage system is cleaned at a sewage cleaning system nearby the port. The water supplier uses a measurement for waste water and this is reported back the environmental reporting unit.

What has been done:

- The port supported the development of new waste water pipeline system which is developed to re-use waste water to the maximum extend.
- The port aims to reduce the cooling water from the river

What are next steps:

- The port wants to create a water management plan to reduce the cool water and to create sustainable usage of waste water where possible.
- The water management should provide clear measurable objectives on water projects.

Waste

This section describes how much waste is produced and how much waste is processed or recycled on own premises and how much waste is transported to other locations. The objective is to be able to show an improvement in the reduction of waste and or the increase in re-cycling (circular economy). The port promotes re-utilisation of waste through re-cycling. Another focus area is to create energy from waste burning and waste separation.

The data on waste is provided through the companies (public and private) active in the port which are required to report via the electronic environment system. Waste reporting normally split between handling and disposal.

Waste handling is classified as waste recycling, waste to energy, burning, dumping and waste separation. The disposal of waste is commonly split between disposal within the country and outside the country and whether it is dangerous waste or not.

In the case of Port of Moerdijk, about 2.3 million tons of waste was produced by the established companies. For comparison, every person in The Netherlands produces about 500 kg of (household) waste per year. Part of this is locally *handled* and part of it is *disposed*.

What has been done:
The reporting entity has expressed that it conforms to the national waste targets (national waste plan) rather than specifying own ambitions. The national waste plan targets are formulated as:

1. Reduce the amount of waste
2. Make waste management effective and reduce it's effect on the environment.
3. Promote production chain approach or circular economy approach to reduce effect on the environment.

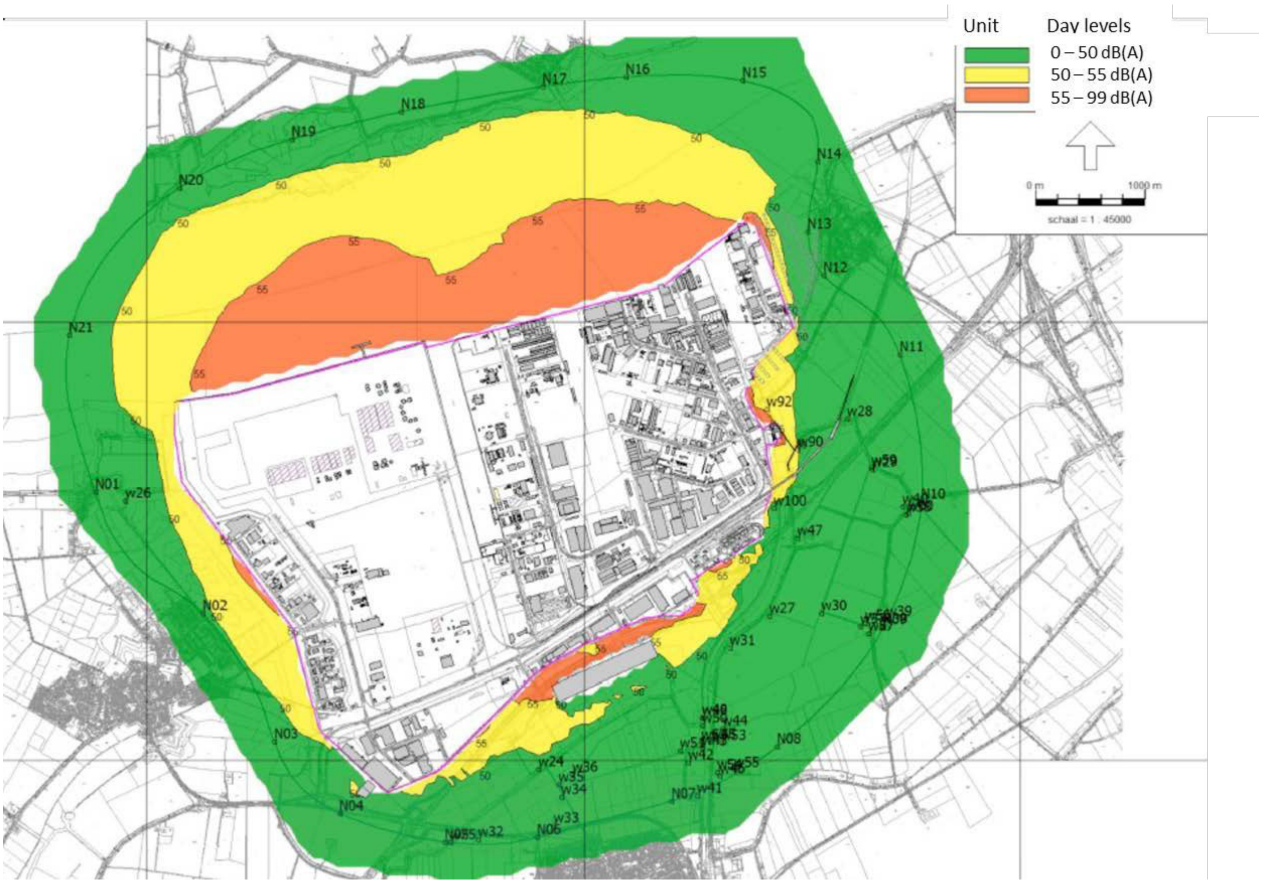
The companies at the port of Moerdijk exchange raw materials, energy and exchange residual flows. Residual flow from one company are re-used as raw materials for other companies (common to the chemical industry). Also, CO_2 exhaust is filtered and re-used for pigment in the paper industry. At the waste burning station, energy is used for new electricity.

What are next steps:
The port is creating an energy (re-)utilisation project to further promote green energy and to promote waste reduction and recycling. Further individual companies work also on their own sustainability targets. Together they strive forward for a more circular economy. This is an economic system in which (raw-)materials are reduced, re-used, and re-cycled as much as possible. Companies in this way will also save production costs and increase their share in sustainable energy and reduce CO_2 footprint.

Noise
Noise is an important element for nuisance of nearby villages or cities. Hence for ports it becomes important to find the right balance between their noisy activities (freedom for business activities) and an acceptable living and working environment. Often noise is regulated through the company's licence to operate or an environmental climate law with separate levels for medium and heavy (noisy-) industry.

When noise is allocated under the licence to operate or concession contracts, it is important that this also reflects the situation of surrounding activities. The combined noise should not be exceeding the boundary levels measured at the villages. In order to manage the noise (when allocating the concessions) in a fair manner, a zone noise modelling is made to establish the individual noise limits when combined do not trespass the boundary level at the measurement stations.

At the port of Moerdijk activities are allowed in the heavy (noisy) industry, the noise measurements were illustrated as follows.



The port did not trespass the noise boundaries at the measure stations.

What has been done:

- Today the port acts still within the noise boundaries. However, for the future expansion the noise levels may go up. A plan is under development to optimise the noise modelling to allow port growth without trespassing the noise boundaries.

What are next steps:

- The port plans aim to reduce the noise to the surrounding. Noise barriers and forest may be some of the solutions.

Nuisance

The nuisance from households living in the surrounding city and villages form an important element in the port-city acceptance. It requires good registration, analysis and communication. The objective is to have a minimum of complaints related to the port. The communication on complaints should be accurate, responsive and transparent, in order to service the general public.

Often a separate entity (outside the port Authority) is responsible for the collection and registration of complaints and they are in charge of control and trespassing.

Nuisance by the general public may relate to many different sources. It is important to understand which of the complaints relate to nuisance caused by the port users. The independent entity will try to locate the cause of the complaint and will try to identify the source of the problem.

Once the cause is attributed to the port, the complaint is categorised into for example air quality, noise, water, noise, gas flaring and general.

Each of the segments can be subcategorised like for air quality: Chemical smell, smog, burnt rubber, cadaver, dung and so on.

As many complaints may be caused by the same event it can be categorised as a nuisance cluster. A cluster is a day in which five or more complaints are received. Noteworthy is the registration of health issues (ranged from headache to insomnia and nausea.

The port of Moerdijk registered 212 complaints in 2016, 35% less than the year before. 85% of the complaints related to air quality with a dominance to chemical smells and smoke. 7% of the complaints were related to health issues. In only 21% of the cases a causer could be identified.

What has been done

- In phases, the port has placed 26 eNoses (electronic noses) which can register smell in an early phase. The system is coordinated by the entity in charge of registry of nuisance, has now an early warning system and is better equipped to understand the cause of the problem. The eNoses report real-time changes in the air and can note CO_2 concentrations but do not register any specific chemical substances.

eNose mounted onto a lightpole.

What are next steps:

- The intention is to report more pro-active on environmental nuisance through quarterly reports on the nature and origin of the nuisance. A special taskforce has been formulated to disseminate the results also through social media.
- Improve on the analysis between complaints and registered incidents to better understand cause and origin.

Nature

Nature in and around the port is a contribution to the wellbeing of people and fauna and flora. Hence the preservation of nature is an important task within the theme environment.

The nature target of a port can be the preservation of what is there but can also be proactive contribution to nature or compensate through nature elsewhere due to port developments.

These issues are profound in Europe where the European nature-2000 regulation and the bird and habitat regulation requires compensation to nature when port development is destroying nature.

In which level the port is contributing to nature preservation and compensation may heavily depend on the local laws and regulations, local environmentalist groups as well as on the ambition of the port management.
In the port of Moerdijk investments in nature are made in various fashions. Examples are:

- Green buffer zones (forest and bushes)
- Butterfly zones
- Ecological shore line for birds (swimming birds)
- Ecological ground wall (for sand martins)
- Ecological mowing zones
- Groundwater levels adjustments for birds

In 2016 Port of Moerdijk counted 74 flora and fauna species under which 57 bird species. The largest sallow colony of the province is located in the port due to the ground wall specifically made for them.

What has been done:

- The port makes an annual inventory of flora and fauna through organising counting days.
- The port has formulated a nature-management plan in which is stipulated how to care for the nature within the port boundary in the next five years. The plan also ensures the practical implementation of licenses related to nature to become easier and faster. New terrains available for development will get one license for all nature required exemptions.
- A pilot project was started to check and test company’s business plans on expansions for the next 3 – 5 years against the legislation on nature. With this pilot compliance on business plans versus nature regulations is tested.

What are next steps:

- As extension on the nature-management plan a management plan for protected species is planned. This is a step in which the nature required fauna- and flora- exemptions can be gained quicker once such plan is in place. Further improvements on monitoring is probably required and possibly support of nature local and regional organisations can be sought.
- The objective is to attract more breeding birds on an island in front of the port.
- Development of biking/hiking paths along “industry and nature”.
- Inventory of the new EU nature regulations and the port’s obligations related to this.
- Development of nature to ensure port expansion can be compensated.

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Appendix XVII Guideline to measure CO_2 emissions of a port

Guideline to measure the CO_2 emissions of a port.
In this annex it is explained how a company or a Port Authority can measure or estimate its CO_2 emission. Please note that the examples are indicative calculations for understanding purposes only.

In developing carbon footprint inventories, GHG quantification protocols[11] define that the emission-producing activities for ports should be grouped by the following three scopes:

- Scope 1 - Port Direct Sources. These sources are directly under the control and operation of the port administration entity and include port-owned fleet vehicles, port administration owned or leased vehicles, buildings (e.g., boilers, furnaces, etc.), port-owned and operated cargo handling equipment (to the extent the port is an operating port), and any other emissions sources that are owned and operated by the port authority or port company.
- Scope 2 - Port Indirect Sources. It refers to the indirect GHG emissions from generating electricity by sources which are not owned by the port but such electricity is used by the port. These sources include port purchased electricity for port administration owned buildings and operations. Note that tenant power and energy purchases are not included in this Scope.
- Scope 3 - Other Indirect Sources. These are indirect GHG emissions due to port activities but occur from sources not owned by the port. These sources are typically associated with tenant operations and include ships, trucks, cargo handling equipment, rail locomotives, harbour crafts, tenant buildings, tenant purchased electricity, and port and tenant employee commuting (train, personal car, public transportation, etc.).

It should be noted that the port administration entity can have various activities depending on its institutional setting. For example, a land-lord port does not have operating activities whereas the port authority as operator, does have operating activities.

The following table illustrates the several scopes.

Scope 1	Scope 2	Scope 3
Port equipment (fuel-based*)	Port equipment (electrified**)	Ocean going Ships
RTG's (diesel)	STS cranes (electric)	Inland going ships
RMG (diesel)	RMG cranes (electric)	Terminal trucks going outside
Terminal tractors	RTGs (electric)	Tenants cars, vans
Reach stackers	Other electrified equipment	Tenants port operators (incl. equipment, buildings etc.)
Empty handlers	Reefers	Private Trucks
Forklift trucks	Administration buildings (total electricity usage incl. ICT)	Tenant locomotives
Spreader TT	Gate complexes	Tenant shipyard
Utilities (fuel based)	Yard lightning	

[11] Green House Gas Protocol as developed by WRI and WBCSD, ISO 14064-1

Own port equipment (fire brigade trucks, ambulance, vans, cars)	Berth lightning
Marine dept. equipment	Roads and premises lightning
Port Support boats	Cold ironing
Port Tugs	Port Locomotives (electrified)
Vans, cars	
Cleaning machines	
Equipment cleaning stations	
Port Locomotives (diesel)	
Other port support equipment	

* Most of the cases this relates to fuel burning equipment, but it can also be electrified equipment in case the port generates its own electricity (which is still not very common)
** in case electricity is bought from third parties (this is normally the national grid)

Emission Inventory Development Methodology
An emission inventory usually contains the total emissions for one or more specific greenhouse gases or air pollutants, originating from all source categories in a certain geographical area and within a specified time span, usually a specific year. The methodology adopted for this here follows referred documents by World Port Climate Initiative (WPCI), Green House Gas protocol and ISO 14064. The following steps can be applied in determining the Green House Emissions:

1. Purpose for developing emission inventory
2. Approach for developing inventory
3. Determination of the boundary
4. Listing terminal sources
5. Collect port specific data
6. Estimate CO_2 emissions
7. Proposing green technologies
8. Monitoring % reduction in emissions after implementing technologies

Purpose for developing emission inventory
The purpose of developing an emissions inventory is a key policy decision that must be established at the start of the process by the management. It will guide subsequent decisions regarding the level of detail, accuracy and the boundaries of the inventory. The aim of the emissions inventory is to develop strategies to set up a carbon emissions management system for the accurate tracking and reporting of carbon emissions and reduce carbon emissions in the entire port system in the future.

Often local legislation is required to get the institutional setting in place. Letters of cooperation and MOU's are sometimes the first step to create a common understanding and goal.

Approach for developing inventory
Commonly three methods can be defined in developing a carbon footprint of the port:

1. Activity-Based - Uses source specific data;
2. Surrogate-Based - Uses surrogates to estimate activity and/or emissions; and
3. Hybrid Based- Uses varying combinations of activity and surrogate approaches.

The activity-based method is the most detailed approach, resulting in the most accurate results and is commonly applied in a situation in which detailed data measurements are available.

The Surrogate-based method is used in situations in which data is incomplete or not available. In that case comparable sources are used for the determination of the emission footprints. In this exercise the approach is often based on lower detailed requirements and can be accomplished in less time and costs but often comes with less accuracy of the results.

If there is the desire or need to more finely determine the port's footprint knowing that further action will be needed and the resources are available, then a hybrid approach can be used to focus attention on the most significant source categories (typically ocean-going vessels, heavy-duty equipment and heavy duty transport but unique to each port).

Finally, a detailed approach may be taken if it is known that emission reduction measures will be planned and implemented (either by regulation or voluntarily).

Determination of the boundary
It is important to set the boundary of the measurement. In defining the boundaries of the emissions inventory, there are three boundaries that define and determine the scope of emissions that will be included in the assessment. They are:

- Physical;
- Organisational and,
- Operational boundaries.

It should be noted that ships only use full power at sea and in the approach to the port different speeds are applied. Also, they use only auxiliary engines while at berth. Therefore, a boundary of 2 kilometres at sea is often applied.

Listing terminal sources
At least the following equipment types should be reviewed:

- Cargo handling equipment. This group together with the ships generate the most emissions in the ports. The group consists of for example; STS cranes, RMG cranes, tractor trailers(TT), Reach stackers, Empty container handlers, forklifts, reefers and trucks visiting the port.
- Utilities and reefers. Utilities are for example lightning, pumps, general electricity consumptions. The reefer boxes generate emissions during their port stay.
- Ships in the port generate emissions through their auxiliary engines on board whilst in the port.
- Locomotives if applicable.

Other equipment as specified in the table with the three scopes mentioned above.

Cargo handling equipment
First of all, an inventory of cargo handling equipment needs to be made in which type of horizontal movers and vertical lifters are expressed by type and engine. Secondly the annual hours of operations are needed for an in-depth calculation under the activity based approach.

For an annual activity-based inventory, the following list is an example of the data that can be collected for each piece of fuel-burning cargo handling equipment:

- Internal equipment identification number/name
- Equipment type

- Model year
- Equipment and engine manufacturer(s)
- Model designation(s)
- Fuel type
- Rated power (e.g., kW or horsepower)
- Emission control devices or methods (other than standard for the model and year)

Data frequency

- Annual hours of operation
- Fuel consumption (per year or per hour)
- Average load factor while operating

Emission data

- Emission factors appropriate to the types of engines in the inventory, kg pollutant/kW-hr or kg pollutant/litre or kg fuel (or lbs pollutant/gallon fuel) obtained from the GHG protocol.
- Control factors (percent reduction offered by identified emission control devices or methods)

In case of the recharging data is not available then this should be included in the overall energy purchased consumption for buildings. Preferably the purchased consumption should be specified by the mix of power generating technologies. In case of electrified STS cranes the power consumption (in MW-hrs) should be estimated from the utilities bills or drop meters.

Not all of the source data listed above is directly needed for estimating emissions. Items such as the internal identification number, manufacturer, and model designations can be used in subsequent planning if equipment changes are considered as a means of reducing emissions.

Collect port specific data

The collection of port specific data refers to questions like the following:
Understanding the national power. What is the CO_2e KWh of the national grid? What is type of diesel applied in the port? Are all equipment's and their running hours available? Is their mandatory law in place for reporting emissions? Has there been a major improvement in respect to STS cranes or RTG cranes which influence the base or reference year?

In case huge gaps of data exists, the CO_2 calculations can still be conducted on a hybrid or on a surrogate method using examples from similar equipment elsewhere.

Estimate CO_2 emissions

In this paragraph examples calculation methods for CO_2 are provided for the cargo handling, marine tugs and heavy-duty truck moves.

Cargo handling equipment

Depending on the information collected, emissions can be estimated using fuel or energy figures. For both fuel-based and energy-based calculations, it is important to calculate the emissions from equipment using different fuels separately, because the emission factors are different for each fuel. In addition, fuels classified as biofuels (e.g., biodiesel and ethanol) should be calculated separately, even if the biofuel is a component of a fuel blend (such as a B20 blend of biodiesel and petroleum diesel).

In case of fuel, the equation per unit would be:

Emissions (kg pollutant/yr) = Fuel consumption (litres fuel/yr) x Emission Factor (kg pollutant/litres fuel)

Example and tractor trailer at the terminal:

Suppose:

- Fuel consumption: 40,000 litres/year (obtained from the equipment owner or operator, from fuelling records or estimates)
- Emission factor: 2.75 kg CO_2/litre (from GHG Protocol value of 74.01 kg CO_2/gigajoule (GJ), with a lower heating value of 0.0371 GJ/litre: 74.01 kg/GJ x 0.0371 GJ/litre = 2.75 kg CO_2E/litre)

Result: 40,000 litres/year x 2.75 kg CO_2/litre = 110,000 kg CO_2/year or 110 tonnes CO_2E /year

Typical running hours at large container terminals and diesel consumption

Type	Terminal Trucks	ECH
Running hours per unit / year	4,000	3,700
Diesel consumption / unit / hour	10 l/h	10 l/h

Source: MTBS

In case of energy, the equation per unit would be:

Emissions (kg pollutant/yr) = Rated Power (kW) x Load Factor (unitless) x Operating Time (hours/yr) x Emission Factor (kg pollutant/kW-hr)

Example of a RMG at the terminal:

Suppose:

- Rated power: 60 kW (obtained from the equipment owner or operator; more specifically from documentation related to that specific piece of equipment or an identical piece of equipment)
- Load factor: 0.65 (to be obtained by other measurements)
- Operating time: 3,500 hours per year (obtained from the equipment owner or operator, either from hour meter or from an estimate based on operating schedule)
- CO_2 emission factor: 661 g CO_2/kW-hr (calculated from engine BSFC of 209 g/kW-hr[12], fuel C content of 86.3%[13]: 209 g/kW-hr x 0.863 x (44/12)[14] = 661 g/kW-hr or 0.661 kg/kW-hr)

Result: 60 kW x 0.65 x 3,500 hrs/yr x 0.661 g CO_2/kW-hr = 90,226 kg CO_2/yr or 90.2 tonnes CO_2E/yr

Typical running hours at large container terminals and electric consumption

Type	STS cranes	RMG
Running hours per unit / year	4,000	3,500
Electric consumption / unit / hour	117 kWh/h	60 kWh/h

[12] BSFC is an example typical of large diesel engines

[13] The carbon content of diesel fuel is from "Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2006 (15 April 2008) - Table A-37: Carbon Content Coefficients and Underlying Data for Petroleum Products"

[14] The factor of (44/12) is the ratio of the molecular weights of CO_2 (44) to carbon (12). This calculation assumes all of the carbon in the fuel is burned to CO_2.

Source: MTBS

Marine department equipment

This section discusses methods that can be used to develop estimates of greenhouse gas emissions from harbour craft and vessels. Harbour craft are characterized by vessels that spend most of their time within or near a harbour and typically are in harbour transit, manoeuvring, and idling modes. Vessels falling under the harbour craft source category include a wide variety of vessel types and applications that tend to operate in and around a harbour or port, relatively close to shore or that are used specifically for assisting with port operations or local public transportation. Harbour craft differ from ocean going vessels in that they do not traverse oceans or seas in typical operation. Examples of harbour crafts are for example:

- Assist Tugboats – assist ocean going vessels during manoeuvring and docking
- Towboats and Push boats –move barges and other floating objects
- Local ferries –carry passengers to specified locations near ports, harbours, and cities
- Excursion vessels – used in commercial sightseeing
- Crew boats –ferry crew members between ships and shore
- Work boats –carry workers to offshore locations
- Government vessels – including police, fire, and coast guard vessels
- Commercial fishing vessels – used in the commercial fishing industry
- Pleasure craft – usually privately owned small boats and yachts

As with all transport sources, estimating emissions from harbour crafts and alike requires gathering as much information as possible on the vessels and engines being modelled. Ideally, information would be collected on the population of the vessel fleet, the types and sizes of the vessels in use, the number and power rating of the engines in each vessel, the amount and types of fuel consumed, and the types of activities as in modes of operation that the vessels encounter in daily operation.

Once the characteristics of the fleet are known, greenhouse gas emissions from harbour crafts can be estimated using the following general equation:
emissions (g pollutant/yr) = emission factor x fuel consumption

The California Air Resiources Board (CARB) provide the grams of polutant per gallon of distilate fuels consumed by engines in the transportation sector.

Vessel Type / g per gallon distillate consumed	CO_2	N_2O	CH_4
Harbour crafts	10,138 g	0.0832 g	0.416 g

Example fuel based:

Suppose:

- Fuel consumption: 10,000 gallons/year (from fuel meter readings/fuel receipts)
- Emission factor: 10.14 kg CO_2/gallon (see above)

Result: 10,000 gallons/year x 10.14 kg CO_2/gallon = 101,400 kg CO_2/year or 101.4 tonnes CO_2/year
In this case, the corresponding activity would be gallons of fuel consumed over a specified period and can be regarded as the most simplified approach.

When a more sophisticated approach is required it would be preferable to have the emission factor expressed in terms of grams of pollutant per kilowatt-hour rather than grams per gallon, the corresponding activity would then be kilowatt-hours. This creates a more reliable calculation, but characteristics and operating parameters of each vessel engine would be required. In the expanded equation below, these factors are taken into account.

The calculation method could be as follows:
emissions (g pollutant/yr) = rated horse power (kW) x load factor (unitless x operating time (hours/yr) x emission factor (g pollutant/kW-hr)

The next table illustrates default load factors by vessel type used by the state of California to estimate the emissions of various types of harbour crafts.

Vessel Type	By propulsion	By Auxiliary
Tugboat	0.31	0.43
Crew boat	0.45	0.43
Ocean tug	0.68	0.43
Workboat	0.45	0.43
Excursion boat	0.42	0.43

Source: California State Authority

Greenhouse gas emission factors for various sized engines expressed in terms of grams of pollutant per unit of work are typically available from state or national environmental protection or regulatory agencies. During the certification process, engines are tested under varying speed load combination to ensure that their emissions are below the allowable limits established through emission standards. Although CH_4 and CO_2 are routinely measured during certification, special testing is required to measure N_2O and this data may be harder to obtain.

Example energy based for an excursion boat:

Suppose:

- Rated power: 1,000 kW for a tugboat (obtained from the engine manufacturer, owner or operator)
- Load factor: 0.42 (see above)
- Operating time: 1,000 hours per year (obtained from the equipment owner or operator, either from hour meter or from an estimate based on operating schedule)
- CO_2 emission factor: 652 g CO_2/kW-hr (obtained from CARB[15])

Result: emission = 1,000 kW x 0.42 x 1,000 hrs/yr x 652 g CO_2/kW-hr = 273,840,000 g CO_2/yr or 273.84 tonnes CO_2/yr

Note a tugboat would have considerably more power often up to 5050 KW or 6772 BP for a 80t BP ASD tugboat.

Heavy-duty truck moves

Similarly, emissions for the heavy-duty trucks moving in and out of the port can be calculated. Here the number of trips and the average trip distance (regional distance) needs to be determined. Another issue is the idle time on terminal and the running at the terminal.

[15] California Air Resources Board (CARB)

The annual distribution of the port truck fleet can be determined by an examination of port tenants' records of vehicle arrival and departure if license plate information is collected at the gate(s). In many cases this information is gathered for accounting purposes either manually or electronically, however most modern terminals use optical character recognition systems (OCR) or radio frequency identification devices (RFID). Whether recorded manually or electronically, the gathered license plate information is ultimately forwarded to government motor vehicle departments, which maintain registration information of these vehicles, to determine trucks age distribution.

At the terminal transport includes idle or very low speed operation of trucks as they wait at gates or in queue, and running which occurs as goods are picked up or dropped off. Therefore, in estimating at the terminal greenhouse gas emissions is based on both hours of idle operation as well as distance travelled. The corresponding emission factors would be expressed in terms of grams of pollutant per hour and grams of pollutant per mile or kilometre driven.

Estimates of the hours of idle operation can be obtained through survey of terminal operators or by actual measurement of queue times at gates. Emission rates of greenhouse gases expressed in terms of grams per hour are readily available from regulatory agencies such as the California Air Resources Board (CARB), as presented in the table below.

Transportation in the port and regional activity are traditionally estimated on a gram-per-distance-travelled basis and take into consideration an overland boundary representing the extent to which the port has influence over, or is accountable for, the emissions associated with goods moved by truck. In some instances, it has been assumed that the port is responsible for and has influence over the emissions from trucks from the point of entry across the overland boundary on the way to the port, and to the first point of rest (initial destination) upon leaving the port. After the initial destination or the first point of rest, additional emissions associated with the movement of these goods is traditionally assumed to be under the influence of, and therefore, the responsibility of the importer or its agent.

The average distance driven per truck trip either at the port or regionally can vary widely. Average trip lengths can be determined through travel surveys where truck drivers or owners are questioned regarding their origin prior to visiting the port and their intended destination upon departure. Alternatively, devices such as global positioning systems (GPS) have been used to electronically track the activity of subsets of the heavy duty truck fleet. Once the average truck trip length has been established, emissions are estimated using a gram per distance travelled emission factor (see below table) multiplied by the total miles driven.

The following tables illustrate the idle time emissions and the Expressway transport emissions[16].

Type (g/hr) emissions for idle hours	CO_2	CH_4	N_2O	CO_2E
Heavy-Duty diesel	4,640	0.183	0.037	4,655.3

Source: CARB

[16] Sources include: Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-1996, Table C-10

8 E.U. 60% Load - Transport Statistics Bulletin: Road Freight Statistics 2005, DfT SB (06), 27 June 2006 9 E.U. Fuel Use - Digest of UK Energy Statistics, Department of Energy & Climate Change.

Type (g/km)	CO_2	CH_4	N_2O	CO_2E
US advanced technology	987	0.04	0.03	997.1
Modern engine	1,011	0.05	0.03	1,021.4
Uncontrolled	1,097	0.06	0.03	1,107.6
EU articulated Diesel truck > 33t				
Average load	943.7	1.53	1.02	1,293.0
Fully loaded	1,123.5	1.53	1.02	1,472.7

With this information two examples are provided, the detailed approach including idle times and the more general approach based on fuel consumed. The latter is based on fuel consumption rates and greenhouse gas emission factors per unit volume of fuel to determine the emission estimates.

Example heavy duty trucks with waiting times at terminals:

Suppose:

- 1,000 advanced technology heavy-duty trucks in the port truck fleet
- Average Idle Time: 30 minutes per truck trip
- Average Trip Distance at the Terminal: 1 kilometre per truck trip
- Average Regional Trip Distance: 60 kilometres per truck trip
- Truck Trips: 1,000 trips per year

Results idle time at terminal: 1,000 trucks x 1,000 trips/year x 30 min/trip x 1 hr/60 min x 4,655.3 g CO_2E/hr = 2,327,650,000 g CO_2E /yr or 2,327.65 tonnes CO_2E /yr

Results terminal running time: 1,000 trucks x 1,000 trips/year x 1 km/trip x 997.14 g CO_2E/km = 997,140,000 g CO_2E /yr or 997.14 tonnes CO_2E /yr

Results regional transportation: 1,000 trucks x 1,000 trips/year x 60 km/trip x 997.14 g CO_2E/km = 59,828,400,000 g CO_2E /yr or 59,828.4 tonnes CO_2E /yr
Total heavy-duty diesel CO_2E = 3,325 + 59,828 = 63,153 tonnes/year

Example heavy duty truck based on the fuel consumption approach:

Suppose:

- 1,000 heavy-duty trucks in the port truck fleet
- Truck Trips: 1,000 trips per year
- Average Fuel Consumed per Trip: 5 gallons per truck trip

Results: emissions = 1,000 trucks x 1,000 trips/year x 5 gallons/trip x 10,248.1 g CO_2E/gal = 51,240,500,000 g CO_2E /yr or 51,241 tonnes CO_2E /yr

Proposing green technologies

The following items are often considered in improving the carbon footprints:

- Routing of trucks and equipment. As transport units travel continuously across the port, a reduction in *travel distance* would directly contribute to emission reductions

- Reduce idle time. The *waiting time* of ships, equipment and trucks generate emissions whilst not contributing to activities. Once waiting times are reduced or engines are switched off whilst waiting (for example for trucks) a significant reduction of emissions can often be realized.
- Upgrade the diesel to bio-diesel. The CO_2 emissions by RTGs are often one of the highest contributors to emissions in port. Reducing the carbon value of diesel through using blended diesel (30% biodiesel) contributes directly.
- Upgrade to E-RTG. It has been reported that E-RTGs can reduce CO_2 emissions by 70% compared to conventional RTGs.
- Improve the modal split. The amount of exhausts are reduced when shifting from truck to rail and or inland barges. The energy consumption per ton mile per inland barge is 83% less comparedto goods transported by truck and 50% less compared to rail transport.[17]
- Reduce consumption in the port through less lights, avoidance of trips and installation of LED lights.
- Improve the engine types and introduce clean engines (for example; trucks with modern engines, LNG power on port vessels, electric bikes and electric cars for port personnel)
- Cold ironing. Ships could use shore power instead of their auxiliary engines whilst at berth. It should be noted that cold iron contributes only to CO_2 emissions once the shore power is generated by effective means. Often shore power sourced through coal fired power stations does not reduce the CO_2 emissions. Important is the CO_2/kWh of the national grid. Studies indicated that if the shore power is more than 800g CO_2/kWh, cold ironing would increase the CO_2 exhausts[18] rather than reduce it.

Monitoring % reduction in emissions after implementing green technologies

Important is to be able to repeat the CO_2 calculations annually (preferably in similar manners) in order to understand the trend in CO_2 produced. A common way is to institutionalise the CO_2 measurements through local environment legislation. In that case the relevant port users are mandatory obliged to report on the exhausts. Before this is done it is important to fully describe the method of calculations aligned with international guidelines on GHG emissions as for example by the Greenhouse Gas Protocol or in the ISO protocol 14046-1.

In a phase preceding the mandatory reporting situation, a pilot could be started to implement such situation and to monitor the CO_2 produced.

[17] European commission, inland waterway transport

[18] Hall, 2010

Appendix XVIII UN Sustainability goals and ports

In this annex briefly an overview is provided on the 17 UN sustainability goals in relationship with Ports.

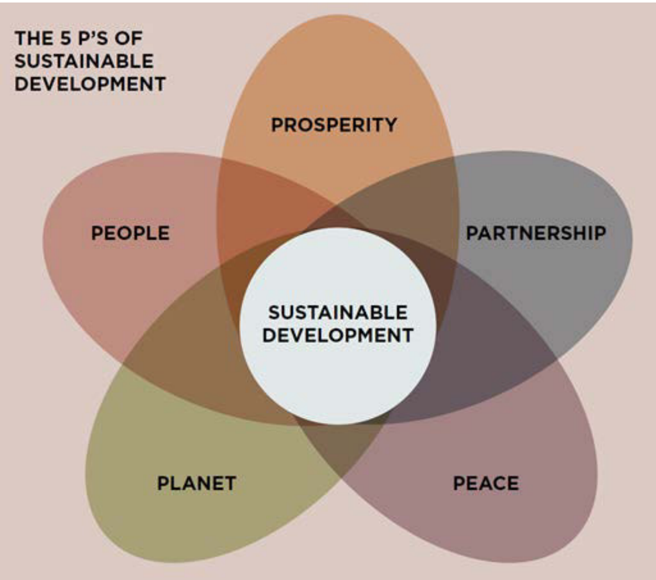
Port Authorities may link their environmental greening agenda to these sustainability goals.
The Port of Antwerp in their sustainability report 2017[19] did the same.

United Nations defined 5 sustainable segments and 17 sustainability development goals (SDG's).

The segments are know as "the five "P":

1. People → labour, welfare, employment, Port city relationship
2. Planet → efficient use of resources, recycle and circulair economy
3. Prosperity → value adding to economy
4. Peace → justice, strong institutions and regulations (transparent& dialog)
5. Partnership → tackle the problems together, cooperate and act

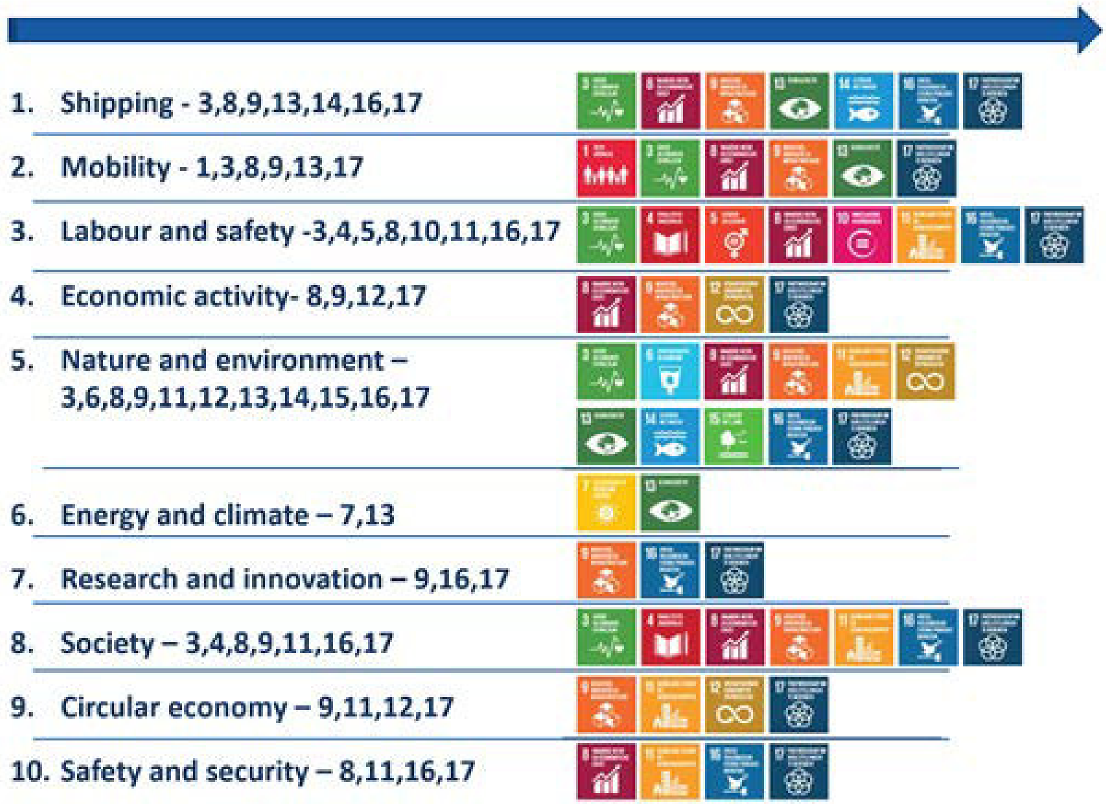
The figure illustrates these five segments.



The 17 sustainability goals for 2030 are expressed in the next figure.

[19] Duurzaamheidsverslag 2017, Port of Antwerp

These 17 SDGs can be linked to the greening aims of a company. The Port of Antwerp has illustared this as follows:



Source: Port of Antwerp

The main sustainability *measurements and or topics* in each section are briefly described here below. For more detailed information reference is made to Port of Antwerp “Duurzaamheidsverslag 2017”

Shipping

1. Shipping waste
    - Volume of ship waste collected (port reception facilities)
    - Polluter pays principal (finance system based on contribution)
    - Sulphur controlled emission area, number of ships arrivals
    - Types of waste (oily waters, chemicals, sludge, household waste)
2. Number of ships with ESI (environmental ship index)
    - Number of ships with ESI (IAPH-index), Green Awards
3. Compliance with Int. Environment legislation (Paris MOU; white, grey and black flag)
    - Ballast water management convention
4. Emission reduction technology
    - Scrubbers
    - SCR (selective catalytic reduction systems)
    - LNG
5. Access to clean energy sources
    - LNG
    - Cold ironing

Note air quality is mentioned under environment

Mobility

1. Modal split
    - Promote rail
    - Promote inland waterways (eg clean inland shipping index)
    - Pipelines
    - More sustainable trucks
2. Communting
    - Improvements local infrastructure
    - More sustainable modi (eg. Monorail)
    - Reduction and more sustainable car traffic
    - Increase communter safety
    - Measurement of road traffic jams
3. Solve hinterland bottlenecks

Labour and Safety

1. Direct employment (FTE)
2. Indirect employment (FTE), maritime cluster, industry
3. Labour safety, zero accidents principle (illness, near miss, deadly)
4. Measurement cumuter distance
5. Number of training centra, graduations in maritime sector
6. Level of education in labour force
7. Relation man female

Economic activity

1. Volume throughputs per segment
2. Investments
3. Labour productivity
4. Value added (Direct & Indirect)
5. Logistics activity
6. Connectivity

Nature and Environment

1. Proper index
2. Waste in water
3. Waste on land
4. Water quality
5. Air quality (SO2, NOx emission, PM10, PM2.5)
6. Noise
7. Biodiversity at special environment zones
8. European bird guidelines
9. EU Flora and Fauna Habitat guideline (Natura 2000)
10. Ecological infrastructure
11. Port Environmental Reporting System (PERS)

Energy and Climate

1. Energy usage & composition targets
    - Coal

- Gas
- Oil
- Renewable energy

2. Emission reduction (CO2, SOx, NOx, PM)
    - Greening yourself
    - Promote to green your users
    - IMO annex VI
3. Sustainable energy / renewable energy
    - Installed capacity (MWe) (windmills)
    - Solar
    - H2 and or Tidal
4. Energy management system (ISO 50001)
5. Synergy between energy usage
6. Climate Change

Research and Innovation

1. Investments in research and development
2. Number of R&D companies per sector
3. Number of ICT companies/innovations

Society

1. Work – live – relax
    - (Cultural and social experience of living and working in the port)
2. Port city relationship
    - Social events
    - Sports events
    - Sailing events
    - Cruise benefit versus burden
3. Society buy-in (society barometer)

Circular Economy

Port is perfect location to handle waste and process in circular economy

1. Waste to energy
2. Waste to product (bio-chemical, scrap to steel, batteries)
3. Waste to plastics

Example BASF invests 16 mln EUR in re-use of methane gas for ammoniac production

Safety and security

1. ILO regulations
2. IMO (ISPS)
3. Emergency training & prevention (from calamity to incidents)
4. Authorized Economic Operators active in the port
5. Refugees/stowaways
6. Oil incidents