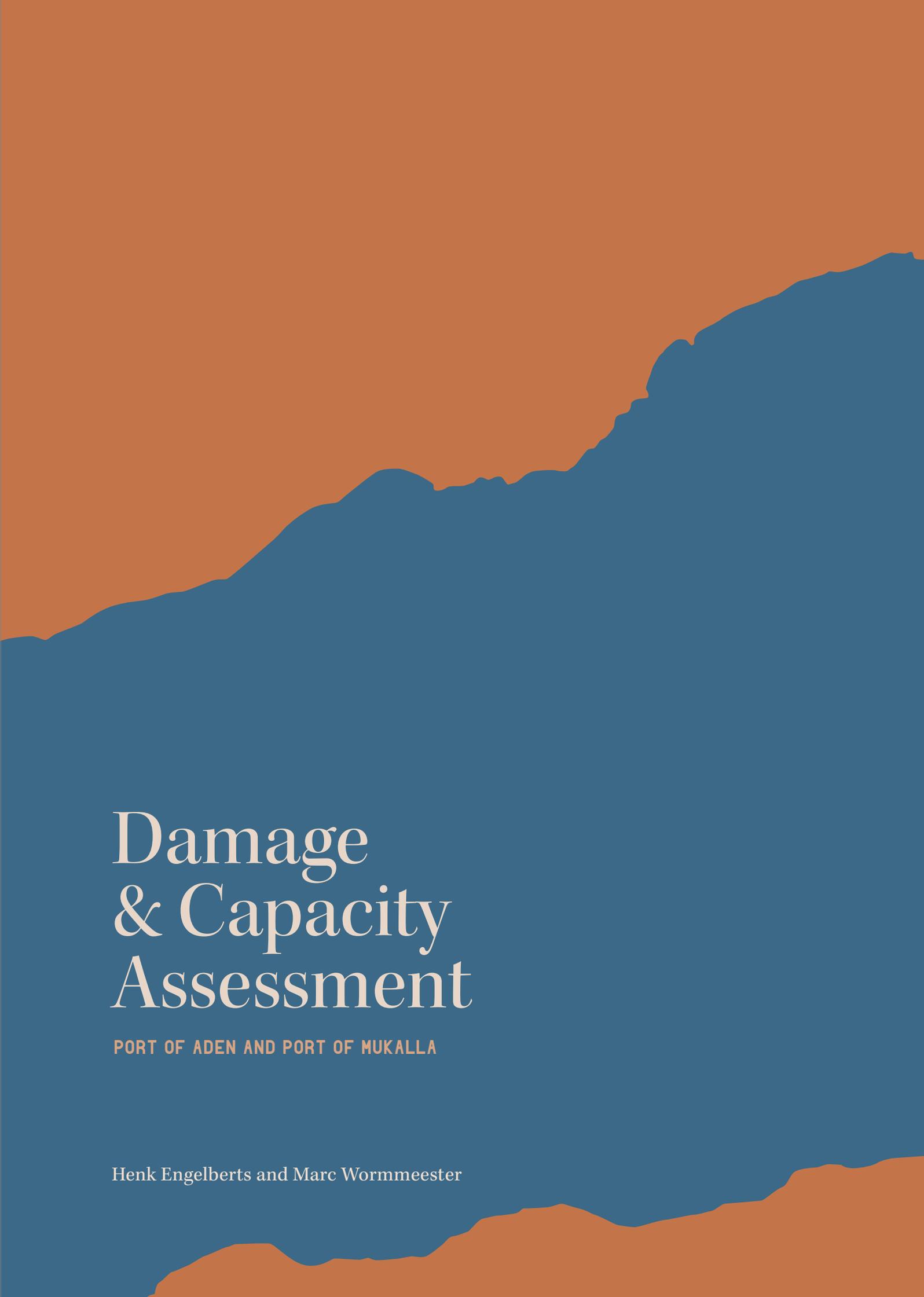




Damage & Capacity Assessment

PORT OF ADEN AND PORT OF MUKALLA





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Henk Engelberts and Marc Wormmeester



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1.0 Executive Summary

The Ports of Aden and Mukalla represent critical and irreplaceable infrastructure that are essential to commercial and humanitarian activities in Yemen, particularly in relation to the overall food supply chain. With Yemen on the brink of widescale famine, the timing of the ports' restorations is more critical than ever.

A recent visit by the United Nations Development Programme (UNDP) to the Port of Aden showcased the need to carry out a damage and capacity assessment. Dutch experts from the Port of Rotterdam and Solid Port Solutions were deployed between 22 November–4 December 2020 to conduct the initial assessment to determine minimum requirements to improve productivity and effective management of the ports. A similar assessment by the same organizations was conducted in 2019 at the Ports of Hodeidah, Salif, and Ras Issa in Yemen's north.

OUTLINE OF COST AND NEEDS OF PORTS

The Port of Aden and the Port of Mukalla assessment determined that an investment package of US\$ 49,590,000 (US\$ 21,560,000 for Aden and US\$ 28,030,000 for Mukalla) is needed to both maintain the current port operations and restore port operations to pre-war conditions.

The projects priorities are outlined below and are classified upon priority. As no list was available at the time of the assessment, the estimates for spare parts were added when writing the report and are based upon high-over assumptions of the assessors.

Priority 1 projects: Will help maintain current port operations.

Priority 2 projects: Will help improve cargo handling at both ports.

Priority 3 projects: Will help restore and/or improve safety and sustainability of Ports' operations and assets.

	Port of Aden	Port of Mukalla	Total
Priority 1	13,540,000	18,150,000	31,690,000
Priority 2	7,225,000	1,880,000	9,205,000
Priority 3	795,000	8,300,000	9,095,000
Total	21,560,000	28,330,000	49,890,000

Below are the major needs in order of priority for the ports that were identified through the assessments.

A | Procure tugboat for Port of Mukalla.

Purchasing a replacement tugboat for the Port of Mukalla is the top priority as the Port is at high risk of closing. With only one partially operational tugboat, should it break down, cargo vessels will not be allowed to enter or leave the port.

As seven percent of all imports into Yemen come through the Port of Mukalla—one of only three operational ports—its closing will impact humanitarian and other necessary goods from entering the country.

B | Secure spare parts for Ports of Aden and Mukalla.

The conflict has caused damage to assets in the Port of Aden, including warehouses in the Ma'alla Wharf, the marine, and carpentry workshop. Fixing the damaged assets to bring the port operations to a pre-war level will require a limited amount of investment.

Due to the conflict, however, the ports have experienced significant difficulties in procuring specialised spare parts for the equipment. This is of particular concern as port operations become strained when equipment breaks down. As such, implementing the Priority 1 projects under the “procurement of spare parts and support of engineers of equipment suppliers” is necessary to maintain humanitarian support for Yemenis.

C | Ensure entry and access to specialists and spare parts.

The need for foreign specialists is urgent in Yemen for training purposes and to provide engineering and technical expertise from equipment suppliers. The training of port staff has been limited as trainers and engineers face difficulties entering Yemen as obtaining entry visas can be challenging. It is similar for Yemeni port maintenance engineers when invited for technical training abroad.

Recently procured equipment has a high level of automation, requiring specialty replacement parts and staff who are highly trained to properly maintain and repair the equipment. However, the report's recommended projects require both specialists and parts unavailable in Yemen. Due to import restrictions outlined in the UN Security Council Resolution 2216 (2015), many of the machine components are not allowed to either enter as spare parts or leave Yemen for warranty repairs.

Well-maintained infrastructure and well-trained staff in the Ports of Aden and Mukalla are critical to Yemen's commercial and humanitarian activities. Urgent action is needed from the Authorities to help ensure both specialists and parts can enter Yemen.

D | Create and implement master plans.

Long-term investment plans, business justifications, and assessment and/or asset prioritization do not exist in the ports, nor is risk management a systematic part of normal decision-making processes. As such, master plans must be created to help guide the ports in decision making today to ensure tomorrow's efficiency and efficacy.

A master plan must be created for the Port of Aden (including Ma'alla Wharf) before large investment decisions should be considered. The plan should include terminals not considered in this assessment, as well as existing plans the Yemen Gulf of Aden Ports Corporation (YGAPC) has for the Aden Container Terminal (ACT) expansion and the new Port of Aden bulk terminals. Using the master plan, a critical asset management strategy can be developed to support capital investment forecasts for assets and prioritization of asset maintenance.

A partial master plan currently exists for the Port of Aden, but there is nothing for the affiliated Ma'alla Wharf. Without a fully outlined long-term vision and master plan, important decisions regarding asset investments and maintenance prioritization remain fluid and are not often made.

The Port of Mukalla indicated some plans for upgrading; however, a master plan has not been drafted to guide the overarching development of the port. It is recommended to separate the fishing port from the main port as dual use imposes risks to compliance with port security regulations. Additionally, outlined Priority 1 investments in this report are required and aligning Priority 2 and 3 projects with a master plan is strongly advised.

E | Implement training programmes: maintenance, personal safety, and working conditions.

The ports' assets suffer from poor or no maintenance, and often the “fire-fighting” maintenance that does occur is only done when absolutely necessary. As such, the reliability and performance of port assets are relatively low. Organizing an asset management principles training will help guide cost projections for asset investments and prioritize necessary maintenance.

A general training programme combined with a safety awareness project will help elevate the port to international standards as there are ongoing issues related to port workers' health, safety, and environmental conditions.

The training of maintenance and operations staff can take place at the Marine Training Centre operated by the Yemen Gulf of Aden Ports Corporation (YGAPC).

F | Ensure increases in commodity prices stop.

Yemen faces many challenges beyond the scope of this damage and capacity assessment. Exacerbated by the conflict, these include increased transport and logistics costs at each stage of the supply chain; significantly increased shipping costs due to war risk insurance premiums; and arduous inspection and clearance mechanisms that are both time intensive and costly.

Beyond the report recommendations, Authorities are urged to take action to stop the continued increase of commodity prices and to help improve the effectiveness of the Ports of Aden and Mukalla. Suggested actions include:

- Reducing or eliminating war risk premiums by installing a Vessel Traffic Management and Information System (VTMIS) in the Ports of Aden and Mukalla.
- Establishing a guarantee of funds account in collaboration with donors and insurance markets.
- Allowing and organising cargo inspections in Yemen's ports to reduce vessel delays and demurrage (vessel owner-incurred charges) costs.
- Increasing port operational capacity to reduce congestion, delays of cargo handling, and cost.
- Strengthening customs capacity by extending office hours and providing information and communication technology (ICT) support hardware—particularly for the Port of Aden—to reduce port congestion and accelerate delivery of commodities to clearing agents, importers, and customers.



2.0 Preface

Yemen is in the sixth year of conflict and is continuing to experience one of the world's worst protracted political, humanitarian, and development crises. It has also resulted in more than 80 per cent of the total population—24 million people—requiring some form of humanitarian aid and/or protection.

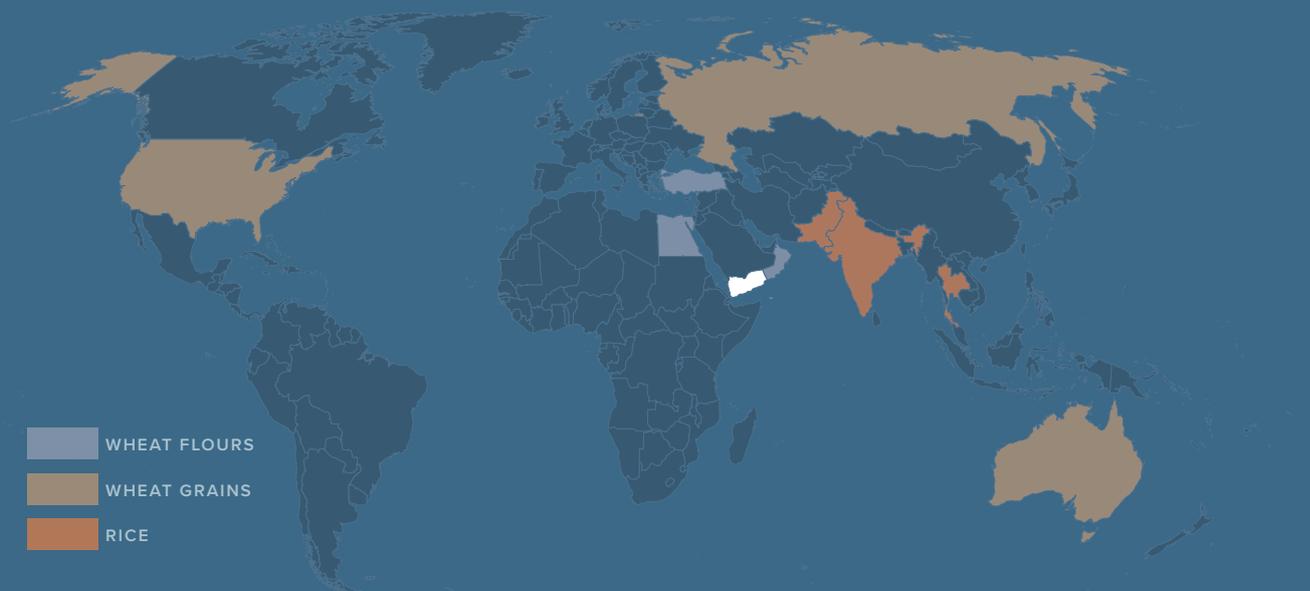
Currently, the World Food Programme (WFP) feeds over 12 million Yemenis, while 16 million suffer from severe food insecurity. Unfortunately, the latest Acute Food Insecurity Analysis from the Integrated Food Security Phase Classification (IPC) points to a continued rise in food insecurity for the months to come.

Between January and June 2021, it is estimated that 3 million additional Yemenis will become severely food insecure—increasing the total population in acute need to 54 per cent. It is also likely that in 2021, the Phase 4 IPC emergency levels¹ will jump from 49 to 154 districts—three times more need than 2018–2019.² Furthermore, a recent study by the Assessment Capacities Project (ACAPS) and Mercy Corps found that food prices have doubled during the crisis (2015–2019) and are continuing to rise.³

With the conflict being the main driver of food insecurity, people are often unable to access food needed to survive. Unstable exchange rates, dramatic fluctuations in the currency (Yemeni Riyal), and challenges accessing credit are the greatest drivers of high food prices—particularly as 90 per cent of Yemen's food is imported. Damaged infrastructure and limited institutional capacity exacerbated by the crisis have also increased transport and logistics costs at each stage of the food supply chain which is directly passed on to consumers.

There must be a concerted effort by the international community as Yemen tatters on the brink of famine due to high food prices, not because its unavailable.

YEMEN'S TOP SUPPLIERS OF WHEAT GRAINS, FLOUR, AND RICE



A Snapshot of Yemen's Food Supply Chain | Source: Observatory of Economic Complexity

ESSENTIAL SEA PORTS

Rehabilitation of Yemen's ports—making them safer, more efficient, and less expensive to do business—is vital. If port infrastructure such as buoys, navigations systems, and cranes were fixed, costs to shipping companies would decrease, ultimately making food more affordable to Yemenis and more humanitarian aid available. As the war risk insurance premiums and expensive extra time spent offloading cargo decrease, the number of ships sailing into the ports and trading companies desiring to do business in Yemen would increase.

In 2020, Yemen's total food imports through the Red Sea ports of Hodeidah and Salif accounted for 60 per cent of the total food imports, followed by the ports of Aden (36 per cent) and Mukallah (3 per cent). (*See Annex 1*)



PORT OF ADEN

The Port of Aden—through the leadership of the Yemen Gulf of Aden Ports Corporation (YGAPC)—is critical and irreplaceable infrastructure that is essential to Yemen's food supply, including commercial and humanitarian. The 2015 destruction of the Port of Hodeidah gantry cranes and the ban on commercial cargo has diverted all container traffic to Aden—increasing the volume received and placing greater pressure on its container handling capacity.

The Port of Aden is a major gateway for food, humanitarian aid, and reconstruction cargo for Yemen. It receives approximately 50 ships a month carrying fuel, bulk food, containerized food, as well as construction materials and other goods essential to Yemen's manufacturing sector.

In 2015, when fighting closed Aden's port, its cargo import figures drastically declined and resulted in much larger tonnages and high container volumes being handled at the Red Sea ports. In 2015, Hodeidah and Salif were handling over 64 per cent of Yemen's total cargo imports. In 2019, this figure fell drastically as nearly all container cargo and all bulk construction materials are prevented from entering via the Red Sea Ports and are now handled in Aden. (*See Annex 2 and 3*)



PORT OF MUKALLA

The Port of Mukalla—under the leadership of the Yemen Arabian Sea Ports Corporation (YASPC)—is the only Arabian Sea maritime port in the Hadramout Governorate. Opened in January 1985 in the Khalaf area, it serves the Hadramout and surrounding governorates as a multi-purpose port serving commercial, fish, and oil products.

The Port of Mukalla was designed to handle ships not exceeding ten thousand tons capacity; however, this has not been observed since its opening. Large capacity ships—some as large as 20,000 tons not exceeding a draft of 8.5 meters—are regularly accepted at the port due to the urgent need.

HIGH COST OF FOOD

High costs levied on international suppliers are ultimately absorbed by Yemenis who cannot afford the extra costs at the markets, grocery stores and shops. For example, port fees currently constitute 50 per cent of the final price of wheat flour, up from 33 per cent in 2017. This is because the expense of congestion and war risk insurance premiums have increased by 50 per cent since 2017 and, coupled with the cost of inspections, has resulted in the doubling of prices for shipping containers to Yemen. Demurrage fees⁴ alone can add up to 10 per cent to retail costs.⁵

HELPING DETER LOOMING FAMINE

To assist in lowering the cost of imports and helping Yemenis better afford food, in November 2020, the United Nations Development Programme (UNDP) in Yemen organized a damage and capacity assessment of the Ports of Aden and Mukalla with Dutch experts from the Port of Rotterdam and Solid Port Solutions. This report summarises the main findings of the assessment and presents a set of concrete interventions that will help contribute to lowering the cost of food in Yemen. A similar review of the Red Sea Ports of Hodeidah, Salif, and Ras Issa was conducted in 2019; the report can be found [here](#).

The assessments of the Ports of Aden and Mukalla found four main factors contributing to the increased price of commodities entering Yemen. These include, but are not limited to:



Both ports have been affected by the protracted conflict and lack of maintenance. Due to the absence of investment, spare parts, maintenance, and outdated systems for port operations, the Ports of Aden and Mukalla have a limited capacity to handle incoming vessels. This results in long waiting periods for incoming vessels (anchorage), long berthing times, and higher fees. In Aden, vessels wait up to 16 days in anchorage and spend an average of 10 days at berth.



Shipping lines pay premium insurance rates to cover vessel loss or damage and for associated risks. Vessels are charged an additional war risk premium when operating in a 'high risk' area. In the Aden Port, this equals 16 times the regular rate. The additional cost of annual insurance premiums is more than US\$ 200 million—a cost that is ultimately transferred to the Yemeni consumer.



Customs authorities do not have sufficient processing capacity when discharging containers. This causes additional container terminal congestion and increases the costs of transporting containers and its cargo from the vessel to the consumer.



Inspections outside Aden double the cost of shipping containers. Cargo inspection must currently take place outside Aden as functioning equipment is unavailable in country. Delays and additional fees from other ports double the cost of shipping a container to Aden compared to shipping the same container to ports in the neighborhood such as Salalah or Djibouti.

UNDP Yemen will continue to work through this unique public-private partnership with the Port of Rotterdam and Yemeni Port Authorities to develop solutions that support port restoration and build operational capacity to facilitate entry of humanitarian aid and commercial shipments.

With Yemen on the brink of widespread famine, timely port engagement and rehabilitation will help significantly combat the looming famine. These efforts will have a vast effect on country-wide food costs and could possibly generate hundreds of millions of US dollars in savings—money that can be used to help rebuild the country and the lives of millions of Yemenis.

3.0 Introduction

Through UNDP, the Dutch port experts supported the Yemen Gulf of Aden Ports Corporation (YGAPC) and YASPC by conducting an initial damage and capacity assessment to outline the minimum requirements needed to sustainably improve the ports' productivity and effective management. The aim is to enhance efficiencies and increase transparency and accountability. The assessment includes proposals for training, equipment, operational readiness, and rehabilitation of critical infrastructure.

The four areas of assessment included are: (1) Nautical; (2) Infrastructure; (3) Logistics; and (4) Operations. The following areas were considered:



Compliance

Monitor compliance of port operations as per international port standards, international maritime law, and other internationally recognized standards.



Human resource capacity assessment

Determine immediate requirements needed for advisory support and training to strengthen technical capacity.



Equipment and infrastructure assessment

Consult YGAPC, YASPC, and relevant actors to assess port damage and determine capacity to outline key priorities for limited critical infrastructure rehabilitation.



Operational readiness

Ascertain requirements needed to bring the ports to an internationally accepted level of operational readiness.

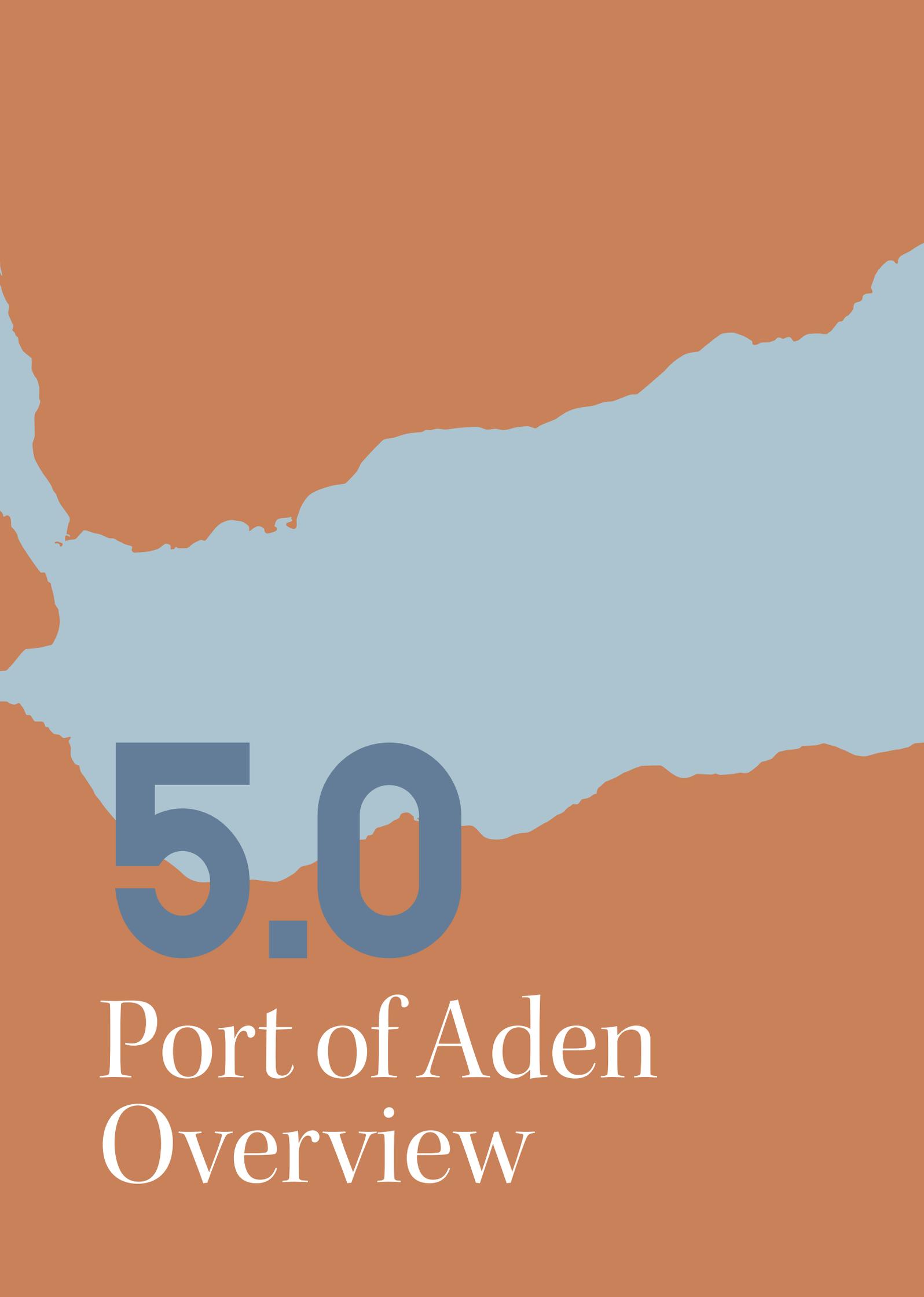
4.0 Assessment Process

The Ports of Aden and Mukalla will only work efficiently if the entire chain of equipment, manpower, and supporting systems are able to optimally perform. Evaluation and proposed follow-up for minimal and optimal remedial actions for effective and efficient terminal operations is part of this report.

To help assess the Ports' current situation, the following was reviewed:

- Port procedures to properly handle vessels (e.g., pilots, tugboats, mooring crew)
- Customs procedures for quick processing of goods arriving in ports
- International Ship and Port Facility Security (ISPS) and security level of the port
- Port operations
 - Maintenance facilities
 - Maintenance support systems
 - Availability of spare parts and services
 - Local supplier contracts
 - Diesel and electrical power supply to operate equipment
- Maritime infrastructure
 - Requirements as per drawings (e.g., quay walls, buoys, jetties)
 - Visual inspection of maintenance conditions
- Training level and readiness of:
 - Operational management and staff
 - Technical and maintenance management and staff
- Availability and readiness of:
 - Vessel load and/or discharge equipment (e.g., cranes)
 - Horizontal transport for cargo between quay and stack and/or warehouses
 - Yard stacking equipment and related power supply
 - Supporting equipment (e.g., forklifts, reach stackers (RS), empty handlers)
 - Terminal Operating System (TOD) and Gate Operating System (GOS) required for coordinating terminal operations
 - ICT network and data centre supporting operational processes

This assessment focused on the Port of Aden's inner harbour including the Aden Container Terminal, Ma'alla Wharf, and the workshop and slipway areas.



5.0

Port of Aden
Overview

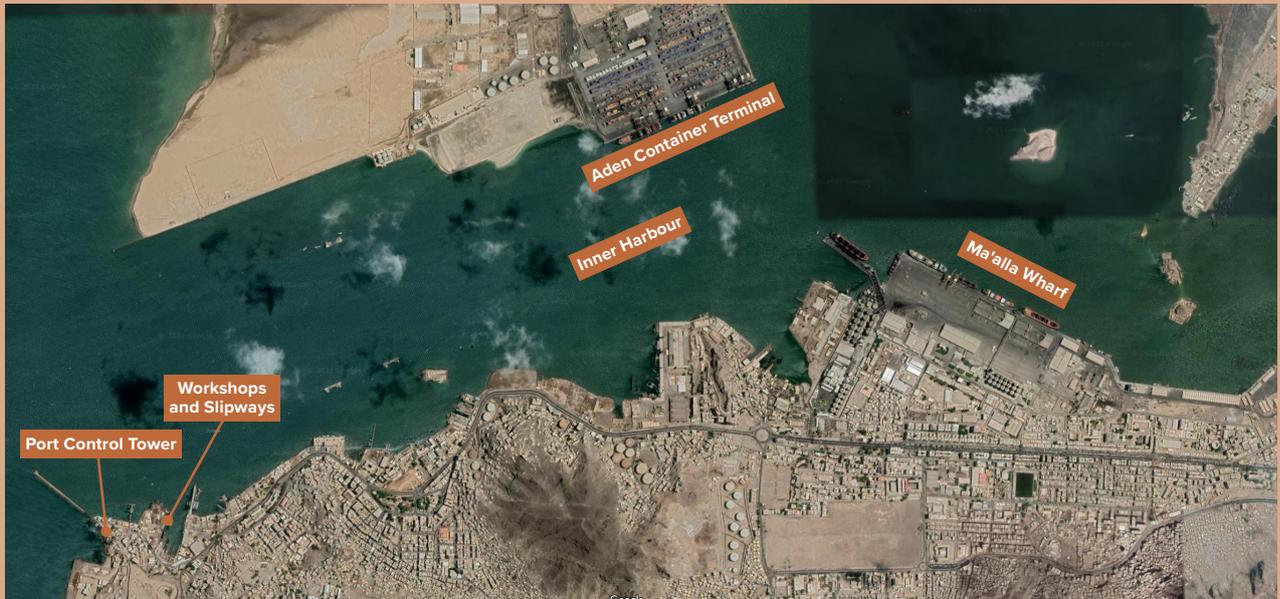


Figure 1: Port of Aden's Inner Harbour | Photo: Google Earth

The Port of Aden is operated and maintained by YGAPC, established in 2007. Its mission is to act as a regional cargo and container handling and distribution centre and to provide high quality services to port users. The Port's goal is to resume its former role as the premier maritime centre for the region and to support the economic development of the city of Aden and to the country. The current situation in Yemen makes these goals even more important, but also presents many challenges and it has proved very difficult to achieve these goals.

Geography

The Port of Aden sits between the hills of Aden [Jebel Shasam, 553 meters high] and little Aden [Jebel Muzalqam, 374 meters high]. Together with the northern land boundary, these landmasses protect the port area from northeast and southwest monsoons, enabling year-round and unhindered operations.

The harbour covers an approximate area of 8 nautical miles east-west and 3 nautical miles north-south and has three distinct areas: (1) the outer harbour that provides anchorage; (2) the oil harbour; and, (3) the inner harbour.

A | Inner Harbour

This area houses the Port Control Tower—where the Harbour Master's office is located—and the workshop and slipway yard where maintenance services for the Port's equipment is provided. The inner harbour has nine alongside berths, three bunkering berths with depths between 5.5 and 11.9 meters (about 18 to 39 feet), and six buoys. The channel to the inner harbour—protected by breakwater at Ras Narbut—is only 15 meters (about 49 feet) deep.

B | The Aden Container Terminal (ACT)

Situated on the north side of the inner harbour, the ACT provides 700 meters (nearly half a mile) of quay with a depth of 16 meters (about 52 feet). Off the terminal is a turning area with a diameter of 700 meters and a depth of 15 meters (about 49 feet). A short approach channel leads to the Ma'alla Wharf.

C | Ma'alla Wharf

Consisting of four berths for the handling of containers, bulk, and general cargo, the Wharf provides 750 meters (nearly half a mile) of quay at a depth of 11 meters (about 36 feet). It also provides a Role on/Role Off (RoRo) berth with a depth of 7.6 meters (about 25 feet). The eastern end contains the Home Trade Quay that is 250 meters (about 820 feet) long and 6.7 meters (about 22 feet) deep.



Figure 2: Port of Aden's Workshops and Slipways | Photo: Google Earth



UNDP has implemented a project with YGAPC to implement a Vessel Traffic Management and Information System that will significantly improve the safety and efficiency of shipping traffic in the Port.

5.1

Port of Aden Control Tower

The port control tower is located on the far west end of the port where it is possible to monitor incoming and outgoing shipping and a good view of shipping traffic is available. With only one Very High Frequency (VHF) radio, however, the Harbour Masters have inadequate communication to ensure safe ship movements in the Port.

UNDP has implemented a project with YGAPC to implement a Vessel Traffic Management and Information System (VTMIS)—including radar, Automatic Identification System (AIS), and VHF transceivers—that will significantly improve the safety and efficiency of shipping traffic in the Port. Preparatory work for installation of the VTMIS has been carried out including purchasing the furniture and air conditioning equipment for the control tower. The system will be ordered soon and installed within the foreseeable future.

5.2

Port of Aden Slipway and Workshops

The YGAPC Technical Department is located on the southwest side of the inner harbour with access to four slipways and workshops including carpentry, marine maintenance, welding, diving, and metal works. From here, the Department provides maintenance for the YGAPC lighthouses, navigational and mooring buoys and tug, and the pilot and mooring boats. The facilities are also being used to provide ship maintenance and repair services to third party customers. Additionally, the Department is responsible for maintenance of the approach channel's harbour bottom, turning basin, and berths along the quays. To ensure the Department can conduct these tasks, it has access to a floating crane, a dredger, split barges, and a survey vessel.

The main slipway—constructed between 1963–1964—is a reinforced concrete structure supported on precast reinforced concrete piles. Vessels can be hauled up the slipway on a rail mounted cradle by an electrically operated winch. The slipway is bound on the west by a quay wall constructed of anchored steel sheet piles, and on the east by mooring dolphins. The yard on the west of the slipway is used for the storage of buoys, among other things.

The following outlines the challenges found in both the slipway and the workshops.

A | Asset Management

An updated maintenance strategy is critical to keep the Ports' assets at acceptable performance levels during their lifecycle. A strategy will allow planning and implementation of maintenance activities that prevent or mitigate degradation of assets, manage the risks of failure, and keep assets performing optimally.

The assessment determined the YGAPC's maintenance strategy is mainly reactive—more of a “fix it when it breaks” principle. Maintenance activities arise from either Original Equipment Manufacturers (OEMs) maintenance and inspection task lists or defects. The OEM task list maintenance and inspections are often generic and do not consider the operational environment, use, or consequences of specific failure. While the defect maintenance is possible for assets of low value and criticality but is not relevant to port infrastructure.

Besides damage from the conflict, most of the assets were manufactured in the 1960s. Significant re-investments are needed in the slipway, workshops, and equipment, but funds are limited. There is also a lack of long-term investment plans, business justifications, and assessment processes to determine the most important investments. Additionally, risk management is not a systematic part of the normal decision-making process, resulting in more “fire-fighting” maintenance tactics. Consequently, Port asset performance and reliability are relatively low against high maintenance costs.

B | Spare Parts

The YGAPC Technical Department provide maintenance of corporate-owned tugs and mooring boats, among other assets. Parts of these assets—such as the automated systems—require high-quality knowledge that staff do not possess.

Reactive maintenance requires a permanent stock of spare materials or speedy delivery times; however, it is very difficult for the Department to obtain either. Because spare parts, next to their intended use, can also be used for war-like efforts, their import is highly restricted. As a result, the equipment is kept operational with a tremendous amount of technical ingenuity, an admirable achievement.

C | Hydrographic Survey and Maintenance Dredging

In 2014, a survey vessel and equipment were purchased to carry out hydrographic surveys of the harbour bottom and berths. This vessel was delivered, but to date staff have not received training in either the use of the equipment or how to create hydrographic maps. Despite requests from the YGAPC for supplier-led training, bringing the experts to Yemen has been challenging. As such, the vessel has gone unused for years and YGAPC is unaware of scour on the bottom of the berths that may pose a risk to the structural integrity of the quay walls. They also cannot track spills or objects that may become navigational obstacles.

The workshop yard also stored a circa 1983 Al-Wahda grab hopper dredger (*see Figure 4*) and split barges—all of which are in poor condition and have been unused for years. Unable to use the survey vessel, the Port is unaware how much maintenance dredging must be performed and whether maintenance dredging work is required in the navigation channel and berths. Discussions revealed, however, that despite not knowing the conditions, there have not been any issues like the unavailability of berths, or damage to arriving or departing vessels.



Figure 3: Survey Vessel | Photo: Port of Rotterdam



Figure 4: Al-Wahda Dredger | Photo: UNDP Yemen



Figure 5: Main Slipway | Photo: Port of Rotterdam

5.2.1

PORT OF ADEN SLIPWAY AND WORKSHOP RECOMMENDATIONS



RECOMMENDATION: Establish a staff training programme in asset management and to provide them with the high-quality knowledge needed. For this, specialists must be able to visit Aden or staff will need to travel abroad for the training. In addition, it is recommended to urge the Authorities to release the import of the necessary spare parts as quickly as possible.

RECOMMENDATION: The YGAPC would like a new dredging vessel. To make optimal use of new dredging equipment, upgrade the current survey vessel equipment to have accurate data for dredging.

SLIPWAYS

A | Slipway's lower end

The lower end of the slipway was damaged by bombing during the 1986 South Yemini Civil War, causing the YGAPC to be reluctant to fully load the slipway. However, the slipway's visible concrete and rail structure appeared in reasonable condition with only minor damages to the concrete and capable of being fully loaded. The Port's tugboats and other equipment are still being maintained on the slipway. Refer to Section 5.5.

A 2010 inspection report of the underwater slipway construction details only minor damages, but no major damage related to the bombing. It does not give reason to doubt the structural integrity of the slipway construction.



RECOMMENDATION: To clarify the presence and extent of the damages and the impact on the maximum load capacity of the slipway, perform a new inspection with results assessed by a structural engineer. In view of this assessment, this engineer must also draw up the inspection protocol.

B | Slipway cradle

The slipway cradle is in moderate condition but requires maintenance and preservation. And the entire installation requires urgent maintenance to keep it operational: the winch's electrical installation (e.g., wiring, controls, etc.) is considerably outdated and unreliable, and the mechanical installation (e.g., cable drums, transmissions, etc.) is in reasonable condition given the year of construction. However, it appears that currently only the most essential lubrication work is carried out.



RECOMMENDATION: Replace the entire electrical installation and perform major (replacement) maintenance on the mechanical installations. After this maintenance has been performed, the entire installation must be tested for maximum load capacity.

C | Slipway safety

The slipway is provided with dogshore stops⁶ and precautions can be taken to prevent the cradle from rolling once ships are hauled up on the slipway. The assessment found that only provisional measures—use of loose concrete blocks to lock the cradle—are occurring, resulting in a serious safety issue. (See Figure 6.)



RECOMMENDATION: Purchase appropriate equipment such as a steel frame to ensure safe use of the slipway.

D | Quay wall

The quay wall to the west of the slipway is in a very poor condition. (See Figure 7.) The concrete capping beam is non-functional, there is no more fendering present, and the quay ladders are unsafe to use. The steel sheet piling shows significant damage above the waterline.

During the construction of the quay, cathodic protection based upon impressed current was applied; however, YGAPC indicated that the installation has not worked for years. Given the high salinity and average water temperature, significant corrosion damage below the waterline is expected upon further inspection. The inspection must include wall thickness and pitting measurements. Port of Rotterdam Corrosion Engineers can provide the inspection protocol and assess the results. The steel mooring posts and concrete dolphin structure on the east side of the slipway are deteriorated and unsuitable for use.

RECOMMENDATION: Conduct further inspection to determine if the quay damages are repairable or whether it must be replaced. It is also recommended to replace the dolphins.

E | Sheet pile wall

The sheet pile wall on the east side of the slipway was not inspected during the assessment. Due to the high salinity and average water temperature, it is also assumed that corrosion damage is present. Further inspection is also needed to determine its current condition.

RECOMMENDATION: Conduct further inspections on both the quay and sheet pile wall to determine actual current conditions.

F | Diving inspection team

The diving inspection team currently does not have adequate equipment - including high pressure cleaners, ultrasonic measuring equipment, and underwater welding equipment—to perform inspections and repairs properly.

RECOMMENDATION: To continue to perform inspection and repair services in the future, work together with the team to further identify their needs.



Figure 6: Main Slipway Safety Issue |
Photo: Port of Rotterdam



Figure 7: Quay Wall and Dolphin Main Slipway |
Photo: Port of Rotterdam

WORKSHOPS AND YARD

The yard contains several workshops with considerable war-induced damage to the marine workshop and a destroyed carpentry workshop. It is critical that both workshops are rebuilt as marine and carpentry services are major deliverables for the Technical Department. A detailed design for the marine workshop has been prepared by YGAPC.

The other workshops (e.g., welding, steel mill, and metal works) are operational to varying degrees. Given the current conditions, the Port staff have found creative solutions and/or workarounds for the situations they face.

Furthermore, the lack of maintenance and upkeep of the buildings and the yards was evident with widespread waste, debris, and scrap material in and around the workshops. This has a negative impact on the work and safety within the yard.



RECOMMENDATION: Remove all waste and scrap material from the yards and workshops to prevent safety issues and increase work efficiency.



Figure 8: Damaged Workshops | Photos: UNDP Yemen



Given the current conditions, the Port staff have found creative solutions and/or workarounds for the situations they face.



Figure 9: Aden Container Terminal | Photo: Google Earth

5.3

Port of Aden Container Terminal

The Port of Aden Container Terminal (ACT) is generally in good shape and fully operational with six ship-to-shore (STS) gantry cranes. Four of which are manufactured by Fantuzzi Regiane and are older, and two are manufactured by Liebherr and are much younger. In the yard, standard and refrigerated containers (Reefers) are handled by Rubber Tyred Gantry (RTG) cranes and the empty containers are handled by Reach Stackers and Empty Handlers.

On average the container yard is stacked between 80–90 per cent, averaging 86 per cent. However, occasionally, while discharging containers, the yard may be over 100 per cent occupied. As such, containers are temporarily stacked in unofficial stacking locations with an increased risk of them getting lost.

The reason for the high yard occupancy is twofold: (1) due to container consignees seeing the ACT as a cheap, safe storage solution and leaving them for an extended period; and (2) the limited availability (one shift per day) of the Customs Department clearance authorities. Despite these issues, in 2019, the ACT handled 465,000 twenty-foot-equivalent (TEU) containers—a record throughput.

The Customs Department would benefit from improved inspection equipment, particularly from hardware needed to implement the Automated Systems for Customs Data (ASYCUDA) World web-based customs management programme. The Customs Department has the software and staff have been trained, but they are limited due to the lack of computer hardware needed.

UNDP may wish to investigate funding options for the hardware needed to provide a higher level of service.

5.3.1

ACT EQUIPMENT

The following are available equipment located at the ACT that were observed during the assessment mission.

A | Container handling operations equipment



Ship-to-Shore (STS) Gantry Cranes
For discharge and loading of containers to and from the quay on vessels



Rubber Tired Gantry Yard (RTG) Cranes
For container stacking



Reach Stackers and Empty Handlers
For container stacking in empty yard



Tractors and trailers
For horizontal container transport between the STS and yard cranes



Forklifts
Mainly used in workshops and port warehouses

There is an unpaved area on the west side of the paved container yard that is used to stack empty containers. This area does not currently have a quay wall with berth locations. Port management wants to use this area as a permanent container stacking location and is planning to install a quay wall to avail more berths for handling container vessels.

According to Port management, the use of container handling equipment like Reach Stackers, Empty Handlers and tractor-trailer combinations on the unpaved roads cause equipment damage. Procurement of heavier, more robust equipment is being considered for this area of the Port.

Figures 10–14 | Photos: Solid Port Solutions

B | Daily operations

The ACT daily operations are governed by a 10-year-old Zodiac brand Terminal Operating System (TOS) made and provided by DPWorld. The TOS keeps track of where containers on the terminal are stored and clears them for transport from the terminal once the consignee handling fees have been paid.

Upgrading this system will allow the Port operators access to extra control features to help enable better handling of vessels on the quay—this is particularly useful if there are multiple vessels. Although more expensive, replacing the Zodiac TOS may be better than upgrading it as there may be more support and features for port operators.

Extra costs related to a new TOS include:

- Writing specifications for new operating system
- Tendering process for procurement
- Implementing selected software
- Training on new software
- New software licenses

Additionally, with no access to Wi-Fi in the yard and quay areas, there is no live information streaming between the TOS and the container handling equipment on the terminal. The tracking and tracing of container movements in the yard is currently managed through handwritten paper slips.

After any container transportation and/or relocation, the paper slips with the updated information are used to upload the information into the TOS. This type of manual process has a high risk of information such as losing stacking location information. This results in repetitive and time-consuming search missions by Port staff to find the missing container to either export it or hand it over to the consignee.

C | Equipment maintenance

All equipment is generally operational and can be used for daily operations. However, the Port has had difficulties with procuring spare parts. Because next to their intended use, spare parts can be used for war-like efforts, the import of items like electronic boards is highly restricted.

The Port of Aden's operational concept of maintenance is based on corrective maintenance. As such, if equipment breaks down, no spare parts are available to repair the broken equipment. The only way to repair the broken equipment is for the maintenance staff to reproduce/recreate the broken item. Because of this, the Port has an extended workshop with trained capable staff. However, the long repair time adversely affects port operations while equipment is not being used.

Additionally, due to the import restrictions, the Port has problems with warranty claims on recently delivered equipment such as tractors, Reach Stackers, Empty Handlers, and power generators. Suppliers are unable and/or unwilling to support the Port with warranty claims due to limitations getting their staff into Yemen to investigate the claims.

Furthermore, due to Yemen's conflict, new equipment suppliers are reluctant to provide extensive maintenance training for Port staff on the new equipment. As such, Port maintenance staff have difficulties maintaining the new high-tech equipment. This applies to generators, electronics on container handling equipment, and specialised equipment and/or technologies required for aligning wheels on ship to shore cranes.

The following maintenance issues due to unavailability of spare parts, warranty issues, or lack of maintenance knowledge were noted during the assessment:

Warranty issues on parts of the new Caterpillar (C175) generator

Yemen's public power grid operates only 10 per cent of the day and is not a reliable power source and the Port's power generators are under high duress. The Port's capacity to generate enough power for its operations is severely stressed and is a concern with a high risk of downtime due to insufficient power generating capacity by the older generators.

Additionally, the lack of spare parts limits timely maintenance and a newly purchased Caterpillar C175 generator (built in 2018) breaks down frequently due to issues with the fuel ventilation fan. This was initially repaired by Caterpillar's local representative but broke again shortly after. Caterpillar has indicated that an April 2021 redesign will solve the problem.

A new electricity generating plant will soon be commissioned, providing 260 megawatts for Aden. To provide power for the terminal, the ACT will run a spur line from the main power cable with existing generators as back-up, when required. This should give the terminal an opportunity to repair and/or upgrade the existing generators.

Even with this extra power supply, the port will require extra generator capacity should the main power supply fail. However, expanding the generator capacity should not replace the effort to repair the frequently failing Caterpillar C175 generator, which should be viewed as a larger part of the ACT operation expansion plans.



Figure 15: Repair of Rear Suspension of Kalmar Tractor (Warranty issue) | Photo: Solid Port Solutions



Figure 16: Misaligned Liebherr Trolley Wheels | Photo: Port of Aden

Generators equipped with outdated SCADA⁸

The older generators have an old Programmable Logic Controller (PLC) system called SCADA. The PLC is becoming obsolete and needs a short-term replacement. Due to the malfunctioning Caterpillar C175 generator, the existing older generators cannot be switched off to safely replace the PLC system. And the Port maintenance staff do not have the expertise nor experience to install a new PLC system next to a running generator to quickly execute a system switch when the generators are briefly stopped.

Warranty issues with new Kalmar tractors, Reach Stacker and Empty Handlers spreaders

Still under warranty, new Kalmar brand tractors appear to have a design flaw and the rear suspension has broken at the same place on most tractors. The staff at the Dubai-based Kalmar were unaware of the issue due to miscommunication.

Senior Kalmar management were informed during the assessment mission about the warranty problems. They have since contacted their maintenance support company to plan a mission to Aden to fix the issues. The same situation applied to electrical faults on the spreaders of new Kalmar Reach Stackers and Empty Handlers.

Bogie and trolley wheel alignment required for Liebherr STS cranes

The two Liebherr ship-to-shore cranes have problems with the alignment of the bogie and trolley wheels, leading to increased wear of the wheels and rails. The Port maintenance staff do not know how to readjust the wheel alignment and require Liebherr support. The solution is to bring a Liebherr engineer to the Port or by sending an experienced mechanic to the Port of Ireland for extensive training.

Fantuzzi Regiane PLC system for STS cranes obsolete

The four Fantuzzi Regiane ship-to-shore cranes have old PLC systems to control the crane's electrical installation. The system's spare parts are no longer available which will eventually lead to long downtimes should there be a system malfunction. In normal operations, these systems will not break down; however, with Aden's unstable power, it is probable that the PLC systems will ultimately break down, rendering the crane unusable. This will hamper continued container vessel operations as the unusable crane will block the operational use of the vessel's cranes.

Replacing the PLC system with a newer system should eventually occur, although there is no immediate need for the upgrade.

5.3.2

POSSIBLE SOLUTIONS

All Port of Aden assistance must start with support to procure spare parts for its equipment. In addition, the warranty issues for new equipment must be resolved. With import and export restrictions, it is difficult to overcome challenges; however, easing these will allow the Port to remain operational.

Training of Port maintenance staff must be a high priority. Recently procured equipment requires high levels of sophisticated knowledge and training to maintain, but the conflict has restricted suppliers' trainers from visiting Aden to train Port staff. As such, sending Port staff to supplier destinations for training is a possible solution. However, it is noted that nearly all foreign embassies in Yemen are closed and obtaining a visa may be difficult.

The high yard occupancy is a major source for the Port's slow performance. As container consignees view the Port as a cheap and safe storage option, many leave them at the Port for extensive periods of time. If the Port's Commercial Department contacts the consignees' clearing agents to discuss the reasons for handling delays, the consignees may be tempted to remove their containers from the port as quickly as possible. And by giving discounts for swift pick-up rather than punishing late pick-up, the consignees may pick up their containers faster.

The Customs Officers—who control and check all passing cargo intended to travel overland—only work eight hours a day, despite the Port sending and receiving containers 24 hours a day, seven days a week. This unmatched work schedule slows the landside Port operations significantly.

High level dialogue between Customs and Port officials must take place to urgently find a solution.

The Port's efficiency will dramatically increase by expanding the wireless connectivity (Wi-Fi) through installing both ICT network access points in the operational areas and Vehicle Mounted Terminals (VMT) on operational container handling equipment. This will eliminate the need for the hand-written paper process that currently controls the Port's container movements and will allow Port Controllers to pinpoint the exact location of containers on the Port.

In principle, this system will result in no mistakes being made and no time required to go into the yard to search for missing containers. The new system will increase available time for the crane and truck drivers during the standard container handling process on the port, ultimately reducing the risk of fraud related to container handling.

A TOS upgrade to the latest software version should be considered as it will introduce new functions for its users and will allow the Port staff to work more efficiently. However, it will have minimal-to-no-effect on ACT's overall efficiency.

An urgent TOS upgrade should only be considered if the current TOS is unable to communicate with VMTs over Wi-Fi. This will help solve issues with container movement being governed by hand-written paper slips.

Currently the yard at the end of the quay is used for empty container stacks; however, it remains unpaved. Standard port equipment like tractors and Reach Stackers must be able to drive on the surface without damage. And because the Port's masterplan includes expanding the container terminal to this area, it would be better to pave it rather than investing in expensive, heavy duty equipment.

NOTE: If container handling equipment breaks down due to driving over unpaved areas, English speaking Port staff should contact the supplier's Service Department directly if the supplier's local agent is unable or unwilling to provide the expected service, repair, and/or successfully solving warranty issues.

5.4

Ma'alla Wharf

In 1954, the Home Trade Quay (HTQ) was constructed in Ma'alla to allow smaller coastal trade ships in the Red Sea and Gulf of Aden to be loaded and discharged alongside berths. Cargo handling has since changed significantly and, in the late 1980's, containers became more important in global trade. This resulted in the quay's eastward expansion and the completion of the new Ma'alla Wharf in 1991 following three years of construction.

The HTQ was built as a gravity wall and consists of unreinforced concrete T Section blocks. The quay extension was also built as a gravity wall using mass concrete blocks placed on stone and gravel bed. The transshipment and storage area are covered with concrete paving stones and a crane rail runs the length of the quay to accommodate rail mounted cranes for loading and discharge of containers and bulk goods.

The quay is equipped with bollards with a maximum load capacity of 50 tons. To protect the quay from damage during berthing, it is equipped with cylindrical fenders. Ladders have been placed along the quay at regular intervals and, to protect them from collision damage, have been placed in a recess in the quay.

Ma'alla Wharf is a multi-use terminal and consists of seven berths. At the west end of the terminal, there is a Roll-on/Roll-off (RoRo) berth that is 150 meters (about 492 feet) long with a maximum bottom level of 7.6 meters (about 25 feet).

Berths 1 through 4—with a total length of 750 meters (about one-half mile)—are for large vessels up to 180 meters (590 feet) long and have a displacement of around 50,000 metric tons. The maximum bottom depth alongside the quay is 11 meters (36 feet).

At berths 1 and 2, containers can be discharged and loaded. The quay is equipped with a rail structure and two Liebherr gantry cranes. The storage yard behind the quay contains reefer points for reefer container storage.

Alongside berths 3 and 4, there are two warehouses for storage of bulk cargo. Between berths 3 and 4, there is a rail mounted grain unloader and conveyor belt that is owned and operated by Al-Rowaishan Grain Silos Company.

The HTQ is 250 meters (about 820 feet) long and the maximum bottom depth of berths 5 and 6 is 6.7 meters (about 22 feet). This part of the quay is currently mainly used by dhows.⁹ Adjacent to the HTQ berths, there are two sheds for bulk storage that are not in use.

The quay extends to the east side of the terminal with a cement factory and additional storage warehouses alongside the quay. The main entrance for freight traffic is located on the far east side of the terminal.

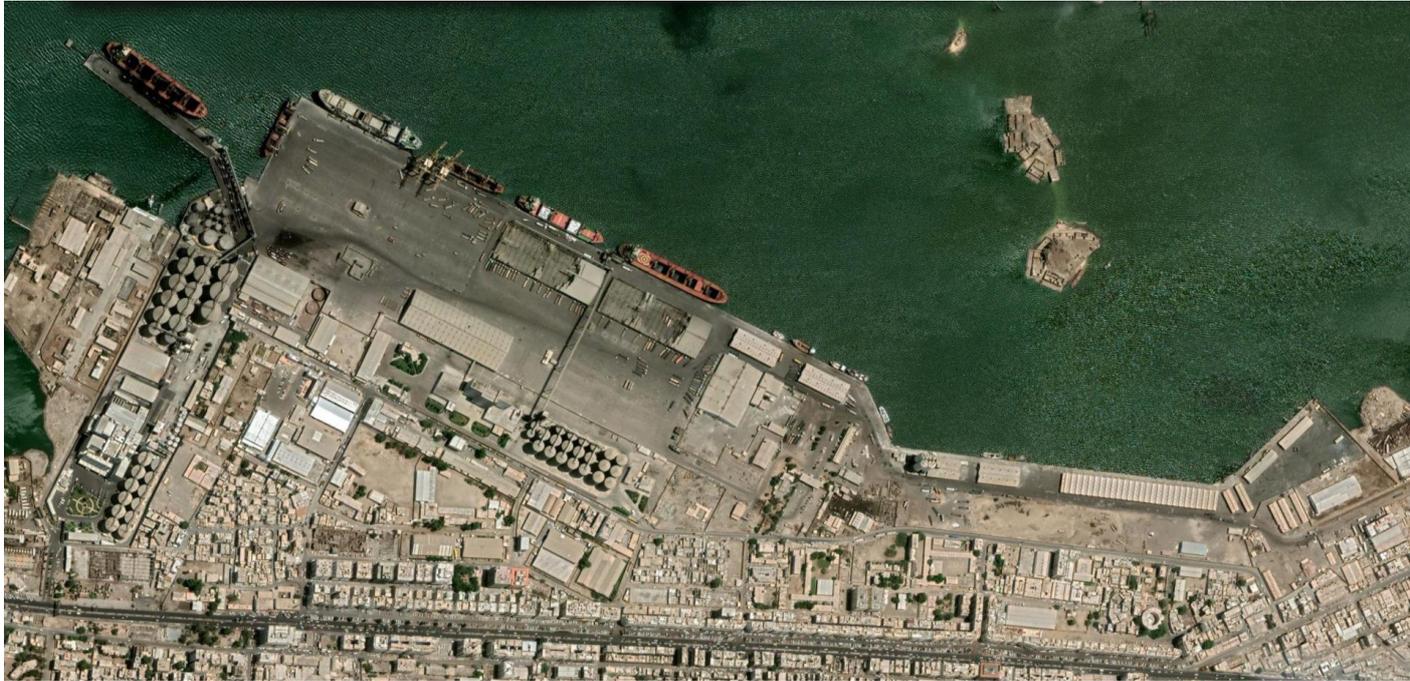


Figure 17: Ma'alla Wharf | Photo: Google Earth

5.4.1 GENERAL RESULTS

Discussions with YGAPC during the assessment—and review of the supplied documents—indicate that congestion and rising costs of import of goods were a concern even before the start of the conflict. At the beginning of 2000, YGAPC studied measures to overcome the congestion issue. Among other things, improving the efficiency of transshipment and increasing the depth of the HTQ were reviewed. With Yemen's current humanitarian and development crisis, investments in the efficiency of the terminal operations are even more necessary.

A | Master plan

As indicated in Section 5.2, an asset management decision-making strategy does not exist and, at Ma'alla Wharf, there is no master plan. As such, decisions around major capital investments in assets and maintenance prioritization are not made based upon a long-term vision for the terminal. This applies to, for example, the previously studied project of deepening berths 5 and 6, and to the rehabilitation of container handling and warehousing facilities.

There must be a guideline to support the development, comparison, and evaluation of investment proposals.

RECOMMENDATION: Create a master plan for the Port of Aden in its entirety before decisions on large investments in the Port are considered. In addition to the terminals not considered in this assessment, the master plan must include plans YGAPC already has for the expansion of the ACT and the new break bulk terminals on the north side of the Port of Aden. It must also provide guidance in economic and financial justification for any necessary investments.

RECOMMENDATION: Based upon this overall master plan, a critical asset management strategy can be developed. This strategy will support the capital investments forecast in assets and maintenance prioritization for Ma'alla Wharf.

B | Increasing the depth of the Home Trade Quay (HTQ)

A solution YGAPC proposed to overcome congestion is increasing the depth of HTQ berths 5 and 6. This involves completing two new berths—on the same location or near the existing berths—and widening the turning basin in front of the quay.

Review of YGAPC documents revealed that the current quay wall cannot be deepened to the necessary depth of 12 meters (about 39 feet), requiring a new design and construction of the quay wall. Based upon indices,¹⁰ an initial estimate of the construction costs was made and will require a minimum investment of US\$15 million.



RECOMMENDATION: Conduct a study of possible technical solutions to determine a more detailed budget.

C | Container ship discharge efficiency

Ships destined for Ma'alla Wharf spend an average of 16 days in the anchorage area and then an average of 10 days at the quay to load or discharge. Unloading general cargo is slow due to a lack of adequate equipment. The terminal yard is not used for storage; goods are immediately unloaded on trucks and removed from the terminal. Should truck drivers' strike, the handling will stop, and ships will remain moored even longer—contributing to an increased cost of goods entering Yemen.

Improving the efficiency of cargo handling will benefit the Port and shipping companies. Handling containers and break bulk on the same quay is not advisable. It is possible to generate greater revenue if more vessels are handled simultaneously and they can set sail in shorter time.

The investment in continuous discharge and loading equipment for bulk cargo is substantial. To enable well-founded investment decisions in loading and discharge equipment, the Port must clearly define who their customers are and what type of commodities they want to handle on Ma'alla Wharf's quay side. Only when a master plan is available, will it be possible to determine large investments into the necessary equipment; currently, there is not a clear vision.



RECOMMENDATION: To immediately increase the efficiency of the current cargo discharge, invest in relatively small additional equipment—like C-hooks—to be used to discharge steel coils and modify existing spreaders to increase the efficiency of timber discharge.

RECOMMENDATION: To guarantee a continuous transshipment process, the Port should carry out the loading and unloading activities. The storage space required is available in the wharf yard.

RECOMMENDATION: Invest in additional equipment for the horizontal transport of goods from the quayside to the yard.

A cement factory outside the Port uses clinker (used coal) that is discharged from vessels at the Ma'alla Wharf. The clinker is unloaded from vessels with grabs and placed into hoppers. Trucks located under the hoppers are then loaded, releasing tremendous dust. (See Figure 20.) This dust pollutes the terminal and equipment, contaminates the employees' breathing zone, temporarily reduce visibility along the quay, and cause road safety issues.

Consequences of the process include:

- Increase in employee dissatisfaction
- Decrease in labour productivity of Port employees
- An increase in absenteeism
- Decrease of the lifespan of equipment



RECOMMENDATION: The Port should purchase three eco-hoppers. Eco-hoppers are equipped with a special dust control system to minimise the escape of dust particles during the grab discharge cycle. Hoppers are mobile and can be transported to the various locations based upon where bulk cargo will be discharged in the Port's master plan.

Figure 18: C-Hook | Photo: Indiamarkt.com



Figure 19: C-Hook in use | Photo: Solid Port Solutions



Figure 20: Particles Emission during Discharge of Cement | Photo: Port of Aden



Figure 21: Eco Hoppers | Photo: Port of Aden



Figure 22: Cracks around Bollard Foundation | Photo: Port of Rotterdam



Figure 23: Vertical Deformation | Photo: Port of Rotterdam



Figure 24: bollards at Ma'alla Wharf | Photo: Port of Rotterdam

D | Concrete structure quay wall

The concrete structure of the quay could not be inspected from the waterside due to busy berths during the assessment, resulting in the visual inspection at only the quay level. The concrete structure appeared to be in fair-to-moderate condition with most of the damage on the eastern part of the terminal and the HTQ. The most striking observation are the cracks around the bollards seen in Figure 22.

E | Deformation

At the connection point of the RoRo berth to berth 1, the Z direction is deformed by approximately 5 centimetres (about 2 inches) with no deformation in the horizontal direction. The deformation appears to have been caused by settling in the subsoil and has been present for at least 20 years with no observable change.

F | Mooring equipment

Bollards

The port is in a warm and saline environment, both temperature and salinity are initiating factors of corrosion. It is well known that chlorides cause corrosion, and therefore affect steel elements. The steel bollards and its anchors are corroded and in moderate

condition. Reduction of the steel profile of the bollard because of corrosion decreases the bollard strength and structural safety. It is therefore recommended to preserve the bollards against corrosion with a NORSOK M-501 system 7A approved paint system.



RECOMMENDATION: As the concrete foundations are cracked, periodic monitoring of the crack width is necessary as increasing width may be an indication of failure. As a mitigating measure, it is also possible to inject the cracks with filler.

RECOMMENDATION: Up to four mooring lines were observed on the bollard during the assessment mission. With the maximum load capacity of the Wharf bollards being 50 tons, only two mooring lines on each bollard should be allowed.

Safe mooring equipment and its foundations should be designed for human failure based upon the Maximum Breaking Load (MBL) and number of applied mooring lines. In line with the international guidelines, Table 1 outlines the advised¹¹ bollard design.

TABLE 1: ALLOWABLE BOLLARD LOADS

Limit State	Formula	2 lines	3 lines	4 lines
Serviceability Limit State (SLS)	$N \times 0.6 \times \text{MBL}$	1.2 MBL	1.8 MBL	2.4 MBL
Ultimate Limit State (ULS)	$1.5 \times N \times 0.6 \times \text{MBL}$	1.8 MBL	2.7 MBL	3.6 MBL
Accidental Limit State (ALS)	$2 \text{ MBL} + (N-2) \times 0.6 \times \text{MBL}$	2.0 MBL	2.6 MBL	3.2 MBL

Ladders

The ladders on the quay are in poor condition due to the lack of maintenance and corrosion damages and prevents safe use.



RECOMMENDATION: Replace all ladders with new ladders made of hot-dip galvanized steel.

Fenders

Rubber fenders are used on the quay, but rubber degrades under heavy weight, and exposure to sun, air, heat, and seawater. The fenders on the Maalla Wharf quay are attached at an angle with one side below the high-water line; they are in poor condition with the rubber severely worn and the anchors and chains corroded. As the fenders hang at an angle, the chains have cut into the rubber. And being attached below the high-water line, maintenance and replacement must be done by a diving team which takes longer and costs more.

Given the ship sizes able to berth at Maalla Wharf, the fenders are under dimensioned—potentially causing ships and berthing equipment damage during berthing manoeuvres. It is possible that ships may file claims against YGAPC due to damage sustained by mooring on the fenders.



RECOMMENDATION: As steel and rubber in warm seawater conditions need extra protection against degradation, it is necessary to replace the fenders with those that can sufficiently absorb the ships' mooring energy. The fenders must also be attached to the quay entirely above the high waterline to improve timeliness and cost of maintenance; arch or V-fenders can be used.

G | Harbour bed

The high speeds of jet flows from main propellers and bow thrusters of berthing ships can cause scouring¹² of the harbour bottom in front of the quay. If the bottom protection is not adequate, scouring holes¹³ several meters deep can form affecting the structural integrity and stability of the quay. Regularly sounding the water depth may reveal scour holes at an early stage, enabling them to be addressed before becoming major concerns.

Because the survey vessel is not in use, there have not been hydrographic surveys of the harbour bottom. As such, there is no knowledge of the degree of scour in the harbour bed in front of the quay. See Section 5.2. The surveys also enable insight into potential spills on the harbour bottom. If not removed in time, spills could present an obstacle to mooring ships.



RECOMMENDATION: Arrange a training programme for survey staff including the use of present equipment, analysis of the measurement results, and preparation of hydrographic maps.

H | Crane rail structure and container handling equipment

The electrical connections for the Maalla Wharf reefer containers are non-functional due to an outdated installation.

Facilities for container transshipment are available along berths 1 and 2 including crane rails, two gantry cranes, and cable ducts for the energy supply. The waterside crane rail is imbedded in the quay apron and the landside crane rail has a separate foundation placed on a continuous concrete beam.

With operational tolerances—inclination, longitudinal, and transverse direction—on crane rails are very strict, the crane rail along berths 1 and 2 does not meet the tolerances needed for smooth operation of the Liebherr gantry cranes. A 2011 survey report by Engineering Consultancy Centre of the University of Aden indicated that the rail profile, rail clamps, and anchors are completely corroded, creating conditions that cannot support the use of the cranes. Combined with the damages and a lack of maintenance, the Liebherr cranes are an obstacle to the terminal's other cargo handling activities.

An inspection report from Aden Ports Development Company (APDC) contains descriptions of the cranes' defects. Provided by the YGAPC, the report shows that the two cranes are around 25 years old, having been installed on the quay around 1995.

The report indicated that the crane is in poor condition, but the only significant structural damage found was on one of the crane's legs. Damaged during the war, and repaired by YGAPC, the report indicated that it must be replaced in accordance with the supplier's design specification. It can be concluded from the report that a considerable amount of corrective maintenance is required to regain the cranes' full operation.

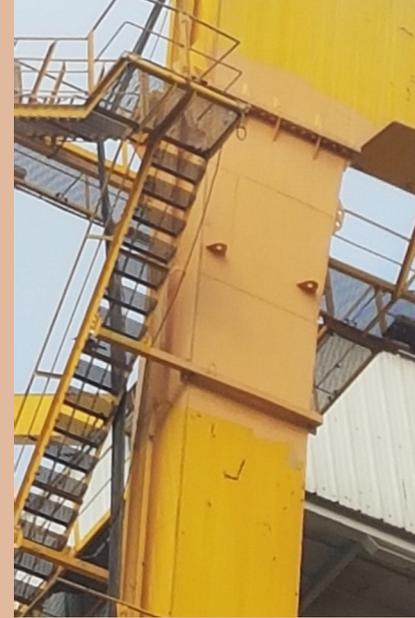


Figure 25: Damage to Liebherr Crane Before and After Repair | Photos: Port of Aden and Solid Port Solutions

Ship-to-shore gantry cranes are designed and built for an operational lifetime of 25 years; theoretically meaning that the cranes are at the end of their lifecycle. Despite the cranes not being fully used for the 25 years due to damage (which should give them a slightly extend lifetime), any investment toward these cranes is not advisable from an economic perspective.

RECOMMENDATION: Any investment in the rehabilitation of terminals' container handling depends upon the master plan to be created. If container handling is not a component of the master plan, the cranes should be demolished. If container handling is part of the plan, then—given the age of the crane and the many defects reported—a detailed inspection must be carried out by the supplier. Based on this inspection, it will be determined whether investments in the repair of the cranes is technically and economically viable.

NOTE: Liebherr engineers have indicated that they do not want to travel to Yemen due to imposed travel restrictions. Authorities are urged to help ensure the required specialists can enter Yemen.

I | Warehouses

Storage warehouses are available at three locations on the terminal:

- Along the quay east of the HTQ
- Sheds 22 and 23 along berths 5 and 6 of the HTQ
- Transit sheds along berths 3 and 4

The warehouses on the east side of the terminal and along the HTQ have been unused for some time and are in a poor state of maintenance.

RECOMMENDATION: Investments in the rehabilitation of warehouses within points 1 and 2 should be based upon the strategy outlined in the impending master plan.

The roof and facade cladding of the warehouses along berths 3 and 4 was largely destroyed because of the conflict with a large part of the cladding debris and trucks still inside.

RECOMMENDATION: Restore the warehouses to create a storage facility for goods such as rice, grain, and flour which must be stored under shelter. Rehabilitation will include removing warehouse debris, renewing, or strengthening the steel structure, and installing a new roof and facade cladding. The warehouse entrance doors must be cleared of waste and/or repaired, and the shed lighting must also be renewed.

5.5

Marine Department

The Marine Department is the responsibility of the Harbour Master and—in addition to supervising shipping—they also provide piloting, towing, and search and rescue services. The Harbour Master and his Deputies are fully certified which is maintained by courses and training.

The Department operates two pilot boats, four tugboats, and two mooring boats.

TUGBOATS

The department has four tugboats with an average of 2 tugs available all the time; the newest tugboat is 18 years old.

YGAPC indicated that because of the lack of the slipway's full use, and lack of spare parts, high-cost repairs are carried out on tugs in Djibouti. Currently one of the tugboats is defective and cannot be used and YGAPC has looked for a replacement tugboat in the Netherlands; however, it did not meet their requirements. Purchase of a tugboat in Vietnam is currently being investigated.

NOTE: Recently, YGAPC carried out repairs on the tugboat "Mayoon" on its own slipway.¹⁴

MOORING BOATS

There are three unused mooring boats on the slipway yard that have subsequently been found unsuitable after use by personnel. These boats are considered unsafe, in part due to water coming on deck. YGAPC would like to acquire two new mooring boats; however, unused boats are wasteful and an unwise investment.



Figure 26: Winch Wagon |
Photo: Vlissingse Bootliedenwacht B.V.

RECOMMENDATION: Modify the existing boats to meet the user's requirements. Alternatively, another cost-effective option includes purchasing winch wagons for those terminals, whose mooring facilities can be reached by land. These are modified pick-up trucks that are provided with a complete winch unit. (See Figure 26.)

5.6

Compliance with international regulations and standards

A | International Ship and Port Facility Security (ISPS) and Port Security Level

The YGAPC indicated that the Port of Aden is fully ISPS¹⁵ compliant and certified. As ISPS certification is relevant for the security of the port, and disclosure is limited to relevant staff, no additional information was provided.

The role of Port Security Officer is assigned to Yemen's Coast Guard with a Port Facility Security Officer appointed at each terminal. Each terminal has a Port Facility Security Plan and the Harbour Masters have a supporting role with Port Security.

B | Compliance with health, safety, and environmental standards

Health, safety, and environmental awareness in the Port is currently unacceptable. The Port contains large areas of conflict-damaged debris, damaged and unusable equipment, and equipment and materials being stored for future use.

Staff safety awareness must improve as general safety measures are not being taken, proper work attire is not being worn, and there is no—or limited—use of Personal Protective Equipment (PPE) such as hard hats and safety vests. The latter makes it difficult to be seen by truck drivers and other heavy equipment drivers.

5.7

Recommendations for the Port of Aden

A list of recommendations was compiled and provided in Table 2 and contains projects necessary for maintaining the current Port operations and restoring Port operation to pre-conflict conditions.

Priority 1

Projects are a prerequisite for maintaining the current Port operation and require immediate action.

Priority 2

Projects to increase the Port's capability but are not required to bring it to pre-conflict status.

Priority 3

Projects are necessary to restore or improve safety and sustainability of the Port's operations and assets.

TABLE 2: RECOMMENDED PROJECTS FOR PORT OF ADEN

#	PRIORITY 1 PROJECTS	Estimated Cost (USD)	Duration (in months)
1	Procurement of spare parts for port equipment	10,000,000 ¹⁶	3–6
2	Arrange a training program for recently procured equipment (i.e., survey vessel)	200,000	3–6
3	Contact Consignee to ask them to move containers from Yard (ACT)	--	1–3
4	Contact Customs to increase availability of staff to 24 hours a day, 7 days a week	--	1–3
5	Make a masterplan for the Port of Aden	300,000	12
6	Installation of Wi-Fi on the Container Yard (ACT)	500,000	6
7	Procurement of Handheld /VMT devices	450,000	6
8	Refurbishment of transit sheds 1 and 2 along berths 3 and 4 (Maalla Wharf)	1,200,000	18
9	Inspection and assessment of the main slipway and quay walls	25,000	2
10	Replacement electrical installation, maintenance and testing slipway	250,000	6
11	Rebuilding the carpentry and marine workshop	600,000	12
12	Cleaning of the workshop yard	15,000	1
	Total	13,540,000	

#	PRIORITY 2 PROJECTS	Estimated Cost (USD)	Duration (in months)
13	Upgrade Zodiac TOS to latest version (ACT)	800,000	6
14	Procurement of C-Hooks and modification of spreaders for timber discharge	250,000	4
15	Paving of empty Container Yard (ACT)] (13,000m)	4,500,000	9
16	Refurbishment of Mooring Boats	75,000	2
17	Renewal of monitoring system power supply ACT including SCADA system	500,000	6
18	Inspection/demolishing of STS cranes (Ma'alla Wharf)	200,000	5
19	Replacement of marine fenders and ladders (Ma'alla Wharf)	900,000	12
	Total	7,225,000	
#	PRIORITY 3 PROJECTS	Estimated Cost (USD)	Duration (in months)
20	Replacement of dolphins main slipway	350,000	12
21	Replacement / rehabilitation of the quay walls of the main slipway	Currently unknown ¹⁷	18
22	Study into deepening of berth 5 and 6 (Ma'alla Wharf)	250,000	9
23	Repair and preservation of bollards (Ma'alla Wharf)	20,000	2
24	Refurbishment of sheds 22 and 23 along the HTQ (Ma'alla Wharf)	100,000	12
25	Safety awareness and maintenance knowledge programme	75,000	-
	Total	795,000	
Overarching total for Priorities 1, 2 and 3		USD 21,560,000	



6.0

Port of Mukalla



Figure 27: View of Port of Mukalla | Photo: UNDP Yemen



The Port of Mukalla has not suffered from an attack or on-the-ground fighting during the conflict and critical assets are intact; however, this does not mean that the Port is in the same condition as it was before the conflict began. The Port is currently handling 40,000 TEU annually. To increase this number, the Port must be upgrade to a higher functioning level. For this upgrade, Port management has developed some plans; however, no detailed master plan is available to guide the overarching development of the Port.

NOTE: The Priority 1 investments in this report are required, independent of the content of a master plan. For the Priority 2 and Priority 3 projects, it is advisable that they are aligned with the Port's master plan.

All Port equipment is generally in urgent need for maintenance and most is susceptible to unplanned breakdowns. Due to the country's ongoing conflict, supplier engineers have had issues gaining access to Yemen to train staff on equipment maintenance and assisting with Port equipment maintenance at an acceptable level of operational readiness. If this situation is not quickly resolved, the Port will cease to operate and must close.

A | Port Operations

Lack of Port operational readiness is most reliant upon the tugboat capacity. The Port of Mukalla has only one operational tugboat and—of the two main propelling engines—one is broken and in need of maintenance; however, there are no spare parts available. When the tugboat's second propelling engine breaks down, the tugboat will be unusable and there will be no more capacity to bring vessels from the sea into the Port and vice versa. If that happens, the Port's waterside must be closed. It is extremely important that the tugboat capacity of the port is restored.

The Port's mooring boats and pilot boat are in a similar condition. Of the three mooring boats, one is broken down. The pilot boat is operational but is frequently broken down. If this occurs, the mooring boats must act as the pilot boat and the pilots will not have the necessary and standard equipment available on the pilot boat. For all these vessels, maintenance is also required, and external assistance is needed.

The Harbour Master's office is combined with the Coast Guard in a control tower; the Coast Guard office is planned for relocation. With the relocation of the Coast Guard, most of the navigational tools will also be relocated, leaving the Harbour Master's office with only a VHF radio to communicate with vessels arriving and departing from the Port. Purchasing modern communication and navigation devices—like a VTMS or radar for the control tower—will be required to allow the Harbour Masters' office to function.

The Port also does not have a proper TOS system to govern the flow of cargo over the Port and their storage locations. When a consignee comes to collect a container, the Port staff must search paper files to find its location and a search party will go into the yard to find the container. The same applies to other types of cargo.

This time-consuming way of working does not deliver professional services to Port customers. Procuring and installing a simple administrative control system linked to the Port's Microsoft Dynamics Enterprise Resource Programme will help the management govern the flow of cargo and limit the possibilities of fraud. Although this type of administrative system will most likely not be able to communicate over Wi-Fi—therefore Wi-Fi is not a priority for Mukalla port.

For now, however, the paper trail system—as used in the Port of Aden—will suffice for the number of containers handled in Mukalla Port.

B | Quay wall

The Port has two operational berths: Berth 1 is 177 meters (about 580 feet) with an available draft of 8.5 meters (about 28 feet); berth 2 is 184 meters (about 604 feet) and has a draft of 8.5 meters.

The quay wall of both berths is in a very poor condition with the concrete capping beam greatly degraded and the steel reinforcement is visible and corroded. Fenders, ladders, and bollards have not been well maintained and have severely degraded. This is a risk related to the safe use of the assets and—in time—the license to operate.



RECOMMENDATION: Rehabilitate the concrete capping beam and mooring facilities in the short term.

Empty containers are currently stored on a rented plot outside the Port. Part of the port is in process of being paved and once paved, the empty containers can be stacked inside the Port, reducing cost, and waiting time.

C | Container Handling Equipment

The Port also has issues with their container handling equipment and has limited-to-no spare parts for the maintenance of its container handling equipment. As a result, a lot of equipment is standing idle in the yard waiting for spare parts. A new Reach Stacker will be required to maintain the operational readiness of the Port.

The handling of cargo on and off vessels is done with the ships' own gear. Vessels without gear cannot be handled in the Port due to missing ship-to-shore handling capacity. Procuring two mobile harbour cranes would allow the Port to handle vessels that do not have their own gear.

The Port has three hoppers for the discharge of bulk items like coal and cement which impose a high environmental strain on the Port and its surroundings. Given the location of the cement factory on the Port, the flow of cement will not reduce any time soon. Replacing the hoppers with eco-hoppers would significantly reduce the negative environmental impact of the discharge of coal and cement.



Figure 28: Berth 2 with Mooring Vessel | Photo: Solid Port Solutions



Figure 29: Unpaved Area of Port being Prepared as Stacking Area for Empty Containers | Photo: Solid Port Solutions



Figure 30: Equipment Waiting for Spare Parts | Photo: Solid Port Solutions



Figure 31: Ships Gear Handling Container Discharge | Photo: Solid Port Solutions



Figure 32: Possible Eco hoppers | Photo: Solid Port Solutions

D | ISPS Status of port in relation to the fishing port

YASPC indicated that the Port of Mukalla is fully ISPS¹⁸ compliant and certified. Port facilities—even properly secured as defined by regulation—are large areas where tremendous numbers of people and goods move around. Measures at the Port have been taken to prevent unauthorized entry from the land side. Entrance from the Port’s waterside is regulated by measures described in the Port Facility Security Plan. As ISPS certification is relevant for the security of the Port—and disclosure is limited to relevant staff—no additional information was provided.

What can be an issue with ISPS regulations is the fact that fishing boats are also berthing along the Port’s quay, as can be seen in Figure 27. Regulations do not apply to fishing vessels; however, people gain illegal access to the Port by using the quay as a mooring facility—risking cargo theft, stowaways, smuggling, or sabotage.

RECOMMENDATION: Further investigate the possibilities of relocating the fishing terminal. In addition to contributing to compliance with ISPS regulations, it has a positive effect on operational optimization of the cargo handling process.

E | Safe working on the port

Safety awareness of Port staff is not acceptable and is evident by people not wearing PPE such as reflecting vests, hardhats, and safety shoes. The same applies to how electrical facilities are handled and maintained. (See Figure 33.)

Yemen’s conflict has put an enormous strain on the country’s healthcare system; an issue compounded by COVID-19. Improving the safety awareness of people in the Port should be part of the general safety protocol to limit the risk of accidents and will impose less strain on an already stressed system.

The safety of electrical installations needs to also improve as a fire resulting from a short circuit or any other faulty installation can have a devastating effect on the Ports operational readiness.

RECOMMENDATION: Continually train the Port staff on personal, operational, and electrical safety.



Figure 33: Lack of PPE by Port Users | Photo: Solid Port Solutions



Figure 34: Problems with Electricity Safety | Photo: Solid Port Solutions

6.1

Recommendations for the Port of Mukalla

A list of recommendations was compiled and provided in Table 3 and contains projects necessary for maintaining the current Port operations and restoring Port operation to pre-conflict conditions.

Priority 1

Projects are a prerequisite for maintaining the current Port operation and require immediate action.

Priority 2

Projects to increase the Port's capability but are not required to bring it to pre-conflict status.

Priority 3

Projects are necessary to restore or improve safety and sustainability of the Port's operations and assets.

TABLE 3 RECOMMENDED PROJECTS FOR THE PORT OF MUKALLA

#	PRIORITY 1 PROJECTS	Estimated Cost (USD)	Duration (in months)
1	Procurement of a tugboat	8,000,000	12
2	Procurement of spare parts for port equipment	5,000,000	4–12
3	Training of Maintenance Staff for recently procured equipment	200,000	4–12
4	Rehabilitation of the existing tugboat	450,000	4
5	Maintenance quay wall and replacement mooring equipment	4,500,000	24
	Total	18,150,000	

#	PRIORITY 2 PROJECTS	Estimated Cost (USD)	Duration (in months)
6	Procurement and installation of an administrative system as a Terminal Operating System	250,000	9
7	Procurement of a Reach Stacker	250,000	9
8	Make a detailed master plan for the entire port ¹⁹	150,000	12
9	Pavement of part of the port for stacking of empty containers	330,000	9
10	Procurement of communication and navigation devices for Harbour Master's office ²⁰	600,000	9
11	Procurement of (2) Eco Hoppers	300,000	9
	Total	1,880,000	
#	PRIORITY 3 PROJECTS	Estimated Cost (USD)	Duration (in months)
12	Separate the fishing port from the main port to allow for port expansion and increase safety standards	150,000 ²¹	6
13	Procurement of (2) Mobile Harbour Cranes	8,000,000	7
14	Safety awareness and maintenance knowledge programme	150,000	12
	Total	8,300,000	
Overarching total for Priorities 1, 2 and 3		USD 28,330,000	

7.0 Recommendations for Government of Yemen

As indicated in Section 2, Yemen faces many challenges beyond the scope of this damage and capacity assessment. Considering Yemen imports 90 per cent of its food and 16 million Yemenis face severe food insecurity, well-functioning ports are of the utmost importance.

Food prices have doubled since 2015 and continue to rise. The very recent ACAPS report²² on the Yemen food supply chain shows the key drivers contributing to the increase of food prices—with note to the increased costs of shipping food commodities to Yemen.

Yemen's conflict has increased the transport and logistics costs at each stage of the supply chain. Shipping costs have increased significantly because of the war risk insurance premiums that are imposed—increasing the insurance costs for vessels travelling to Yemen by 16 times more than normal. Annual additional cost associated with this exceed more than US\$ 200 million.

Inspection and clearance mechanisms that are in place ensures that the cost of a container shipped to Yemen is the double of a container shipped to Djibouti or Salalah. It is evident that this is increasing the prices of food and other commodities.

The assessment mission determined a reduction in Port capacity, exacerbated by a lack of maintenance. In this report, many recommendations focus upon increasing operational capacity of the Ports to reduce congestion and delays. However, beyond the recommendations, urgent action is necessary to stop the further increase of commodity prices and to help improve the effectiveness of the Ports of Aden and Mukalla.

Actions the government could include:

A | Reduce or eliminate the war risk premiums

This can be achieved through the installation of a VTMS on both Ports, compliance with ISPS regulations, and setting up a guarantee fund in collaboration with donors and insurance markets.

B | Allow and organise cargo inspections in Yemeni Ports

This will reduce vessel delays and demurrage (vessel owner-incurred charges) costs. It will also increase the number of shipping lines into the Port of Aden and Mukalla, decreasing the price of commodities entering Yemen.

C | Ensure Ports can receive spare parts

This will reduce long waiting times for spare parts and avoid long times of cargo and container handling equipment out of service.

D | Increase Ports' operational capacity

Increase operational capacity of the Port of Aden and the Port of Mukalla to reduce port congestion, delays of cargo handling and cost in line with the recommendations of this report.

E | Strengthen Customs' capacity

Strengthen the capacity of the Customs Office by increasing the office timings and supply of ICT support hardware—particularly for the Port of Aden—to reduce congestion and accelerate delivery of commodities to clearing agents, importers, and customers.

8.0 Conclusions

The assessment mission found that the damage due to the conflict at the Ports of Aden and Mukalla is limited. The Port of Aden suffered only damage to the warehouses at the Ma'alla Wharf and the carpentry and marine workshops in the Maintenance Department were severely damaged. Rehabilitation of these damaged assets will require a limited investment to bring them back to a pre-conflict status.

Addressing the Ports' cargo handling equipment delays that are caused by procurement issues of spare parts to maintain Port equipment is critical. This has created a precarious situation that may adversely affect the operational status of Ports of Aden and Mukalla as they can come to a complete stop due to critical port equipment breaking down. If the Ports cease operations, the related fees will impact both the Port and the Yemeni consumers who absorb the costs, millions of whom already cannot afford the cost of food to stay alive.

The Maintenance Department in both Ports have done a remarkable job in keeping the equipment functioning with limited resources. However, the ability to procure spare parts and have support from suppliers' engineers to repair issues with high-tech Port equipment is urgently needed to maintain and improve humanitarian support in Yemen.

Given the importance of the Port's assets—and recognizing an ageing asset portfolio—a master plan must be created for both Ports. Based upon the strategy outlined in this master plan, the Ports can evaluate and prioritize capital and other investments

and maintenance activities. This contributes to well-founded and sustainable investment decisions. Additionally, staff must be trained in asset management principles to manage and maintain Port infrastructure.

The precarious situation with the tugboat is very troublesome in the Port of Mukalla. For vessels to enter and leave, the Port relies on one tugboat with only one operational engine. Any malfunction to this engine will render the Port closed due to its inability to tow vessels in and out of the Port. Thus, the procuring a tugboat for the Port is of the utmost importance. Once a new tugboat arrives, the current one must be overhauled and both engines should be refurbished. Only with two tugboats will the Port of Mukalla be able to serve incoming and leaving vessels at any given time.

Finally, the safety awareness of staff in both Ports is not to the high levels necessary. Training of staff in relation to personal and operational safety should be one of the priorities of port management. Supply of PPE and training facilities could help improve this situation.



ANNEX 1: AMOUNT OF IMPORTS INTO YEMENI PORTS (METRIC TONS)

Location	Product	2018 Total	2019 Total	2020 Total
Aden	Fuel	1,718,787	1,654,179	2,047,250
	Bulk Food	1,485,720	1,761,508	1,402,293
	Food in Containers	1,185,897	1,398,502	1,261,347
	Total Food	2,671,617	3,160,009	2,663,640
	Non-Food in Containers	1,449,430	1,709,280	1,541,646
	Non-food in Bulk	2,945,619	2,961,132	3,487,331
	Total Dry Non-Food	4,395,048	4,670,411	5,028,977
	Total Cargo	8,785,453	9,484,600	9,739,867
Mukalla	Fuel	662,921	663,672	1,066,424
	Bulk Food	22,300	54,103	58,486
	Food in Dhows	24,985	30,305	22,748
	Food in Containers	86,492	132,230	161,188
	Total Food	133,777	216,638	242,422
	Non-Food in Containers	105,713	161,615	197,007
	Non-food in Bulk	404,698	387,055	467,370
	General Cargo in Dhows	122,326	87,516	54,240
	Total Dry Non-Food	632,737	636,186	718,617
Total Cargo	1,466,798	1,516,496	2,027,463	
Salif	Fuel	0	0	0
	Bulk Food	1,404,275	1,714,523	1,541,485
	Food in Containers	0	0	0
	Total Food	1,404,275	1,714,523	1,541,485
	Non-Food in Containers	0	0	0
	Non-food in Bulk	47,000	32,963	43,999
	Total Dry Non-Food	47,000	32,963	43,999
Total Cargo	1,451,275	1,747,486	1,585,484	
Hodeidah	Fuel	1,648,734	2,153,188	1,704,232
	Bulk Food	2,147,363	2,544,265	2,765,035
	Food in Containers	11,834	82,210	119,368
	Total Food	2,159,197	2,626,475	2,884,403
	Non-Food in Containers	0	0	0
	Non-food in Bulk	4,229	4,602	4,809
	Total Dry Non-Food	4,229	4,602	4,809
	Total Cargo	3,812,160	4,784,265	4,593,444

ANNEX 2: 2019 IMPORTS PER YEMENI PORT (PERCENTAGE)

	2013	2014	2015	2016	2017	2018	2019
Salif Sea Port	12.40%	12.90%	29.50%	22.90%	17.90%	8.87%	8.63%
Hodeidah Sea Port	34.70%	35.90%	33.70%	39.00%	34.50%	23.30%	25.42%
Aden Sea Port	39.60%	38.40%	22.80%	30.20%	40.30%	53.70%	50.79%
Mukalla Sea Port	3.40%	3.80%	1.50%	0.00%	0.00%	7.26%	6.85%
Nishtun Sea Port	0.00%	0.00%	0.00%	0.00%	0.00%	0.62%	0.35%
Wadiya Land Port/KSA	1.30%	1.10%	5.00%	3.70%	3.80%	3.82%	4.78%
Shahen Land Port/Oman	1.20%	1.00%	3.40%	3.50%	2.70%	2.43%	3.17%
Totals	93%	93%	96%	99%	99%	100%	100%

ANNEX 3: 2020 CAPACITY OF ADEN PORT

Berths Numbers and Codes	Allowed Ship Draft (in meters)	Allowed Summer Deadweight (in metric tons)	Allowed Length of Ship (in meters)
Maalla Wharf Berths (MW)	MW1	10.40	36,000
	MW2	10.40	36,000
	MW3	10.40	36,000
	MW4	10.40	36,000
	MW5	6.10	18,000
	MW6	6.10	20,000
	RoRo	7.00	11,000
Stream or Bunkering Berths	1A	9.00	9,000
	1 IN	9.00	3,000
	4 IN	10.00	70,000
	4 OUT	9.00	39,000
	5 IN	9.50	35,000
	5 OUT	9.50	35,000
	8 IN	10.00	30,000
	8 OUT	10.00	27,000
	6 IN	11.00	71,000
	6 OUT	11.00	104,000
Aden Container Terminal (ACT)	7	11.00	70,000
	ACT 1	13.75	149,000
	ACT 2	13.75	149,000
Aden Gulf Terminal (AGT)	ACT plus	13.75	149,000
	AGT 1	12.60	103,000
Oil Harbour	AGT 2	10.80	49,000
	LA 1	12.25	85,000
	LA 2	10.25	65,000
	LA 3	10.25	65,000
	LA 4	14.50	110,000
	LA 5	10.40	15,000
	LA 6	10.40	15,000
RoRo	10.40	3,500	

Endnotes

- 1 Phase 4 classified as a “humanitarian emergency” whereby at least 20 per cent of household face extreme food consumption gaps, resulting in very high levels of acute malnutrition and excess mortality or households face and extreme loss of livelihood assets that will likely lead to food consumption gaps.
- 2 IPC acute Food Insecurity Analysis (October 2020–June 2021). Issued in December 2020.
- 3 ACAPS Yemen Analysis Hub 2020: Yemen Food Supply Chain
- 4 A charge payable to the owner of a chartered ship in respect of failure to load or discharge the ship within the time agreed.
- 5 ACAPS Yemen Analysis Hub 2020: Yemen Food Supply Chain
- 6 A short timber between a block bolted to the ground ways and a similar block on one of the bilge ways to hold a ship while the keelblocks and shores are removed before launching.
- 7 A dolphin is a man-made marine structure that extends above the water level and is not connected to shore. They are usually installed to provide a fixed structure when it would be impractical to extend the shore to provide a dry-access facility, for example, when the number of ships is greater than can be accommodated by the length of the berth/pier. Typical uses include extending a berth (a berthing dolphin) or providing a mooring point (a mooring dolphin).
- 8 Supervisory control and data acquisition (SCADA) is a control system architecture comprising computers, networked data communications and graphical user interfaces for high-level process supervisory management, while also comprising other peripheral devices like programmable logic controllers (PLC) and discrete proportional-integral-derivative (PID) controllers to interface with process plant or machinery. The use of SCADA has been considered also for management and operations of project-driven-process in construction.
- 9 Dhow is the generic name of traditional sailing vessels with one or more masts with settee or sometimes lateen sails that are used in the Red Sea and Indian Ocean region.
- 10 Gijt JG. De [2010] A History of Quay Walls PhD 2010 TUDelft
- 11 E.J. Broos et al. PIANC-World Congress Panama City, Panama 2018 paper “Bollard loads on new port infrastructure, Port of Rotterdam Authority Policy”
- 12 Tidal scour is sea-floor erosion caused by local high water velocity from main propellers or bow thrusters resulting in the removal of inshore sediments and formation of deep holes and channels.
- 13 Swiftly moving water can scoop out scour—or deep—holes in the bottom of the harbour bed.
- 14 <http://www.portofaden.net/en//news/show/501/Having-completed-its-repairs>
- 15 The International Code for the Security of Ships and Port Facilities (International Ship and Port Facility Security Code, ISPS Code) is an amendment to the Safety Of Life At Sea (SOLAS) Convention (1974/1988) which sets out the minimum requirements for the security of ships, port facilities and government institutions. For more information reference is made to http://www.imo.org/en/OurWork/Security/Guide_to_Maritime_Security/Pages/SOLAS-XI-2%20ISPS%20Code.aspx
- 16 Currently there is no list of required spare parts. The maintenance staff of the Port of Aden will have to compile a list of required spare parts and discuss the list with a port specialist before actual procurement value can be determined.
- 17 A detailed estimate can be made when the full extent of the damage to the quay is known. Taking full replacement into account, a minimum budget of US \$ 1.5 million is required.
- 18 The International Code for the Security of Ships and Port Facilities (International Ship and Port Facility Security Code, ISPS Code) is an amendment to the Safety Of Life At Sea (SOLAS) Convention (1974/1988) which sets out the minimum requirements for the security of ships, port facilities and government institutions. For more information reference is made to http://www.imo.org/en/OurWork/Security/Guide_to_Maritime_Security/Pages/SOLAS-XI-2%20ISPS%20Code.aspx
- 19 The assessment considered the masterplan to be drawn up combined with the masterplan for Aden. If done separately the presented estimated cost will be higher.
- 20 This is a very rough estimate. An expert on the subject is needed to draw up the terms of reference and determine the associated costs together with the port authority.
- 21 The Port of Mukalla has general plans to relocate the fishing port to another location. Detailed research will be required to determine a project plan with attached project costs. The mentioned costs and duration relate to such a research study.
- 22 ACAPS is a non-profit organisation that provides independent humanitarian analysis. The ACAPS Yemen Analysis Hub was set up to conduct integrated analysis in support of humanitarian and development actors working on the Yemen crisis. Their report on the “Food supply chain” can be found at: <https://www.acaps.org/country/yemen/special-reports>

