Introduction Container Terminals

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1 General

1.1 Introduction

A modern container terminal is an industrial enterprise where a variety of activities are taking place at the same time: Large machines travelling in all directions, lifting and moving containers and other cargo and vessels, trains and trucks arriving and departing, etcetera. At first glance this abundance of activities seems to be very chaotic. However, studying the movements for some time will show that there is logic in the movements and a number of controlled activities can be identified by making use of procedures.
The main purpose of the activities is to arrange for a change of modality for the container or cargo as quickly and efficiently as possible.
The container terminal has a central role in the (international) transport of cargo and containers, *the (international) transport chain*. The various shackles of the transport chain corresponding to the different steps of pre- or on-carriage are connected to the shackle main transport (sea transport) by the shackle container terminal. The transport chain will be created for a product that is sold by the seller to a buyer.
This topic aims to explain the various activities that can be identified on a container terminal.

1.2 Routing of the container

What happens to a consignment of cargo that is being sent from a manufacturer's or producer's premises in one country to a buyer's premises in another? The terms used in contracts to refer to these parties are *consignor* for the shipper or exporter and *consignee* for the importer or receiver of the goods.
The shipper, either by using a freight forwarder or doing this himself, arranges for a convenient sailing with a ship operator. The shipper books space on board of the vessel. Depending on the agreed delivery conditions (*INCO terms*) it may be the buyer who will have to arrange for the transport.
The ship operator will send a container to the shipper's premises. The shipper will arrange the goods to be packed in the container and returns the container by road, rail or inland waterway to the port of export. The container will be accompanied by the necessary documents. In the port of export the container will be temporarily stored on the container terminal until arrival of the ship on which the container will be loaded.
Upon completion of the cargo operations, the vessel will sail to the port of import.
In the port of import, the container will be discharged and temporarily stored on the container terminal until being on carried by inland waterway, rail or by road to the consignee's premises.
If there are sufficient goods to fill a container, the shipper will have a *full container load* or FCL, to be sent to the consignee. In case the goods will only fill part of the container, the goods can be consolidated with goods to other consignees. This will be an LCL shipment or *less than container load*.
The shipper may make use of an *inland clearance depot* (ICD) or *container freight station* (CFS) in case of only one small consignment being exported. This may also happen in case the infrastructure to or at the shippers premises does not allow handling or transporting a container. In these cases the shipper will arrange for the consignment to be

transported to the ICD or CFS, where the consignment is consolidated with other consignments from other shippers, until the container is filled.
The container terminal is not interested if a container is LCL or FCL: for the container terminal a container is a container; a box is a box. There is one exception, which is when the container terminal also has a CFS on its premises. This will be explained in this topic.
On the container terminal in the importing port the same will occur, however, the actions are mirrored to the exporting port.

1.3 Modalities

A *modality* is a mode of transport carrying cargo. On a container terminal we can identify five different modalities:

- Deep sea vessel
- Feeder
- Barge
- Train
- Truck

All these modes of transport are designed to carry the ISO standard containers of 20, 40 and 45 feet. Because the goods are kept packed in the easily-handled container for the whole of their journey, handling at each point of exchange between modes of transport is as simple, rapid and efficient as it could be. This will also reduce the risk of damage to the goods by the handling. Document handling too is kept to a minimum.
By packing the goods in a container, the goods are also protected against adverse weather conditions and pilferage. The container may even travel under customs seal to the consignee's premises before being inspected and opened by the customs. This will reduce the risk of delay.
An example of a modality which is not handled at a container terminal is a plane.

2 Transport routes

A container travels from A to B via a container terminal. Depending on the position of the container terminal in the route from A to B we can name a number of routes, which will identify the status of the container. This will be discussed in this chapter.

2.1 Transshipment

Not all cargo’s arriving at a container terminal will be destined for that port. If the port has a strategic location and has the equipment and the infrastructure to handle that cargo, it can serve as a hub for other countries that do have a port which does not have the necessary infrastructure or equipment.
A small port may not have the necessary water depth to accommodated large super post panamax container vessels (see chapter 3). In that case, containers destined for the smaller port may be discharged at a container terminal in a port located conveniently close to the smaller port. A smaller vessel or *feeder* vessel will arrange for on-carriage of the container to the smaller port: The container is *transshipped*.
For a container terminal it is important to know if a container is transshipment cargo as this is decisive for arranging a temporary stack-position. Because the container will leave the container terminal via the water-side, a position in the stack, close to the water-side needs to be arranged.

2.2 Import

*Impor*t containers are containers that are stuffed with cargo originating from another country with destination the country in which the container terminal is located. Import containers are being delivered by deep sea vessels or feeders and on-carried by road, rail or barge.
The temporary stack position allocated to import containers will be to the land-side of the stacking area. In some cases there is an exception to this rule: If barges are handled at the deepsea terminal, transit containers for connection to barges will be seen as transshipment containers.
As the terminal can also bee seen as the gate to the country, import containers are also called *inbound.*

2.3 Export

Export containers are containers that are stuffed with cargo originating from the country in which the container terminal is located. Export containers can be delivered by road, by rail and by barge, and will be loaded on feeder vessels or deep sea vessels.
The temporary stack position allocated to export containers will be to the water-side of the stacking area.
As the terminal can also bee seen as the gate to the country, export containers are also called *outbound*.

2.4 Transit

Containers in *transit* do not have the country of the port as final destination, but will have to travel inland by barge, rail or road, passing one or more borders.
It is not very important for the container terminal to know if a container is in transit. Transit containers are treated in the same way as import containers. In some cases there is

an exception to this rule: If barges are handled at the deepsea terminal, transit containers for connection to barges will be seen as transshipment containers.

2.5 Cargo-flows

For a container terminal it is important to know if a container is transshipment, inbound or outbound. The other status indications are not important. Table 1 below indicates the cargo-flows that are important to a container terminal.

Table 1. Cargo flows.

Out / to:▶ **In / from:▼**	**Deepsea**	**Feeder**	**Barge**	**Rail**	**Road**
Deepsea	Tranship	Tranship	Inbound or Import	Inbound or Import	Inbound or Import
Feeder	Tranship	Tranship	Inbound or Import	Inbound or Import	Inbound or Import
Barge	Outbound or Export	Outbound or Export	Tranship	Tranship	Tranship
Rail	Outbound or Export	Outbound or Export	Tranship	Tranship	Tranship
Road	Outbound or Export	Outbound or Export	Tranship	Tranship	Tranship

3 Activities

3.1 General

The container terminal has a central position in the transport route followed by the container. It connects the modalities, deepsea to road, rail or inland waterway and via ICD or CFS to the buyer's premises. All the transport routes merge in the container terminal. The container terminal also has an impact on the speed and efficiency of the transport. This results in the services that the container terminal offers to its customers. This chapter aims to describe the various services the container terminal can offer and which activities make up a service. The container terminal will bill it's customers for each service rendered.

3.2 Services

There are three main services provided by the container terminal:

- Container arrival
  Containers arrive by road, rail and inland waterway, as well as from feeder and deep-sea. There are a number of activities involved in this service, which are described in this chapter.
- Container storage
  Following the arrival of the container at the container terminal, the container will be temporarily stored until it leaves the container terminal again. A number of activities can take place, including the CFS and empty depot activities. These will also be described in this chapter.
- Container departure
  Containers leave the container terminal by road, rail and inland waterway, as well as from feeder and deep-sea. There are a number of activities involved in this service which are described in this chapter.

Whether containers arrive for import or export does not really matter when the activities are considered, be it that activities are opposite and the container flow is mirrored.

3.3 Ship operation

The ship operation consists of movement of containers from the ship to the quay and vice versa.
For the inbound container the ship operation starts with the crane operator positioning the spreader of the crane on top of the container. The spreader will be locked to the container and the crane operator can lift the container and move this to the quay, where it is landed on the ground or on the chassis which will arrange transport to the stack. Once landed, the crane operator will unlock the spreader, hoist the empty spreader and move back to the vessel to pick up the next container. This completes one *discharge cycle* of the crane.
For the outbound container the operation consists of attachment of the spreader to the container as it stands on the quay (either on the ground or on a chassis). The crane operator will lift the container and move to the vessel. When the container is over its stowage position, the crane operator will land the container in its assigned stowage position, after which the crane operator will move the spreader back to the quay to load the next container and complete the *load cyc*le.

3.4 Quay transfer operation

The quay transfer operation consists of movement of the containers from the quay to the stack area and vice versa.
Inbound containers will be moved from the quay to the landside section of the stacking area. This includes lifting the container by the transfer equipment from the quay surface beneath the crane, or by the crane landing the container directly on a chassis. The transfer equipment then follows a prescribed route to the stack area dictated by the system. The transfer equipment stacks the container in the storage position or stops at an interchange position to allow the stacking equipment to lift the container from the chassis and deliver it to its storage position.
For outbound containers the movement is mirrored, with the exception that outbound containers have a preferred storage position on the waterside of the stacking area. Also the route followed by the equipment that arranges the transfer differs from the inbound route. Storing inbound containers on the landside and outbound containers on the waterside of the stack will prevent traffic congestions of public road traffic with terminal traffic and reduces the risk of accidents.

3.5 Container yard operation

Two different operations can be identified in the container yard or stacking area: the moving of containers within the stacking area and the movement of containers to and from CFS for stuffing- and stripping activities.
When there is dedicated equipment for the stack, to only lift containers to and from the quay transfer equipment, the stacking and un-stacking activities are part of the container yard operations. In case the quay transfer equipment directly enters the stacking area to also lift containers from and into the stacking area, these movements are part of the quay transfer operation.
Stacking area activities are also the movement of containers from one stack position to another stack position to reach a target container that is to be moved to the quay or gate.
Another activity in stack operation is the movement of containers from to stack to the CFS for unpacking or stripping activities after which the (empty) container is returned to the designated empty container storage area. Alternatively, the activities involved with moving of an empty container to the CFS for stuffing and subsequent return of the full container to the stacking.
By order of the custom authorities and by request of the customer, the container may be moved to an inspection area, and subsequent return to the stack. Occasional movements may also be requested for damaged containers which need repair, and their subsequent return to the stack.

3.6 Container receipt and delivery operation

The activities involving the delivery and receipt operation are depending on the modality taking receipt of the container or delivering the container. When the modality is a barge and the barge operation is the deep sea quay, the operation will be the same as it is for the deep sea vessels and feeders.
When the modality is a train, the container is lifted from the stack and is positioned on the transport to the rail terminal. If the equipment arranging the quay transfer operation

directly enters the stack, the equipment may deliver the container directly at the rail terminal.
On some terminals, the public trucks may enter the terminal to travel alongside the stack to receive a container from the stack operating equipment. Some terminals have an interchange area, where containers are delivered to a truck. The truck, having received the container, will then move to the gate area. In the gate area the container is inspected, the seal number is verified and the documentation is checked.
There are equivalent activities for containers being delivered to the terminal by road, rail or inland shipping transport.

3.7 Non-core activities

The core activities of the container terminal are described above. There are also activities that a container terminal can offer to its customers that are not directly related to the transfer of a container from one modality to the next modality. These are called the non-core activities. The container terminal will bill its customers for these non-core activities.
Non-core activities can be related to a CFS being located on the terminal, and empty depot or activities related to the temporary management of the containers by the terminal.
CFS activities are related to the stuffing and stripping (the packing and un-packing) of the container and the acceptance and delivery of loose LCL cargo.
Empty depot activities are related to the storage, maintenance and repair of empty containers.
Activities related to the temporary management of the containers by the terminal are for instance the (dis)connecting of reefer containers, the monitoring of their temperature and possible repair of the reefer machines. Others can be labeling containers with IMO labels, weighing the containers, bundling of flats, fumigation, storage of containers or inspections of containers and their content.

4 Design

4.1 Introduction

The various activities described in chapter 4 occur simultaneously. Therefore, these activities must be structured and regulated. This requires a logic design and layout of the terminal, which must be considered when designing the terminal. Without this structure, regulation and logic, the operations will turn into chaos and disorder, resulting in mistakes and accidents.

4.2 General design

In general, a container terminal will have a few specific features where the activities as described in chapter 4 will occur. These features are quay side where vessels berth and the vessel operation is being executed. The quay transfer brings the second feature: the stacking area, temporarily storing the containers. The third feature, the gate area, for the acceptance and delivery of containers by land-transport.
Other (optional) features may be: a rail terminal, or railhead, a Container Freight Station (CFS), an empty depot for storage and repairs of empty containers. Offices and a maintenance and repair shop will complete the general layout and design.

4.3 Quay area

The most essential facility of a container terminal is the quay: The quay allows vessels to come alongside for discharge and loading of containers. The length of the quay and the water depth alongside must be large enough to allow the vessel to come alongside. As a rule of thumb, the quay must have a minimum length of 300 meter to accommodate a deep sea vessel, 500-600 meter for a two berth terminal and 750-900 meter for a three berth terminal. Some terminals will also have a ramp to accommodate the quarter ramp of a ro-ro vessel, to allow terminal equipment to drive into a ro-ro vessel via the ramp.
The width of the quay must be enough to accommodate the large quay cranes or Ship To Shore (STS) cranes. The quay cranes move parallel to the quay on rails. Typical rail-span is 30 meter or 100 feet. Mostly, the containers are being picked-up from and loaded on the quay transfer equipment between these rails, while the vessel's hatch covers are landed ashore behind the quay cranes. Depending on the size of the cranes, the width of the quay will be up to 75 meter or approximately 10% of the total terminal area.

4.4 Stacking area

Behind the quay area an extensive storage area is located, called *the stacking area, stack* or *container yard*. This area is primarily used to stack containers that await their next mode of transport. The layout of the stack is depending on which system is used to operate the stacking area. If all containers are stored on a chassis, the capacity of the stack is small, while a rail mounted stacking crane operated stack can accommodated a lot more containers. The speed at which the stacking area can absorb and spit out containers is decisive in the production of the terminal.

The stacking area uses up to 70% of the terminal space. Some dedicated areas can accommodate containers that require special attention or do not fit in a regular stacking position like:

- Reefer containers
  Live, or working, reefer containers require a power connection to ensure that the reefer unit can function. The reefer units also require monitoring and sometime repairs, which do not allow 3-high (or even higher) stacking.
- Empty containers
  Empty containers mostly have their own stacking area, close to a workshop where the containers can be repaired.
- Special containers
  Special containers like Out Of Gauge (OOG) boxes mostly do not fit in the stack due to the cargo dimensions being larger that the standard container dimensions. Also tanks may not be permitted in the standard stacking area due to the absence of a bottom-, top- or side-rail.
- Hazardous cargo
  Containers containing hazardous materials may not be permitted in the normal stacking area. Therefore, a separate area must be allocated to accommodate these containers.
- Transfer area
  In case public road trucks are not allowed to enter the stacking area, a special transfer area is created where the equipment operating the stack can transfer the containers to the public road trucks.

The stacking areas are well marked with painted lines and numbers on the tarmac. Sometimes signs are also used to indicate the location in the stack. For a reasonably large terminal, the stacking area may well accommodate over 100.000 TEU. All these containers must be tracked and traced:

- Each container is stored in the correct position
- The storage location of the containers can be communicated
- The new position of an overstowing container is communicated
- The containers are quickly and accurately located
- The stack density is known

To track and trace all containers in the stacking area's, each cell position is numbered with a unique code. The stack is divided in blocks, each block in a number of rows, lines and tiers.

4.5 Gate area

Movement of containers into and out of the terminal is controlled at the gate facility, where documentation, security and inspection activities are attended to. Typical for a gate area are the many lanes separated by curbs and cabins covered by a canopy, and the large parking area for trucks. The cabins are the workstations for the clerks and inspectors. The canopy serves as protection from the environment when inspecting containers that pass the gate. Often, the custom officers have their own office in the gate area. Other facilities located in the gate area may be a weighing bridge and raised walkways to allow for inspection of the roof of containers.

The size of the gate area can be up to 20% of the total terminal area.

4.6 Rail terminal area

Some terminals that have a connection to a rail network, can have a rail terminal or rail head. Depending on the size of the terminal or the number of tracks, dedicated equipment can be allocated to the rail terminal to facilitate the respective activities. Special rail terminal equipment can be a rail crane or a reach stacker.

4.7 CFS area

In those terminals where a large proportion of cargo is delivered as separate consignments, or is collected as separate consignments, often a CFS is located within the premises of the container terminal. It is here that LCL containers are stripped, or several consignments stuffed into one outbound container before they are moved to the stacking area, awaiting shipment.
The CFS consists of a large shed to safely store the different consignments and large open areas for storage of large loads. Not all container terminals have a CFS.

4.8 Customs or bonded area

Mostly, the customs have a separate area where they can inspect contents of containers. This area can also be used for inspection or de-gassing. In some countries there are strict regulations controlling imports of foodstuffs and other natural products. This special area allows examination and tests to be carried out.

4.9 Offices and workshops

Where people work, offices must be located for the white collar staff, but also to accommodate facilities for the blue collar staff and truck drivers. A control tower is often included in the office building.
A separate building houses the maintenance and repair facilities.
Other facilities are the fencing surrounding the whole terminal with manned access points. Customers and other third parties supplying services to the terminal may require offices. Lightning will allow work at night time.

4.10 Dependencies

All the activities taking place at the various areas are very much depending on each other. A disruption of the activities in one area will have a knock-on effect on the other area. Delays in receipt or delivery of containers will result in traffic queues on the public road, resulting in delays to containers arriving on the terminal, possibly even missing their connection to the vessel, etcetera.
A shortage of stacking equipment may result in a slowing down of the discharge operation of a vessel, resulting in a delay to the schedule of the vessel. A shortage of equipment for quay transport will have the same effect.
All activities combined form a chain. An activity in one of the shackles of the chain will affect the next shackle in that chain.

5 Equipment

5.1 General

The performance and efficiency of a container terminal is depending on the handling equipment. The presence of large and fast moving equipment is a characteristic feature of a container terminal. This chapter describes the main features of the most commonly seen equipment.

5.2 Quay crane

The most distinctive feature of a container terminal is the quayside gantry crane. This crane is also known as *quay crane* or *ship to shore crane*. Due to the development of the size of the container vessels, from first generation to super post panamax, the design of the quay cranes had to follow, to allow the cranes to reach the containers stowed on the most outward positions on the super post panamax vessels. All cranes however are basically the same.

The quay crane is mounted on rails. The rail span can differ. Small cranes can have a small rail-span, maintaining stability and strength requirements, while saving on materials. A large crane will have a bigger rail-span to ensure the minimum stability and strength requirements. Most common is a rail span of 100 feet or 30 meters.

The frame of the crane is a box girder construction in which a boom is attached. The boom can hinge to allow topping up, which is required when the crane travels under its own power over the quay, or when the vessel is arriving or departing. When the crane is in the correct position next to the vessel, facing the bay it must discharge or load, the boom will be lowered. The operator’s cabin with the spreader can travel over the boom to reach the most outward placed containers on the vessel and deliver these on the quay to the waiting transport. The space under the back reach is usually used to store the hatch covers of a vessel. The height of the portal beam must be enough to allow the quay transport to move under the crane to deliver the containers to the crane. The lifting height, like the outreach, will depend on the size of the crane. For super-post-panamax cranes the outreach can be 67 meter with a lifting height of 43 meter. A panamax crane will have a lifting height of 35 meter and an outreach of 37 meter. The lifting capacity varies from 40 tons to 100.

The speed at which the quay crane operates, determines the vessel’s handling rate and can be a decisive factor in the production of the container terminal. The production of the container terminal is also depending on the productivity of the other activities on the container terminal. All activities combined form a chain of shackles. An activity in one of the shackles of the chain will have a knock-on effect on the other shackles in that chain. Productivity of a quay crane can be from 20 up to over 50 containers per hour, with an annual production of 100,000 to 125,000 containers. The crane productivity will depend for a large extend on the vessels layout and stowage of the containers on board of the vessel.

5.3 Terminal truck and terminal chassis

The terminal truck and chassis combination is the most common equipment for quay transfer. Each set consist of a truck and trailer.

Normally the truck will not be suitable for public road as it is adapted for work on a terminal. The cabin will have special features to allow the operator to execute the instructions received and report back the executed instructions. Also, the engine of the truck will be adapted: a gearbox will be installed that allows frequent gear changes, while the speed of the truck will be maximized at 30 kph. Furthermore, the fifth wheel lifts higher than a public road truck.
The terminal chassis is a trailer, mostly not suitable for the public road, due to absence of lights and breaks. It is a sturdy frame with strong guiding plates on the sides that not only hold the container in place, but also guides the container in it's position when it is landed on the chassis by other equipment like the quay crane.
The chassis can lift one 40 foot container or two 20 foot containers and has a capacity of 40 – 70 tons.
The number of terminal truck and chassis combinations required for a normal operation will largely depend on the driving distance. Generally 4-6 combinations will ensure a that the quay crane can have a continuous and uninterrupted operation.

5.4 Straddle carrier

A *straddle carrier* is a tall, self-propelled wheeled frame that can straddle over a container. The operator can lift a container from the ground or chassis by attaching a spreader to the top of the container and drive the container to its next position.
It is at least tall enough to lift a container over another container. In some cases it is tall enough to lift a container over three high containers, a *1-over-3 straddle carrier*.
When a straddle carrier is used to operate the stacking area, the containers are often stacked perpendicular to the quay. This allows easy access of the straddle carrier when it picks up containers from the quay to deliver to the stack.
Straddle carriers are used for horizontal transport, from quay to stack vice versa, for delivery and acceptance of containers from stack to public road chassis, and for stack operations.
The number of straddle carriers required to ensure an uninterrupted operation of the quay crane depends again on the travel distance. As a rule of thumb 3 straddle carriers per quay crane is acceptable.

5.5 Rubber tired gantry crane

A *Rubber Tired Gantry crane* (RTG) is an equipment type like a straddle carrier, only straddling more than one container. The standard type is straddling 6 rows of containers and a roadway. The roadway is used to service the terminal truck and terminal chassis and the road truck and chassis combination. The RTG can lift and stack containers to a height of 6 and even 8 containers.
The operator can attach a spreader to a container lift it and position the container to its next position. Even though the RTG can travel horizontally, the rubber tires are only used to position the RTG in the stack over the correct container. The RTG can also move from one block in the stack to the next. The truck/chassis combination will position itself on the roadway next to the position of the container. In a stack operated by RTG's, the containers are stacked parallel to the quay.
The RTG is an equipment type only used in the stack. A productivity of 15 containers per hour or 70,000 – 80,000 container per year can be expected.

5.6 Rail mounted gantry crane

A Rail Mounted Gantry crane (RMG) is even larger that the RTG. It can straddle even up to 20 rows of containers between it's legs and stack them up to 1-over 5 and sometimes even higher. The operator of the RMG can move the RMG on steel wheels over a set of rails that run over the length of the stacking area. The activities of the RMG are restricted to the stacking area, even to its block within the stacking area: The RMG cannot move freely from the one block or lane to the other.
RMG's are very suitable to be automated, in which case the containers are stacked perpendicular to the quay.
RMG are also used for handling trains in a rail terminal or railhead. Also inland river terminals have RMG's, which will straddle over the complete terminal.
The RMG has a productivity of approximately 25 containers per hour or 100,000 per year.

5.7 Reach stacker or top-lifter

Reach stackers and top- or side-lifters are commonly used as auxiliary equipment on many container terminals.
A reach stacker is a tractor like vehicle with and extending boom that can reach containers over an obstacle, with a lifting capacity of up to 45 tons.
Top- or side-lifters are forklift type machines that either pick up a container using a spreader on the top of the container, or using hooks to the side of the container. They are often used for handling of empty containers.
They will operate the (smaller) rail terminals, the CFS and empty depot and for handling special containers. On smaller terminals they can also be used for quay transfer and to operate the stacking area.

6 Operating systems

6.1 General

In the previous chapter the functions of the main types of equipment have been discussed. The combination a container terminal uses for quay (horizontal) transport and equipment used to operate the stack is called *the operating system*. Some operating systems are pure in form and there are a number of combinations making use of the different types of equipment. These will be described in this chapter.
All operating systems will also include the quay crane.

6.2 Chassis system

The *chassis system* is a pure system. Only a few container terminals operate a pure chassis system. Inbound containers are discharged directly on a public road chassis and moved to a storage area by a terminal truck. The truck will disconnect the chassis and connect to another empty chassis to return to the quay for the next container.
The container, together with the chassis, will remain in the stacking area until it is being picked up by a road truck to be delivered to its final destination.
Of course, containers cannot be stacked, so a lot of surface area is required to allow for sufficient parking space to stack all the containers and their chassis. This allows for sufficient space for the trucks to maneuver themselves and the chassis in a correct position.

6.3 Lift truck system

The *lift truck system* is also a pure system, which is operated effectively in smaller container terminals like inland waterway. The truck (lift truck or reach stacker) lifts, transfers and stacks containers at all stages of the terminal operation at the quay, the stacking area and the gate area. Due to the required maneuvering space to position the containers in the stack, much space is required for the stacking area. Maneuvering space combined with the longer travel distances makes this system not suitable for the larger container terminals.

6.4 Straddle carrier system

The last pure system is the *straddle carrier direct system*. In this system, straddle carriers move containers from the quay into the stack, stack and unstuck in the stacking area and are responsible for collection and delivery at the gate area. This is a flexible system; however, due to the fact that each ground slot takes up more space than the ground surface of a container, this system is space consuming. On larger container terminals travel distances will also be longer for the straddle carrier.

6.5 Straddle carrier relay system

The *straddle carrier relay system* is a combination system where terminal truck/chassis move the containers from the quay to the stacking area, while straddle carriers pick up the containers from the chassis at the interchange points and position the containers in the stack. The straddle carriers also service the delivery and receipt of the containers in the gate area at a dedicated interchange area.

This is a very flexible and fast system, however, due to the fact that each ground slot takes up more space than the ground surface of a container, this system is space consuming and the maximum height is 3 high.

6.6 Yard gantry system

Another combination system is the *yard gantry system*. This system is seen all over the world. Both RTG and RMG are confined to the stacking area, where the connection to the quay is by terminal truck and chassis combinations. These drive along truck lanes or roadway alongside the stacking blocks. The roadway is in fact a long interchange area. The truck will stop under the gantry, which will lift or land a container on or from the chassis.

Public road trucks are allowed into the roadway to the appropriate row for delivery and receipt of containers.

Both RTG and RMG can be used at railheads or rail terminals.

As the RMG is very accurate in positioning the containers, the containers can be stacked in a denser pattern than compared to the RTG. Containers can be stacked up to 8 containers high.

The yard gantry system is a fast system that does not require much space. A disadvantage is however the high wheel loads which require additional infrastructure, especially the RMG.

6.7 Automated systems

Due to ever increasing cost of labor, more and more container terminals are automating (part) of their operations. We can see the following developments:

1. Automated stacking cranes.
   A number of container terminals have an automated stack. RMG's operate the stack and the Terminal Operating System will direct the RMG to pick up a container from the stack and arrange for delivery on a transfer point on the land side or on the water side of the stack. There the container will be picked up by either public road truck or by the quay transport.
2. Automated quay transport.
   Mostly in combination with an automated stack, there will be automated quay transport by an Automated Guided Vehicle. The AGV is a self-propelled chassis that can navigate over a restricted area and find it's way from the various transfer points in the stack to the quay cranes. They are being routed by the TOS and position themselves under the quay crane to deliver a container to the quay crane or receive one.

A system using both automated stack and transport is not very flexible; however a very stable and constant production can be achieved.

In the table 2 an overview is given including the estimated stacking area required for each system.

Operating system	Transport quay – stack	Stack	Stack delivery landside *	m^2 per TEU
Chassis system	Terminal Truck	On chassis	Road truck	45 m^2
Lift truck system	Fork Lift truck Reach Stacker	Fork Lift truck Reach Stacker	Fork Lift truck Reach Stacker	FLT: 25 m^2 RS: 15 m^2
Straddle carrier system	Straddle Carrier	Straddle Carrier	Straddle Carrier	16 m^2
Straddle carrier relay system	Terminal Truck and Chassis	Straddle Carrier	Straddle Carrier	16 m^2
Yard gantry system	Terminal Truck and Chassis	RTG RMG	Road truck	RTG: 12 m^2 RMG: 8 m^2
Automated system	AGV or Automated SC	Automated RMG	Automated RMG	8 m^2
* Stack delivery landside	If indicated Road truck, a public road truck will enter the stack area to deliver or receive the container directly from the equipment operating the stack. If indicated otherwise, the public road truck will deliver or receive a container from the mentioned stack operating equipment at a dedicated interchange area.			

Table 2: Overview of the various operational systems.

7 Terminal capacity

Having discussed the various services offered by the container terminal to it's customers, the equipment used and the operational systems available, the size of the terminal area needs to be calculated given an expected volume of containers. Alternatively: what would be the volume of containers that a container terminal can manage given the size of the terminal area?
This chapter will explain the various criteria that influence the terminal area.

7.1 TEU factor

The volume of containers that can be managed by the container terminal will clearly depend on the available area of the terminal. The volume of containers is expressed in TEU.
One TEU is a standard container size that is equal to one 20ft container. So one 40ft container equals to 2 TEU. The ratio between the volume and the number of containers is called the TEU factor:

TEU factor * number of containers = volume in TEU

Volume in TEU – number of containers = number of 40ft containers

The TEU factor is depending on the trade. Trade from South America will contain large numbers of 20ft containers, resulting in a low TEU factor of 1.2. Far East and North American trade will have a higher TEU factor of 1.6 or 1.8 due to a larger volume of 40ft containers.
The customers of the terminal can advise a forecasted volume of containers.

7.2 Resources

Resources are defined as equipment, space, or staff. Obviously these should be sufficient for a proper management of the available containers.
Equipment must be of sufficient technical design to allow the expected volumes to be handled. Speed and weight capacity of the cranes must be high enough, while sufficient trucks need to be made available to ensure a steady flow of containers to and from the quay crane. The equipment operating in the stack must be sufficient and fast enough to accept or receive such flows.
At the same time the quay must be long enough to accept the expected vessels, while the stacking area must be large enough for the expected containers.
The quay will not be occupied 100%. Time will be lost for moving vessels to and from the quay. The various sailing schedules of the vessels will not be aligned with each other. All in all, a quay occupancy of 60% is seen as the maximum possible.
The capacity of the stacking area will depend on the equipment which is selected to operate the stack. Each type of equipment has its own stack density expressed in TEU per m^2.
Enough equipment should be available to ensure an uninterrupted flow of containers between quay and stack, while at the same time the land-side stack operations, acceptance and delivery of containers, continue.

To operate the equipment and manage the processes on the terminal, sufficient staff must be available to ensure a safe and smooth operation.
It will be up to the management of the terminal, and the shareholders, to decide if the terminal must have sufficient resources available to allow 100% service during all times, inclusive the peak operations. This will come at a cost as additional investments are required for equipment to ensure the service levels during the peaks. Mostly investments will be made to allow a service level of 95%.

7.3 Other criteria

Other criteria that influence the capacity of the stack area are:

1. Dwell time.
   The dwell time is the average period that a container remains in the stack area between acceptance and loading for export containers, between discharge and delivery for import containers or between discharge and loading for transshipment containers.
   The dwell time for export containers is 3 to 5 days. For import containers the dwell time tends to be longer: 6 to 9 days, while empty containers, if stored in the stack, can have a dwell time of over 20 days.
2. Peak factor.
   The volumes advised by the customers of the terminal will not be a regular flow. These will arrive with peaks and troughs. The higher the amplitude of a peak, the higher the peak factor. Normal peak factors used in calculations are approximately 1.2 to 1.3.

7.4 Calculation example

Using an assumed volume and indicators, a calculation can be made of the terminal area required.
Assumptions:
350,000 containers per year
TEU factor 1.4
Dwell time 8 days
RTG equipment for the stack
Maximum yard occupancy is 70%
Peak factor 1.2
Stack area is 65% of terminal area

350,000 containers * 1,4 = 490,000 TEU (140,000*40ft and 210,000*20ft)
Dwell time of 8 days results in (490,000 * 8)/365 = 10,740 TEU in stock per day.
Consider 12m²/TEU for RTG, this will require gross (10,740 * 12) = 128,877 m²
With maximum 70% occupancy (128,877 / 0.7) = 184,110 m²
Considering the peak factor of 1.2 a nett storage capacity of (184,110 * 1.2) = 220,932m²
Storage area is 65% of terminal area, the terminal area required for this volume considering the mentioned criteria is (220,932 / 0.65) = 339,895m² or 34 hectares.

Alternatively it can be calculated how many containers can be managed per year on an area of 34 hectares considering the above mentioned criteria.

8 ICT

8.1 General

A small container terminal perhaps can still run it's day to day operation by using a card and plan board system. However, when the throughput increases, this system will not suffice to keep track of all containers on the terminal. This is where a *Terminal Operating System* (TOS) offers a solution. A number of suppliers offer a TOS off-the-shelve. However, most TOS systems will have to be adapted to present the actual layout of the container terminal.

8.2 Track

The core of each TOS is the central database, which stores and maintains the correct position of each container and the activities for those containers ordered by the customers of the container terminal. For each activity other containers may need to be moved to a new position in the stack. It is of utmost importance that these new positions for these containers are adjusted in the TOS. This allows for proper track and trace of all containers on the terminal.
To operate the terminal there are a number of modules that are plugged into the database:

- Operating module
- Planning module
- Management module

8.3 Operating module

The operating module allows for entry of the various orders of the customers to be uploaded into the database. This can be by EDI or Web application, but also by manual input. Another functionality is the operating system, responsible for the scheduling process. This also allows the monitoring and control of the operation.

8.4 Planning module

The planning module allows the various plans to be created, like the berth planning, the stack planning, the rail planning and the vessel planning. In this module, the resources and the objects are planned.
Resources are: space, equipment and people.
Objects are: vessel, feeder, barge, train and truck.

8.5 Management module

The management module allows the billing information which is used by the finance department to create the invoices through the ERP system in use at the container terminal. This module also allows management to create reports for study of statistics and analysis.

9 Organisation

9.1 General

The organization of a container terminal looks like many other organizations. In the case of a container terminal the operations department, the department covering the core business, is the most important department. The other departments are there to support the operations department. Figure 2 shows an example of what an organization of a container terminal could look like.

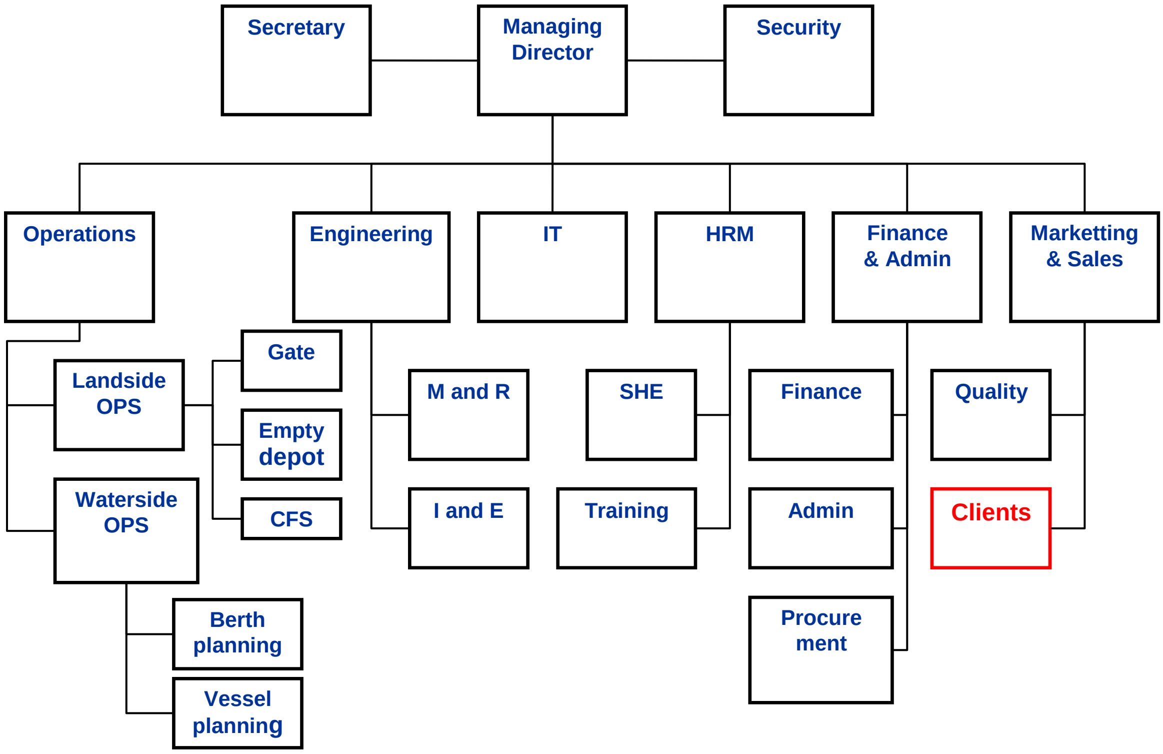

Figure 2: Example of container terminal organization

Following are the departments that can be identified in a typical organization of a container terminal:

- Operations
- Engineering
- ICT
- HRM
- Finance & Administration
- Marketing & Sales

9.2 Operations department

The operations department is responsible for the core business as it is directly concerned with the handling of the containers. Often, the operations department is split into a number of sub-departments as indicated in the organization structure. The main responsibilities of these sub-departments are:

- Providing the necessary resources to plan and execute the quay, stack, gate, CFS and empty depot operations. Often this is a 24/7 operation. Resources are equipment, space and staff.
- Completion of the documentation, *the order process*.
- Planning the resources and objects. Objects are vessels, deep sea as well as feeders, barges, trains and trucks. This is *the planning process.*
- Managing the operations.

9.3 Engineering department

The main responsibility of the engineering department is maintenance and repair to ensure that all equipment and infrastructures are available when they are required and in good and safe condition. To properly support the operations department, these main responsibilities must be available 24/7 as is the case with the operations department.
The responsibility of the innovation and engineering department is maintenance engineering and improvement projects: How can the equipment be improved to arrange for a faster container handling or reduce the down time?
The Engineering department will have close contact with the operations department to ensure that maintenance is performed in time, to ensure that equipment can be operated safely.

9.4 ICT department

The ICT department is responsible for all information and communications technology soft- and hard ware. They will not only be responsible for TOS, but also for ERP, EDI and their maintenance, as well as the required hardware. The ICT department is also responsible for the communications soft- and hardware, like phones and radio communication.

9.5 HRM department

The HRM department main responsibilities are:

- Personnel organization
- Collective labor agreement
- Social legislation
- Representation
- Information

These main responsibilities include recruitment, training and appraisal of staff, negotiations with trade unions regarding the collective labor agreements and administration and information, like the salary payments.
Another task of the HRM department can be safety, health and environment. Safety, Health and environment can also be a separate department, reporting directly to the senior management of the terminal.

9.6 Finance & administration department

The main responsibilities of the finance and administration department are billing the customers for the services rendered and their financial control. The other major task is the presentation and control of the financial status of the container terminal. Often, the treasury and procurement departments report to finance.

9.7 Marketing & sales department

The marketing and sales department is the department that has the contacts with the customers of the container terminal. The marketing and sales department negotiates the service contracts with the customers.
Sometimes the quality department reports to the marketing department because of the effects quality improvement can have on the relation with the customers.

9.8 Security department

The security department, sometimes included with safety, is often a stand-alone department reporting directly to the managing director. This is because all staff and all equipment and infrastructures will have to abide by safety and security regulations. Both have an ever increasing importance: Security because of the international threat of terrorism, Safety because of the ever increasing awareness on safety, not only of the terminals, but also of the customers on the container terminal. Customers do not wish to be associated with a company that has a negative name and reputation relating to safety.

10 Finance

10.1 Introduction

An important department of a terminal organization is the finance and marketing section. It is the finance department that will create the invoice for the activities performed for the customers by orders received from these customers. These invoices reflect the rates for the activities as agreed between the customers and the marketing department of the terminal. These rates are confirmed in the contract the customer has with the terminal. This chapter will explain how the rates can be calculated.

10.2 Costs

To allow for financial survival of the terminal, the expenses of the terminal, or its costs, need to be made good by the income of the terminal, or revenues of the terminal. Revenues are generated by the payments made by the customers of the terminal, based on the invoices and the underlying contracts.
The costs are generated by a variety factors. These can be the cost of the equipment used for the handling of the containers, the power consumption, the cost of labor or the cost of the offices and terminal area.
Costs can be fixed or variable, which depends on the dependency of the production: Fixed costs are for instance the cost of the crane, while its power consumption is a variable cost.
Costs can also be identified as direct or indirect. Direct costs are for instance the costs involved with lashing labor, while the costs for the office are indirect.

	Direct	**Indirect**
Variable	Lashing labor	Power
Fixed	Crane	Office

Table 1: Overview of costs

There are a number of methods how to calculate the costs per container move:

- Direct costing
- Absorption costing
- Activity based costing
- Cost center

These methods will not be discussed in this chapter as this is typical material for a finance for managers study. Included in this chapter is a (non-scientific) calculation to give an idea of the various aspects which have to be considered for such calculations leading to a cost price per container move.

10.3 Terminal staff

An important cost factor is the cost of staff. We can identify operational staff, directly involved with the discharge and loading of containers, the blue collar staff, and the supporting staff and management or white collar staff. Some services, e.g. lashing, may be outsourced.

The cost of staff is depending of a few factors:

- The standard of living.
  The salaries of labor in European and North American countries differ greatly from those in Africa and Asia.
- The type of the organization.
  Organizations of similar terminals can differ in size depending on the local culture. Where all organizations have a pyramid structure, the organization can be steep or flat: additional management layers will cause the organization to be steeper. English companies tend to have more layers in their organization than the Dutch organizations. More layers means more staff which leads to higher costs.
- Operational system.
  As the one operational system will require more staff that the other, the selection of the operational system will directly influence the cost of labor for the terminal. A straddle carrier direct system will require less operational staff than a yard gantry system using terminal truck and chassis combinations for quay transport.
- Availability of competition.
  If an area can only be served by one port or terminal, the unions representing the labor in the negotiations regarding their salaries may demand higher increases. More terminals in that area will increase the competition resulting also in increased cost awareness.

Assuming that lashing is being outsourced, the cost of the lashing staff is directly involved with the production of the terminal and is therefore direct and variable. The costs of the other staff are however fixed.
The cost of operational staff can be directly linked with the production of the terminal. The cost of the finance and marketing departments and procurement and HRM departments however are more difficult to calculate. Often these costs will be included in the overhead costs. Using the annual production of the terminal, these costs can also be calculated per container.

10.4 Terminal equipment

The cost of the equipment is a bit more difficult to determine. A large piece of equipment, like a quay crane, will be paid for when it is delivered. A quay crane has a life expectancy of a number of years. Therefore the expenses made by the terminal for the purchase of the crane will be written off over this economic life expectancy. The resulting annual expenses can be seen as the annual costs involved with the purchase of the crane. The technical department will, in consultation with the finance or treasury department, decide on the economic life of the equipment.
The purchase price is not the only cost factor of the equipment. Other costs we can identify are:

- Insurance.
  Equipment used to handle containers will sometimes damage a container for whatever reason. This will result in claims from the operator of the container, the terminals customer. The terminal equipment will have to be insured to restrict financial risks of the terminal.
- Fuel- or power consumption.
  Operating equipment will require power (for electrical equipment) or fuel. This will come at a cost, which needs to be included in the total cost for the terminal.

- Maintenance.
  Maintenance cost is often calculated as a percentage of the investment. Some terminals having vast experience and good records will be able to give an estimate cost of maintenance on a per move basis.
- Interest.
  The value of the equipment is included as asset the balance books of the terminal. This value is depreciated over an agreed period of time, usually the economic life of the equipment. The money contained in the equipment, the book value of the asset, can not be touched and is deprived of incurring interest. This can be seen as a cost for the asset.

The sum of the above mentioned components can be seen as the annual cost of the equipment.
The equipment of the terminal will not run 24/7. The quay cranes will operate only when a vessel is alongside. With a quay occupancy of 50% the quay cranes will also be operational 50% of the time. Considering 8000 hours per year will result in 4000 operational hours per quay crane.
The cranes operating in the stack will be operational for a longer period and handle more containers, as these are also involved in the acceptance and delivery of containers from and to road- and rail transport. Depending on the design of the stack, more moves will also have to be made as target containers may be overstowed by other containers. The overstowing containers will have to be moved elsewhere in the stack to allow the crane to pick up the target container. The stack cranes can not operate 24/7 as time will have to be planned for the regular preventive maintenance of the cranes.
Not all equipment, e.g. the forklift trucks in use by the maintenance organization, can be directly allocated to the operation of a vessel. The per-container-costs can be calculated by dividing the annual costs by the annual production of the terminal. Alternatively these costs can be included in the overhead costs.

10.5 Terminal area and infrastructure

In general the port authority is the owner of the terminal area, or the port authority manages the area on behalf of the owner. The terminal will agree to a lease of the land and its infrastructure. The infrastructure will include the waterway, quay wall and water depth, but also the sewage and pavements. Sometimes buildings will also be included. The specifications of pavements and buildings will be in close consultation with the terminal to prevent discussions and ensure that the terminal is satisfied with the infrastructure.
The dimensions of the area of the terminal are defined by:

- Available area.
  If the available area is restricted, the terminal will have to be satisfied with the area. The terminal will have to select their operations system considering the expected container volumes and the available area.
- Operational system.
  Given an operational system and an expected container volume, the terminal may request for a specific area with a minimum quay length.

The Port Authority will charge the terminal a rental fee for the area and infrastructure. The conditions and pricing can be negotiated and will depend on the size and availability of the area.
A price per m² will include the following components:

- $/ m² to recover the investment of the port authority for quay wall and infrastructure.
- $/ m² for the lease of the land area.
- $/ m² for the maintenance of the area.
- $/ m² for the deprivation or loss of interest.

The cost of the total terminal area will be divided by the terminal throughput to calculate the cost per container

When calculating the price for storage of containers on the container terminal the price per m² will have to be corrected with a factor for the total terminal area versus the storage area, need case corrected for the stack utilization.

10.6 General overhead

Not all staff of the terminal will be directly involved with the operations. The finance and marketing department will make cost price calculations and negotiate with the customers of the terminal. The procurement department will tender for new equipment, while the HRM department will be involved with hiring and training of new staff. This will also be the case with some equipment. The costs of the offices (if not included in the infrastructure), the power consumption and office supplies will also be difficult to calculate per container. This is the reason why often a percentage is used to increase the direct costs calculated for a container move, called overhead. Often this percentage will be 30%.

10.7 Container handling rate

Using the above, an indicative container handling rate can be calculated. Using an official calculation method mentioned earlier in this chapter will give a more accurate result. For an off-hand calculation of the container handling rate, the following model can be used.

- Direct cost per crane team per shift.
    - Equipment cost
    - Labor cost
    - Area cost
- Indirect cost.
    - Overhead
- Profit
- Productivity
- Rate

This does not include:

- Additional moves for housekeeping.
  Housekeeping moves improve the productivity of the operation, resulting in reduced cost. Therefore these are not included.
- Additional moves for over-stows.
  Assuming a maximum stacking height of 4 and average stack occupancy of 50%, the stack crane will have a hit-rate of 50% to reach the target container with only one move. This will only be the case for delivering containers.

Equipment cost	**STS Crane**	**RTG Crane**	**T. Truck**	**T. Chassis**
Investment (I) $	$ 8.000.000,-	$ 1.200.000,-	$ 120.000,-	$ 18.000,-
Annual direct costs:				
Depreciation yrs	25	12	12	6
Depr. Annual	$ 320.000,-	$ 100.000,-	$ 12.000,-	$ 3.000,-
Cost of interest 10%	$ 416.000,-	$ 65.000,-	$ 6.480,-	$ 1050,-
Maintenance %	2,5% * I	2,5% * I	5% * I	10% * I
Maintenance $	$ 200.000,-	$ 30.000,-	$ 6.000,-	$ 1.800,-
Insurance %	2% * I	5% * I	5% * I	2% * I
Insurance $	$ 160.000,-	$ 60.000,-	$ 6.000,-	$ 360,-
Power/Fuel kWh/lph	50 kWh	20 lph	10 lph	0
Fuel/Power	$ 80.000,-	$ 80.000,-	$ 40.000,-	$ 0,-
Total Annual costs	$ 1.176.000,-	$ 335.000,-	$ 70.480,-	$ 6.210,-
Operational hours per year	4000	4000	4000	4000
Costs per hour	$ 294,00	$ 83,75	$ 17,62	$ 1,55
Required units per gang	1	1	5	5
Cost per gang per hour	$ 294,00	$ 83,75	$ 88,10	$ 7,76

Table 1: Equipment cost calculation

Labor cost	**#**	**Weekly rate**	**Total $ per week**
Foreman	1	$ 600,00	$ 600,00
Crane driver	1	$ 480,00	$ 480,00
RTG driver	1	$ 480,00	$ 480,00
T Truck driver	5	$ 400,00	$ 2.000,00
Checker	2	$ 400,00	$ 800,00
Lasher	3	$ 400,00	$ 1.200,00
Total per week			$ 5.560,00
Cost per gang per hour	40		$ 139,00

Table 2: Labor cost calculation

Area cost	**#**	**$/m²day**	**Total $ per week**
Terminal area	340.000 m²	$ 0,05	$ 120.000,00
Cranes	4		
Per crane per week	168 hour		$ 30.000,00
Cost per crane per hour			$ 178,60

Table 3: Area cost calculation

Direct cost	Equipment cost	$ 473,61	
	Labor cost	$ 139,00	
	Area cost	$ 178,60	
Subtotal			$ 792,21
Indirect cost	Overhead 30%	$ 221,31	
Per crane per hour			$ 1012,52
Per crane per shift	8 hours per shift		$ 8100,18
Productivity gross	Per crane per shift	250	
Lost labor	20%	50	
Productivity nett	Per crane per shift	200	
Handling rate	**Per move**		**$ 40,50**
Profit and risk	20%		$ 8,10
Handling rate	**Per move**	(inclusive profit)	**$ 48,60**

Table 4: Handling rate calculation

10.8 Cost for acceptance an delivery

Besides the discharge and loading activities, the terminal will accept containers from barge, truck and train for loading on a vessel and deliver containers from a vessel to the barge, truck or train for transport to the final destination. For these activities costs will be made. These costs need to be recovered from the customers of the terminal.
The calculation of these costs can be done in the same manner as the container handling cost. The calculation will include a container move made by the relevant equipment, the staff involved and the gate area. Included should be the average number of moves the stack equipment has to make to load the target container in connection with over-stows as explained in the previous chapter.
To recover these costs from the customer, a separate invoice can be raised. However in most contracts a container handling rate is agreed that includes the loading of the container on the vessel, the acceptance of the container on the terminal and an agreed period storage in the stack.

10.9 Cost for storage

Included in the agreed rate for container handling, a proportion is included to reflect the use of the terminal area and infrastructure. This will also include an agreed period, the free storage period, for which the terminal will not charge storage. In fact the storage fee is included in the terminal handling rate.
In case the storage period will surpass the free storage period, the terminal will charge the customer operating that container.
When calculating the price for storage of containers on the container terminal the price per m² will have to be corrected with a factor for the total terminal area versus the storage

area, need case corrected for the stack utilization. In case the utilization is high, pricing for storage should increase to encourage the customers to take delivery of their container as soon as possible. Alternatively accept containers for loading on a vessel during a very short period prior to arrival of that vessel.
Empty containers can be accepted in the general stacking area; however they will occupy space which is better used for full containers. Alternatively the terminal can arrange for a separate, dedicated, area where the empty containers can be stored, and create an empty depot. In this empty depot additional services may be offered, like maintenance and repair of the containers.
Empty containers can be stacked higher than full containers, resulting in a reduced storage fee: more containers per m².

10.10 Costs for non-core activities

Core activities of a container terminal are the discharge and loading of containers. To allow for a continuous uninterrupted flow of containers, these core activities also consist of acceptance and delivery of containers and their temporary (!) storage.
This does not mean that a container terminal does not offer additional services. Stuffing and stripping can be additional activities, especially if the terminal also has a CFS. Other activities include arranging transport for a scan by order of the custom authorities, monitoring the temperature of reefer containers and arranging for repairs of the machinery in case of breakdown, labeling of containers stuffed with hazardous cargo’s, weighing containers and changing the door direction of the container on a truck.
For all these activities the costs involved can easily be calculated.
The calculated rates inclusive profits can be standardized as hourly rates for staff and handling rates per move per equipment type. These can then be included in the contract the terminal has with the customer.