The Venice Offshore-Onshore Terminal Concept

Venice Port Authority

Royal HaskoningDHV

The Venice Port Authority (VPA) guides, plans, coordinates, promotes and monitors port operations in the Port of Venice.

In the framework of the project entitled “New offshore platform to serve the port and logistics area of the converted industrial areas of Marghera”, the Port of Venice is examining the issues related to the creation of an offshore island hub with container terminal, an oil terminal, and an onshore terminal at Porto Marghera (named Montesyndial) and the methods for transferring containers from one terminal to the other (see Figure 1).

The offshore terminal will be on a T-shaped artificial island with container operations occupying a pier of dimensions 1000m (total berth length) by 200m (width) (see Figure 2). At the end of the pier on one side there will be an oil terminal with four tanker berths, designed to accommodate large oil carriers that cannot enter the Venice Malamocco Channel, and on the other side there will be auxiliary facilities to the container terminal.

The Implementation study to prepare a Public Private Partnership (PPP) to improve the capacity of the Port of Venice and the related logistics system, was launched with this aim. The study was commissioned as a part of the 2011 annual tender of the TEN-T Programme.

Royal Haskoningdhv is supporting VPA as part of the above study with the specific task to define the equipment, handling systems and layouts for the two terminals: the offshore container terminal and Montesyndial.

Venice Offshore Container Hub Terminal Concept

Port of Venice Authority is planning an offshore platform at some 8 miles off the Malamocco port mouth where the seabed has a natural depth of 20 m. The offshore terminal will be connected with a barge link, specifically designed for this project with the onshore terminal in Marghera (Montesyndial).

The offshore terminal will allow today’s and tomorrow’s ultra-large ships to call at the Port of Venice without having to further dredge the existing lagoon channels. Thanks to the offshore concept, Venice will be among the few ports in Italy where 20,000 TEUs-ships will be able to berth.
It will also be possible to distribute goods to the European and Italian markets exploiting the most convenient land port. The terminal is expected to become the central link between the existing logistics centres and the maritime traffic generated by global trade.

The barge link comprises of purpose-designed barge carriers that can carry 2 barges at a time, going from the offshore terminal through the Malamocco Entrance to the onshore terminal. The barge carrier (called “mama vessel”) is designed for the sea conditions outside the Venice lagoon (see Figure 3). It carries two purpose-designed barges, equipped with cell guides, each having carrying capacity of about 380 TEU.

The main characteristics of the onshore container terminal at Montesyndial are:

- Brownfield development (merging of two former chemical loading facilities)
- Area of 90 ha
- Berth of 1400m
- Connection with the inland rail network.

![Figure 1. Location of the Offshore and Onshore Terminals. Source: VPA](image)

**Benefits of the offshore terminal**

The offshore terminal will create new jobs, will benefit the economy, and will also help the environment. It has been estimated that choosing the Port of Venice means to:

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• spend 5 less days at sea, and to cut greenhouse emissions (97 CO2 kg less for each container transported to Munich via Venice instead of via a Northern Europe port);
• reduce the need to dredge the port channels (saving money and helping the environment);
• increase the safety of navigation in the lagoon.

Figure 2. The offshore terminal. Source: Royal Haskoningdhv

The role of Royal HaskoningDHV in the project

As this is a part private part public (PPP) financed project, it has to be a feasible and attractive proposition to a private terminal operator. Royal HaskoningDHV role is to come up with an operating concept for the two terminals (offshore and onshore) that would make the project’s implementation feasible technically and financeable. ROYAL HASKONINGDHV has also produced an operational model for the container terminals with a key priority are to reduce operational and capital expenditure costs to make it attractive to a potential terminal operator.

In summary, Royal Haskoningdhv aim was to ensure the study provides the VPA with the following key project benefits:

1. Develop a state of the art and robust layout and operational concept, attractive for future terminal operators.
2. Support the Port Authority to build a robust business case for a PPP financing structure and appropriate for successfully negotiating a concession for the terminal areas to a competent operator.
3. A clear and achievable route to implementation.
In order to assess these requirements, a vessel forecasting study was carried out to provide the expected vessel and call size for the deep sea services that would call at the offshore terminal. Based on these vessels and sizes and the given geometry of the terminal, the storage and productivity requirements were acquired and used as a starting point for the equipment and layout planning of the two terminals.

Through extensive study of the available options and using sophisticated tools from operations modeling and simulation, the Royal Haskoningdhv study managed to devise layout and equipment arrangements for the offshore and onshore ports that met the VPA requirements and achieved more that 25% reduction in the overall cost per TEU of the project, including equipment CAPEX and Operational Expenditures.

The logistic system and its challenges

The Logistic System for handling containers from a mainline deep sea vessel to the onshore container terminal to the hinterland transportation network comprises of the following subsystems:

- Off-shore deep water berth
- Offshore Storage Yard acting as a buffer on island
- Off-shore barge berth
- Barges acting as a floating buffer (see Figure 3)
- The Barge Transport System (SSBT) which transports the barges to the onshore terminal (see Figure 4)
- Onshore barge berth
- Onshore Storage Yard acting as a buffer on land
- Rail yard
- Road gate

Each of these sub-systems has to be sized to accommodate the corresponding flow rate of containers (productivity) while at the same time the buffers (storage and barges) have the mission to modulate the stochastic variations in this flow rates.

Lack of off-shore yard space is the main challenge for two reasons:

- It limits storage capacity
- It limits the number of equipment one can put to handle the containers without congestion and conflict, therefore limiting the terminal productivity.

On a container terminal with a deep-sea quay on one side and a barge quay on the other side and a depth of only 200m (from quay wall to quay wall), there would hardly be any space left for a container yard. So, for the terminal to work an extraordinary operating model would be required. Area, density, dwell time are the main determinants of yard storage capacity. Here the area is very small, so density has to be as high as possible and or dwell time as short as possible.
Even an extraordinary operating model would place a significant demand on the productivity of the sub-systems, particularly the barge berths and the barge transfer system as the flow rate to maintain the throughput at very low dwell times would be high.

Key Performance and Implementation Requirements

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The landside (barge side) of the off-shore terminal is most unusual, as there are only a few destinations for import containers, i.e. Montesyndial and may be two Inland Water Ways (IWW) destinations. The landside import stack operations are likely to be even simpler than deep-sea export stack operations. Selectivity of import containers is likely to be no issue at all. Therefore import containers could be stacked on the basis of type, size, destination and weight class only, to the technical maximum stacking height, just like export containers.

For each of the two flows through the terminal the following requirements apply.

- **Import flow** - Import container discharged from the vessel must leave the off-shore terminal, by barge, as quickly as possible. The possibility for direct transfers of import containers from one berth to another has to be exploited.
- **The import containers that are not transferred immediately have only very few on-shore destinations, Montesyndial and a few IWW destinations. That would allow stacking on the basis of type, size, destination and weight class, just like export containers. Unlike an on-shore import stack, here a high stack occupancy is also possible.**
- **Export flow** – Export containers need to be delivered to the off-shore terminal as late as possible, preferably a few hours before loading the deep-sea vessel. Any export containers stacked at the off-shore terminal should be stacked as high as possible, on the basis of type, size, destination and weight class. This method allows a high stack occupancy.
- **The productivity demands of the deep sea vessels have to be modulated through the stacking yard to a homogeneous flow of containers through the barge transfer system.**
- **The handling system needs to be able to cope with extra-ordinary events such as disruptions in the barge transfer system of certain duration without diverting vessel services.**
- **At the same time, the handling system has to be sized to handle the regular flows. Design for the extra-ordinary rare events would be uneconomical, and under the space constraints not feasible.**
- **The equipment and systems to be used has to be relatively easy to procure and tested elsewhere so that the technology risk to the operator will be as low as possible**
- **The staffing needs and operational costs have to meet two conflicting objectives:**
  - On one hand, to be low enough to compensate for the cost of the barge link in the handling process.
  - On the other hand, the terminal has to provide sustainable employment benefits to the local community.

**Proposed container handling systems**

Under the Royal Haskoningdhv scope, options for container handling operations on both the onshore and offshore terminals were explored and developed in detail.

Following detailed feasibility studies, and examining many options, a pragmatic approach for handling of containers and their transfer between offshore and inland terminals was proposed. This approach was based on the following principles:

1. **The equipment concept should meet the forecast throughput and productivity demands as closely as possible**
2. **Equipment should be as close as possible to what is available now or in the near future to minimize the technology risk for the operator.**
3. **As much flexibility as possible to accommodate the geometry of the vessels, the barges and the offshore terminal layout.**
4. Ability to cope with gradually increasing throughput without significant expansion investment
5. Environmentally friendly with as less light air and noise emissions as possible.

**Offshore Terminal**

The selected equipment system for the offshore terminal was Automated Straddle Carriers working with remotely operated STS and Barge Cranes.

In this system the horizontal transport and stacking equipment are one and the same. Automated Straddle Carriers, similar to those deployed in Patrick Terminal in Australia are working in the Ship to Shore crane backreach picking up the containers and stacking the containers 3 high. Out of gauge cargo, service lanes and hatch covers are laid between the crane rails allowing separation of the automated operations from the manual ones. Figure 5a shows a side view of the offshore terminal and Figure 5b shows the terminal from above. Direct transfers from the Deep Sea berth to the Barge berth are facilitated by cross lanes that go from one berth to the other. Refrigerated, damaged and Out of Gauge cargo would be stacked outside the automated area in a manual handling area with access for personnel. The stacking in that area will be by Reach Stackers and the horizontal transport with manned Tractor-Trailer Units.

The advantages this arrangement offers to a potential operator are:

- Standardized equipment, available today.
- Automated, low OPEX horizontal transfer and stacking
- Tried solution applied elsewhere, supplied by one of the largest port equipment manufacturing companies
- Capability to handle all cargo including OOG.
- Minimal transient time in the offshore terminal as at the final throughput, all imports to Montesyndial will be directly transferred to barges
- Minimal infrastructure CAPEX requirements (pavement, reflector posts or transponders)
- Possibility for greener power (hybrid straddle carriers are in operation). No lights required in the automated yard.
- Easy phasing as throughput increases (just add more machines).
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Onshore Terminal

The requirements for the onshore operations are similar to a standard container terminal. Given the throughput, two options are proposed for consideration:

- Option 1: A conventional rubber tyred gantry crane (RTG) option;
- Option 2: An automated terminal using automatic stacking cranes (ASCs).

After careful analysis of the above options with respect to their storage capacity, handling productivity, ease of implementation and equipment capital cost, Option 1 was selected. The selected equipment for the onshore terminal was Electric Rubber-Tyred Gantries for yard stacking and Tractor Trailer Units for horizontal transport. The layout (see Figure 6) is a typical RTG layout with the feeder berth next to the barge berth, sharing the crane rails and allowing extra berthing space for mooring of additional barges, larger feeders and the barge carriers. Phasing will occur from the deep end to the east to the more shallow area. In the areas of soft reclamation soil we have allocated empty storage.

This is a simple and practical solution that provides:

- Standardized equipment, low technology risk
- Ease of initial implementation and phasing
- Flexibility to accommodate both feeder and barge operations in the same storage area and with the same equipment, allowing for variations in the mix of throughput between feeders and deep sea containers.
- Low initial CAPEX investment
- Opportunity for employment to the local population

Further encouragement for hybrid, LNG/LPG or battery-operated TTUs may achieve additional air emission and noise pollution reduction.

Figure 6. Perspective view of the Montesyndial Terminal. Source: Royal Haskoningdhv

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Conclusion

The regulatory and environmental constraints on the development of navigation channels within Venice Lagoon, together with availability of land for development in the industrial Port of Venice and the unique location of Venice in Northern Adriatic created an opportunity for the development of a new container hub and logistics centre and a potential alternative gateway to Europe. Venice Port Authority’s proposed offshore container terminal incorporated a novel approach to transferring containers which could provide the opportunity for large oceangoing containerships call at Venice and for the fast and efficient distribution of containers to inland terminals.

Overall, although challenging, the functional requirements for a potential operator in terms of equipment and operations are met in a realistic, flexible and economically feasible manner. Through extensive study of the available options and using sophisticated tools from operations modeling and simulation, the Royal Haskoningdhv study managed to devise layout and equipment arrangements for the offshore and onshore ports that met the VPA requirements and achieved more that 25% reduction in the overall cost per TEU from an operators perspective, i.e. including equipment CAPEX and Operational Expenditures.

Discussion on the economic aspects of the proposed scheme is beyond the scope of this paper but it can be said that detailed studies have been carried out to investigate the scheme’s attractiveness and its economic viability and that interested parties can enquire with Venice Port Authority for more information.

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