SMART MASTER PLANNING FOR SMARTER PORTS

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The topic of smart ports has become more prominent in recent years, as part of the expanding feasibility and applicability of Industry 4.0 themes - automation, data analysis, device connectivity, portable working - within traditionally conservative port operations. Before we discuss what these themes mean for master planning, it is important to consider the overall business rationale of why a port should become 'smarter', as this is vital for the strategic design phase. In essence, a smart port is designed, built and managed to use less space and resources while reducing the environmental impact of operations.

Much of the focus has been placed on the deployment of technology within existing ports and terminals to improve workflow, labour and equipment use, and energy efficiency, all of which are essential. However, the greatest long-term gains for port and terminal efficiency are laid in the design foundations of the strategic positioning, purpose and functions of the facility, where a properly thought-out master plan can have a significantly positive impact on efficiency. The horizon for a master plan can typically be 25 years into the future, so accurate forecasting can be challenging, but the adoption of some key principles will deliver benefits.

MODELLING PORTS ROLE WITHIN THE SUPPLY CHAIN

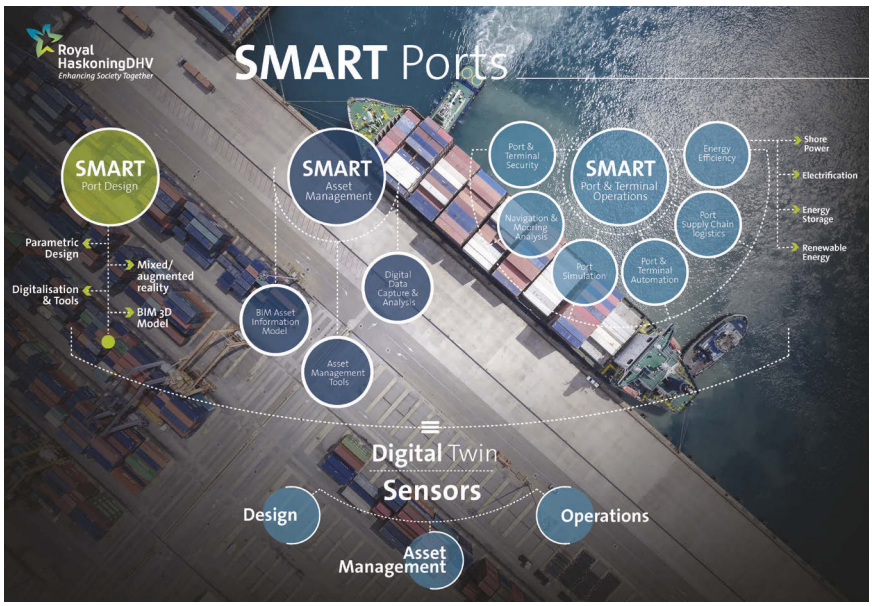
An important element of port master planning is the estimation of cargo mix and volumes that will transit this link in the supply chain, supporting hinterland industries and consumers, as well as broader regional trade, within the competitive environment of other port facilities and economic growth. Given the long-term horizon for port developments, there is some consideration needed for how the whole supply chain may become smarter and leaner, or quick to change due to external drivers.

Within the regional supply chain, pull-factors from the port's clients may include reduced port transit/storage times to support Just-In-Time (JIT) production facilities, yet may also require more port-centric storage and processing where the port facility incorporates some pre-processing activities, already common in many regions.

From a planning viewpoint, the modelling of these multiple cargo flow and client demands creates a mixture of storage, facility and equipment demands that the port should incorporate. The traditional modelling methods with flat spreadsheets can be enhanced here by the absorption of multiple sources of supply chain data - Big Data - to build multi-dimensional models

that outline the supply chain role of the port and the importance of key variants on the layout and capacity of the site.

The focus in master planning should be on how the port can provide the leanest facility to service the supply chain demands and minimize the addition of excess space, resource and financial contingencies from the outset, which requires confidence in data predictions and models from the engineer and end client. The focus should be on overall cargo processing within supply chains, not only quay or gate productivity.



MASTER PLANNING FOR RELIANCE ON PORT & TERMINAL TECHNOLOGY

As part of the roles they play in the supply chain, the port and its terminals will have a range of technology tools to fulfil customer services and internal management. These tools will impact on the design of the port as a whole and it is important to build-in a reliance and demand on this technology as an integral part of the port design. Smart master planners should have a strong grasp of the potential role of technology throughout a port to avoid missed opportunities. For example, it can be expected that future terminal operators will deploy process automation and workflow control systems such as terminal operating systems (TOS) or SCADA/equipment control tools to maximize their own efficiency.

This may extend to equipment automation, which will have a more significant impact on high level design needs. At the early planning stage, consideration of the expected terminal productivity should be ambitious to reduce equipment and physical resource needs for the cargo throughput by enforcing the use of technology to deliver higher standards of terminal efficiency.

The increased use of terminal technology and automation also alters the quantity, role and location of staff, changing the need for buildings and access. For the wider port, the efficient supply chain will demand streamlined cargo access/egress from the port, particularly at the landside. The adoption of appointment systems and gate automation for terminal and port security can greatly reduce the traditional buffer areas for truck parking, admin processing and regulatory inspections, reducing the land and environmental impact of the facility.

For marine services, similar logic applies to reducing berth waiting times at anchorage by smarter voyage planning and liner-coordination, and the provision of coordination (Vessel Traffic Services) can be remotely provided from a distant location. The inclusion of technology considerations available today can notably alter the layout zoning, purpose and capacity of port facilities, reducing the huge outlay on civil and infrastructure works in favour of leaner and more profitably operated ports. The technology mission and focus for the port and its terminals should be a key element of the master plan; setting down the expected operational and asset management principles for the site and ensuring that the port is built and managed to its design potential.

TAKE A LONG-TERM VIEW

Considering the life of a port, the adoption of today's technology alone will be insufficient; the future resilience of the facility will depend on its agility and capacity to adapt to changes that are still beyond the horizon. A smarter port needs to be able to respond to external changes. For example, the electrification of road vehicles and port equipment will lead to significant demand for power and battery charging of visiting trucks and mobile equipment, stretching the infrastructure design and strengthening feasibility for onsite power generation.

A similar example is the expectation of driverless trucks, where the port will need capability to receive and process driver-less trucks for load and discharge, possibly by remote control, from their highway interchange. In tandem, the rise of on-demand trucking (Uber-style) may create interesting transport hub opportunities for ports to manage and store pools of driver-less trucks between jobs. In marine services, fleets of fully autonomous vessels may be distant, but semi-automated berthing and remote-control manoeuvring - or 'pilotage' - may become more feasible. Unmanned craft within the port for surveying, rubbish collection or other routine tasks are already available, thus it can already be seen how the changing role and requirements of the port to manage these sophisticated tools needs to be considered.

PRIORITIZING PEOPLE IN A SMART PORT MASTER PLAN

For all the impacts of technology, the role of people in a port master plan should be prioritised, both as local employment and skill generator, but also to design the facility to operate safely. With the changing roles of staff in a modern port, the removal of personnel from hazardous work areas is increasing, reducing the need for overall manpower but with a far greater skillset than the traditional dock labour force.

ENVIRONMENTAL IMPACT

The supply chain and its ports are under pressure to improve their local environmental impact and contribution to the global effect of greenhouse gas (GHG) emissions. These sustainability aspects are key drivers to designing leaner and less impactful ports, using technology to provide services efficiently. Electrification and equipment automation can play a significant role, but the monitoring and control of air pollution elements and traffic congestion management are also important for being a good neighbour to the port's host city.

Often, when managing a significant port estate, the options for onsite renewable power generation and energy storage can be built into the master plan, to produce power for operations and the local grid. Equally important is the storage of excess power for recycling and to reduce peak loads; this is vital for wider grid demands in the city or in remote areas particularly. Provision of shore power for vessels is a major challenge not only for existing ports that might be considered for a new port master plan (although there are significant investment return challenges), but also with the ongoing switch in bunker fuels - to LNG for example. This creates new opportunities for port design to support both vessel types.

Example of a visualisation from a Port Simulation

With our changing climate, future challenges can also be expected in the harvesting and recycling of rain-water for port use in [currently] temperate areas. The use of big data from climate models can be used to enhance future resilience and planned investment in port assets for flood and extreme weather preparation, which will become more common within the lifecycle of ports under construction today.

SMARTER MASTER PLANNING

Gathering of and modelling with big data, while factoring in technology performance and future resilience demands is vital for a port master plan. Improved methods can support better creation of port master plans. The simulation of process and resource demand is an important approach to bring together all the elements in a working model of the future port facility.

Beyond standard 3D modelling, the use of 4D (time) and 5D (cost/cash flow) elements within this concept create a working model of the port, to allow a guided creation of phases for investment and operation. These models have a life beyond the master plan stage and can evolve into a live digital twin model for the port facility, receiving real-time data from the technology elements, equipment, civil assets, operational systems and external supply chain. This provides the operator with a live parallel model of the facility (or parts of it) to support better decision-making, as well as forecasting and scenario testing for short-term operational challenges. Alternatively, the twin can be updated as circumstances change and used to plan future developments, changing layouts, equipment needs or new cargo flow adoption.

LOOKING TO THE FUTURE

In the future, semi-automated optioneering could become feasible with the use of artificial intelligence (a series of algorithms and parameters). Here, the machine can create many variations of feasible port layouts beyond that possible by humans, quickly revealing the best options mathematically for the engineer to review.

Smarter Ports are formed in the initial stages of master planning, including the demands of modern supply chains and embracing port technology for space, resource, equipment and environmental efficiency. For the benefit of port cities tomorrow, low impact and digital ports are vital, and the foundations are laid in smart approaches to master plans.

ABOUT THE AUTHORS

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