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Port 4.0 concept – Terminal operator perspectives on port 4.0 development

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Summary

The vision of the Port 4.0 concept currently seems incomplete for the terminal operators. It all starts with lacking a widely adopted concept definition for Industry 4.0 in the port context and thus results in some organisation-specific interpretations of Port 4.0.

What the terminal operators seem to share are the basic characteristics of the concept: system intelligence, automation, connectivity and a high level of digitalisation. Terminal automation and digitalisation priorities fit well with the overall concepts that are understood as Port 4.0 from the perspective of the individual stakeholder. The impression, however, is that terminals to some extent mirror the Port 4.0 vision with technical developments and digitalised operations at the terminal-level only. Hence, connectivity as part of Port 4.0 means connectivity between systems and machines inside terminals, and efficiency via automation means terminal productivity. This is logical but also somewhat controversial in terms of the origins of Port 4.0. It excludes the systemic layer of Port 4.0 development.

Considering Port 4.0 as a community effort, whether between a few local stakeholders or in wider supply-chain context, one cannot exclude terminal operators by any means from that community. Neither do the terminal operators themselves. Different interpretations arise

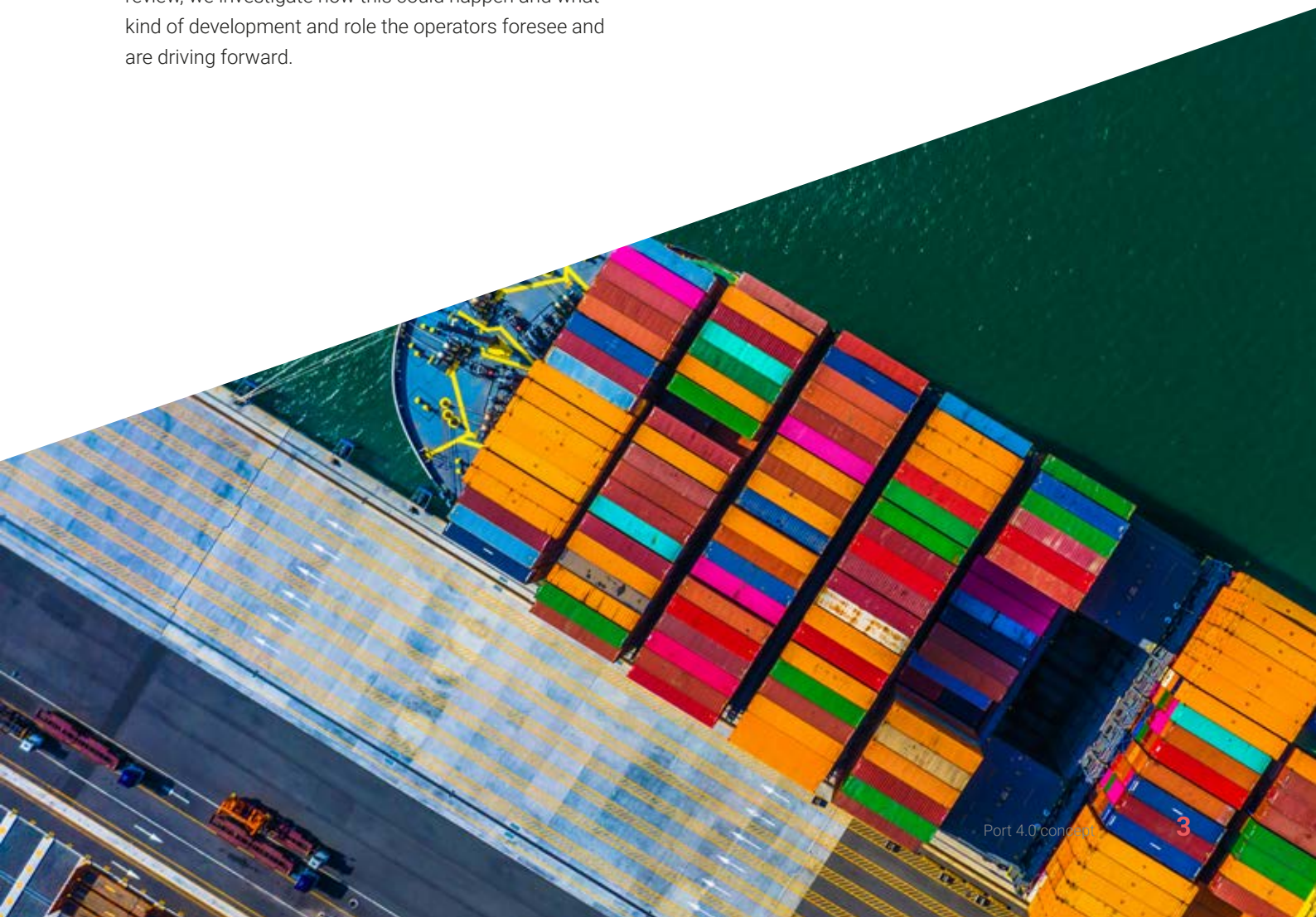
more in terms of how the terminals position themselves in the development and what they consider the game-changing Port 4.0 ecosystem to consist of. Some position themselves more directly in the driver's seat, whereas others approach the development more like followers or as part of a team. What is also evident is the orientation towards the seaside and the shipping lines, leaving value chain stakeholders on land in a secondary position.

Based on the views expressed, the potential pathway towards Port 4.0 implementation is a multi-stakeholder journey where the concrete push is likely to come from outside the terminal sector. Ports are also different and hence the Port 4.0 development is likely to be implemented with local or regional twists and not as a result of definitions. What the vision perhaps still lacks most is the ecosystem constellation: how several or many technologically advanced parties form a community that strives for foreseen Port 4.0 benefits, what the community extension level is, and who drives the development. Several scenarios are therefore possible for the development.

Introduction

Terminal operators are among the key stakeholder groups in ports. In addition to operations within the terminal, they also have daily operational interfaces with both sea and land and could have an impact on connectivity within the supply chain. Thus, Port 4.0 development is to a large extent dependent on how the terminal operators contribute to the adoption of Port 4.0 objectives in their own operations, but also on how they engage in collaboration with other stakeholders. In this insight review, we investigate how this could happen and what kind of development and role the operators foresee and are driving forward.

The following presents container terminal operators' perspectives on Port 4.0 development. Rather than specifying technology trajectories, we try to draw a picture of the concept and function of Port 4.0 as well as the roles of different stakeholders in the evolution pathway from the terminal operator's viewpoint. The views presented are based on interviews with international container terminal operators.



The rationale of automation and digitalisation in general



From the container terminal operators' perspective, automation and digitalisation investments specifically serve two main purposes: cost reductions and operative efficiency, and these are often interlinked. Automation is targeted to maintain profitability, measured by cost per container move, for example. Operative efficiency, measured by the number of container moves per hour, for example, contributes to the service level and competitive position among the terminals. These are at the core of the motivations for technology and operative improvements that outpace any other related factors.

Table 1. Importance of different factors to digitalisation and automation investments (scale: 1 = not important at all, 5 = very important). Each bullet refers to a single interviewed corporation.

The above prioritisation is also clearly visible when comparing a wider range of objectives for digital and automation investments (Table 1). Terminal operators unanimously rank ROI and economic KPIs as well as operational efficiency as the top priorities, while the importance of most other objectives clearly divides corporations. For example, the avoidance of human

errors, regularly referred to as one potential digitalisation benefit, currently lags behind as many manually operated terminals still function more efficiently than fully automated rivals. It also seems clear that respondents have differing views on the importance of data sharing and connectivity with other port stakeholders.

Views related to more specified technology and automation areas to be developed in the coming three to five years show a range of areas where local terminal conditions and advancements also play a significant role. However, two areas seem to attract wider interest among many: advancing electronic object identification and the use of data in the tracking of containers in yard optimisation and system improvements, as well as gate automation. Rather than total solutions or terminal-wide extensive turnarounds, some are looking for smaller automation components and step-by-step improvements in the terminal network.

Given the priorities and perspectives of the terminal operators, it is evident that Port 4.0 development and the evolution pathway should also be viewed against the same rationale.

IMPORTANCE					
FACTORS	1	2	3	4	5
ROI and related economic indicators					
Operational efficiency					
Safety					
Security					
Removing human errors					
Customer service					
3 rd party connectivity/cross-border integration					
Future value/potential of data-driven processes					

Table 1. Importance of different factors to digitalisation and automation investments (scale: 1 = not important at all, 5 = very important). Each bullet refers to a single interviewed corporation.

Port 4.0 vision is still fragile and dispersed

The foundation

Interestingly, whereas the foundation of Industry 4.0 seems to be well defined and widely accepted among terminal operators, the adoption of the Port 4.0 concept remains open to interpretation. Basically, all the interviewed terminal operators state that Port 4.0 is not clearly defined at all or at least the company is lacking the precise definition. Some also use alternative concepts like *intelligent port* or *smart port* but the association to Port 4.0 remains partly open. Given this position, it is evident that terminal operators do not have a precisely defined strategy towards Port 4.0.

Some operators state that Port 4.0 is a concept referred to by Port Authorities rather than other port stakeholders.

The meaning

Despite not having an exact definition for the concept, port operators characterise and interpret the Port 4.0 concept and functions in quite similar ways. In terms of terminals, Port 4.0 is characterised as being highly automated, transparent, connected and smart. Here the characteristics are mainly mirrored inside the terminal and not across the whole port community. For one, the concept means the introduction of most intelligent technologies in terminals. For another, the concept is about an incremental, stepwise increase in automation of those currently manual processes and functions. For a third, it means highly automated terminals.

For the terminal operators, the automation in the Port 4.0 context means lean operations and standard processes, transparency and full visibility in the terminal area, as well as real-time data and operations management. For one, it also means new digital services for customers. Some state that the focus depends on the initial state of terminals and can be very different between locations – the outcome is not the same everywhere.

Interestingly, a few operators see Port 4.0 as a state where technology is utilised in as much and as sophisticated a way as possible, meaning fully automated terminals, while some try specifically to avoid this and introduce incrementally well-functioning digital processes and services. A few of the experts also mention connectivity to other stakeholders. One foresees an increase in the digital focus from seaside to landside, especially to gates and digital services to land carriers.

Based on the interviewed experts, the concept of Port 4.0 is mostly founded on technology advancements utilised inside terminal boundaries and not so much between and in interaction with different stakeholders.

The above might straightforwardly indicate that terminal operators evaluate and view Port 4.0 from their own perspective, i.e. the terminal itself. However, as we discussed the level and coverage of the concept with the operators, the experts seemed to favour the view that it is multi-stakeholder by nature, extending beyond the terminal. From the four different alternatives presented below, the operators chose options 2, 3 and 4.

Port 4.0 concept meaning

Option 1: Port 4.0 is mostly a terminal-level target/concept

Option 2: Port 4.0 is mostly a (local) port community-level target/concept

Option 3: Port 4.0 is mostly a supply chain-level target/concept

Option 4: Port 4.0 involves all possible port actors/stakeholders

The industry experts also argue that the perspective might evolve over time so that the current port community concept develops towards a wider supply-chain perspective, or that the starting point is the terminal but the vision will extend to all possible port stakeholders at some point. Wider connectivity is called for but at the same time it is considered to be partially challenging, for example in the case of several competing terminals operating in the same port community.

So, whose case is it? A single actor or a community?

Considering ports as places and interfaces where multiple stakeholders operate, who then contributes the most to the Port 4.0 concept? Is there an 'owner' of the concept that ultimately judges the development, or is Port 4.0 a communal effort by multiple port stakeholders? There seems to be *four kinds of views* among terminal operators. Some see Port 4.0 as having no concept owner and being a true joint effort by the port community. The others state that ultimately the owner is the port authority. Some state that it is specifically the terminal operator, depending on local circumstances to lesser or greater degrees. Between these fall the views that Port 4.0 is a joint effort between the port authority and terminal operators. Many of these views are somehow in line with responses to the earlier topic about the level and coverage of the concept. None of the interviewed experts consider Port 4.0 to be just a terminal concept, but a wider multi-stakeholder concept involving few or many. However, many stress that, in its concrete execution, terminals play a crucial and vital role.

As the implementation and realisation of Port 4.0 is inevitably an effort between many stakeholders, regardless of who is acting as the concept owner, certain stakeholders play a far more critical role for the terminals themselves. For most of the experts, these are *shipping lines and port authorities*. Many emphasise that this kind of development has to be built into customer needs and hence the role of shipping lines is key for any type of realisation of Port 4.0 plans. Besides the two mentioned stakeholder groups, a few experts also include governments, regulators and other authorities as well as employees as critical stakeholders. One expert, on the contrary, emphasises the role of port technology and digital system providers first and foremost.

On the contrary, no single expert refers to cargo owners, road/rail carriers or forwarders as the most important stakeholders for the implementation of Port 4.0.

Besides the importance of stakeholders in the implementation, we also talked to some of the terminal operators about the catalysts for actions and sources of needs to act and proceed with Port 4.0 development. The views were partly divided. Some considered shipping lines and their port-related needs, like efficiency, as the ultimate driver for the development. Some commented that it all starts from the beneficial cargo owners' requirements and moves towards their priorities, including environmental, social and governance criteria and seamless information flows.

Current status

Without an exact definition of the Port 4.0 concept, the readiness or maturity level of current ports and terminals in the light of Port 4.0 is more complicated to evaluate. However, the interviewed experts do not consider Port 4.0 to be a far-reaching futuristic construction but something that will materialise within the next 10 to 15 years. Some estimate that in specific ports it might take just five years to achieve the status, while some consider the 2030s as realistic timing, with real game-changers yet to come. Importantly, some state that the question will be very port- and terminal-specific: it depends on the global location and there will be major differences in timing.

Many experts consider the current situation to still be taking the first steps on the evolution pathway towards Port 4.0, with more profound changes yet to come.

What then stands in the way of development: technology, juridical questions, people or other possible issues? Two factors seem to incite more comments compared to others: *social* and *commercial*. By social, experts refer to a general mindset in the need to change towards future needs and requirements, anti-technology perspectives and scepticism, and labour interests. In terms of commercial factors, experts refer to the high entry-level costs of new solutions and especially the mediocre return-on-investment ratio of automation. Some related technological aspects are also evident despite some considering the question as not being particularly related to technology. For example, some highlight the fact that most automated terminals are actually no faster than manual terminals. Also, reliability of new technologies is not always considered to be at the level that would foster their expansion. Besides these factors, references are also made to regulations and laws that restrict the current use of some automation solutions, for example.

COVID-19
– Exceptional times
will have some
impact on priorities



The COVID-19 pandemic has challenged economies and businesses around the world and has also impacted global supply chains in many ways. Overall, many terminal operators faced a cargo volume drop in the first half of 2020 but rebounded at least partly in the second half. In 2021 the interviewed terminal operators look towards the future quite positively. Operatively the terminals have managed to stay functional and productive all the time, but front-line workers have experienced a lot of stress and pressure.

In the discussions with the terminal operators, the authors were also interested to see whether COVID-19 as a global crisis itself can be seen as factor that is slowing down or otherwise impacting the development of automation and digitalisation. Certain impacts are visible (see Table 2). In terms of priorities, some operators point out that COVID-19 has completely speeded up digitalisation efforts in the terminals. This may not be visible in machinery

but in expanding digital services, management and collaboration and communication between personnel. In addition, many have accelerated investments and also some new investment needs have become visible during the pandemic (for example company network infrastructure, smart working conditions, operations planning and tools). Some companies consider these new priorities to be permanent.

At the same time, the investment behaviour remains the same in many ways. Most terminal operators see no impact on the scope and volume of digital investments and no investment postponements or breaks. It seems that the current plans and investments underway will remain in focus, regardless of the pandemic.

In the bigger picture, majority of the terminal operators consider that COVID-19 does not require a total rethinking of port operations and ways of doing business.

COVID19 - IMPACTS ON DIGITALISATION AND AUTOMATION	YES	NO
Changes priorities permanently in your terminal(s)	● ● ●	●
Changes scope/volume of investments in your terminal(s)	●	● ● ●
Postpones investments in your terminal(s)		● ● ● ●
Makes certain investments in your terminal(s) more acute and rapid	●	● ● ●
Has revealed new types of needs that were not visible before	● ●	● ●
Makes it more difficult to justify investments for operative needs	● ●	● ●
Caused a break for terminal digitalisation and automation until we reach the new normal in the business		● ● ● ●
Requires total rethinking of port operations and ways of doing business in the port sector	●	● ● ●

Table 2. 2021 views to Covid-19 impacts to investments in container terminal. Each bullet refers to a single interviewed corporation.

Background information about the Insight

This insight review was carried out by a research group from the Centre for Collaborative Research CCR, Turku School of Economics at the University of Turku, Finland. It is part of a larger study analysing Port 4.0 development and scenarios. The full study was commissioned by Kalmar, a part of Cargotec group.

Terminal operator perspectives were collected in H1/2021 via phone interviews and electronic distance meetings. Each interview included the same selection of structured questions but also wider themes for open discussion. In addition, the interviewees were asked to evaluate given statements and claims, and rate priorities. Interview themes focused on three broad areas:

- Port automation and digitalisation priorities in general
- Port 4.0 vision and the development pathway
- COVID-19 impacts on digitalisation and automation

Those interviewed represented industry leaders and experts with positions in senior management and typically with an extensive industry background. A total of eight experts from five corporations were interviewed.

Interviewees represented container terminal operators with a global presence on all continents. Although limited in number, the corporations represent the world's top container terminal operators, thus have a major impact on terminal sector development.

The authors would like to thank the interviewees who shared their insights and perspectives on the outlook for the ports of the future. We would also like to thank research assistant Edona Pepiqi, who helped us with the data collection and interview arrangements.

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