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# New Technologies in Small and Medium-sized Ports: Its Impacts on the Future of Work

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*ABSTRACT*

The port industry, because of its complex nature - which involves an extended number of actors / stakeholders - is often slower than most others when it comes to adopting emergent technologies to expedite the shipping process. There is no one clear definition of an automated (or, "smart") port. However, it is true that the current level of automation in the port sector is at relatively early stages, with 97% of the world container port terminals still not "sufficiently" automated. The share of containers that are processed via a fully automated path is just 1%, while semi-automated terminals are about 2%. In any case, as in many large-sized ports around the world that are already under the influence of automation, a similar impact could soon be felt in middle and small-sized ports in certain countries around the world.

It is a rather self-explanatory fact that increasing the level of automation and digitalisation can also introduce significant changes in port business: from loading and unloading operations, to design infrastructure development and maintenance. Furthermore, it can transform traditional port activities, including the types of jobs needed to effectively fulfil these activities. An examination of the global port sector indicates that the implementation of automation has been increasing to a certain degree, when taking into account several drivers. This paper will examine port automation and digitalisation, and their impact on jobs relating to middle and small-sized ports. It will investigate the concept of automation and digitalisation in ports and will identify the factors driving the respective development; then, it will perform a brief evaluation concerning the impacts on port workers.

## 1. Introduction.

Extensive pressure is now put upon small and medium-sized ports (SMPs) due to expanded demand for goods; there is also a desire to make supply chains move with short sea services that can be a reliable alternative to road transport across land borders (Paixão and Marlow, 2002, Medda and Trujillo, 2010, Suárez-Alemán et al., 2015). Ports in all their categories constitute a crucial link between land-based and sea-based transport, while SMPs play an important role when it comes to the distribution of goods and people within national and international transportation processes (Ng, 2009, Christodoulou and Kappelin, 2020). The supply chain system needs SMPs as feeder ports to supply large hub ports and hence accommodate demands for multi-level port layouts (Ding et al., 2015).

SMPs, just as large ports, are a vital component to the economic growth and prosperity of a country; it is a self-explanatory fact that they positively influence in different ways and degrees the development of their regions, with indicative examples being employment and GDP (Monios and Wilmsmeier, 2013, Baird, 2007). They also contribute into job creation and support activities within the entire supply chain process. Additionally, they can help other related industries to function, even when these ports are not involved in major international trade or handling large volumes of cargo or passengers.

The scientific literature in the port field often explicitly or implicitly limits its considerations to large container ports. However, the last few years an increase on scientific publications

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on Small and Medium sized Ports with a focus on the ongoing trend of increasing container ship sizes has been recorded, as highlighted by several studies (Ding et al., 2015, Monios and Wilmsmeier, 2013, Svindland et al., 2019, Feng and Notteboom, 2013).

However, defining Small and Medium Ports is always a bit of a challenging question as there is no universally accepted definition. How is a port defined as being "small" or "medium"? Is it determined by the size of the surface of the port area, the volume of goods handled, the number of passengers that pass through the port, the economic benefit, the personnel employed or via a combination of all these factors?

Numerous port experts have tried to provide definitions combining several approaches. The most common approach is to measure the port according to its size and scale based on the annual volume of goods handled by the port, essentially cargo volume (i.e. total weight of goods loaded and discharged) or shipping tonnage (i.e. total volume of ships handled). In a case study "Small and Medium-sized Ports in Multi-Port Gateway Regions: the Role of Yingkou in the Logistics System of the Bohai Sea" (Svindland et al., 2019), it is proposed to define SMPs by using a multidimensional method. This approach includes the port's competitive position in its cluster region as well as the position of the port reflected in the following five indicators: (a) cargo volume and market share (b) international connectivity (c) relative cluster position (d) port city and hinterland connection and (e) logistics and distribution function. This method looks mainly at how SMPs survive and compete in a multi-port gateway region. The indicators (a) (b) and (c) focus on the role of SMPs in the competition dynamics between SMPs and large ports. The indicators (d) and (e) examine the potential economic impact of SMPs on the hinterland. This method puts the SMPs in a logistics system that assesses their performance and competitiveness, especially from the perspective of the inland port and intramodality.

Other experts firmly believe that the definition of SMPs is much wider than this. Based on certain studies, SMPs should acquire tangible and intangible assets including soft value and non-socio-economic benefits such as their reputation in the market, the quality of management, historical heritage and capabilities, and economic remit (Meyer, 2021).

In "The ESPO Fact Finding Report: European Port Governance" (Verhoeven, 2010) the following definitions are put forward:

- *Small port authority*: the annual volume of goods handled in all the ports managed by the port authority is less than or equal to 10 million tons;
- *Medium port authority*: the annual volume of goods handled in all the ports managed by the port authority is more than 10 million tons, up to and including 50 million tons;
- *Large port authority*: the annual volume of goods handled in all the ports managed by the port authority is more than 50 million tons.

Whatever definition for SMPs is chosen, port authorities have to guarantee that SMPs remain competitive and efficient. Unfortunately, SMPs cannot generate large traffic volumes like large ports. On the minimum, they have to be efficient with low costs, which means being able to carry out their traditional functions, likely accompanied by reliable infrastructure and personnel with the right skills and competences.

The internal transport community is currently making significant effort to make the port more integrated into the transportation system by creating more connectivity between the sea and the shore, contributing to efficiency and sustainability in transshipments and inter-modal shifts (Christodoulou and Kappelin, 2020, Monios and Wilmsmeier, 2013, Grosso et al., 2010, Baindur and Viegas, 2012, Christodoulou and Woxenius, 2019). The growth of digitalization and automation in the port sector will somehow embrace all types of ports including SMPs (Acciaro et al., 2020, Karaś, 2020). As a supplier of local jobs, often relying on limited human resources, SMPs need to be prepared for any change that might happen due to the adoption of new and emerging technologies by sharing experiences, knowledge, and best practices.

In this paper, the current situation of the port sector vis-à-vis automation and digitalization will first be described. Evidence associated with the impact on jobs at ports will be presented, followed by the identification of gaps between existing and anticipated skills needs in the market. The paper will also examine the extent to which automation could play a role in port efficiency and productivity and identify the impacts on human interventions in ports, specifically small and middle-sized ones.

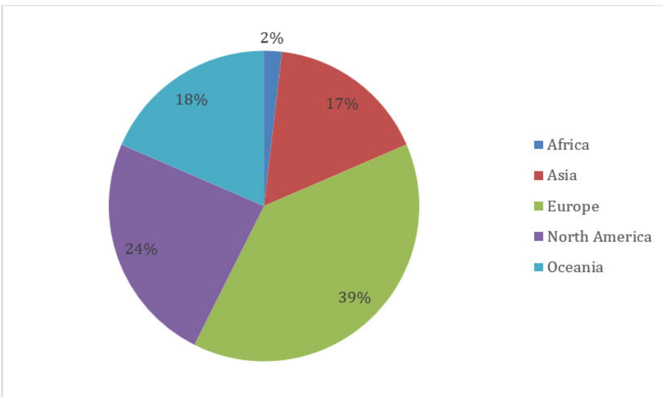
## 2. Technology trends in port developments.

In the last couple of decades, several ports around the world have seen changes in their infrastructures due to the expansion of new and emerging technologies in the port sector (Karaś, 2020, Molavi et al., 2020, Dalaklis et al., 2022). Modern port infrastructure has become essential as a competitive advantage. Increasing levels of digitalization and automation are now seen as drivers of competitiveness in the specific sector (Yang et al., 2018, UNCTAD, 2021, X, 2022). It can introduce significant changes in port business: from loading and unloading operations, to design infrastructure development and maintenance (Yau et al., 2020). It can also transform traditional port activities, including the types of jobs needed to effectively fulfil these activities. An examination of the global port sector indicates that the implementation of automation and digitalization has been increasing to a certain degree, when considering several factors such as the economic impact, social acceptance, and regulations.

For the time being, digitalization is more relevant for the port industry. However, it seems that there is a tendency to focus on automation and electrification when it comes to increasing efficiency of container transport and reducing time and costs (Molavi et al., 2020, Dalaklis et al., 2022, Yang et al., 2018, UNCTAD, 2021, X, 2022, Yau et al., 2020). Port information systems have also increased across vessels, trucks and terminals to reduce the use of paper documents (Sanchez-Gonzalez et al., 2019). Systems like e-maritime initiative and e-seal system are used by a large number of ports worldwide.

54 worldwide contemporary port initiatives associated with the implementation of new technologies including automation and digitalization were identified by (Merkel et al., 2020) (Appendix 1). These initiatives are analyzed here in relation to the continent and country where these ports are located, but also the modes of transport that are affected by the various automation and digitalization programs.

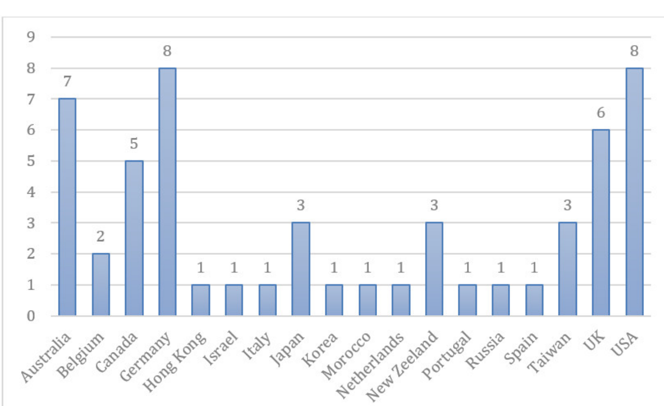
Figure 1: Port automation and digitalization programs by continent (2019).




Source: Own elaboration based on data from (Merkel et al., 2020).

As can be seen in Figure 1, more that one third of the automation and digitalization programs have been implemented in European ports, with North American ports coming at the second place (24%). Asian ports and ports in Oceania have adopted a7% and 18% of these initiatives respectively and only 2% of automation and digitalization programs were implemented in African ports. Figure 2 highlights the fact that ports located in North Europe (Germany, Belgium, Netherlands, UK) have been proactive in the adoption of automation and digitalization initiatives, followed by ports located in USA, Australia and Canada.

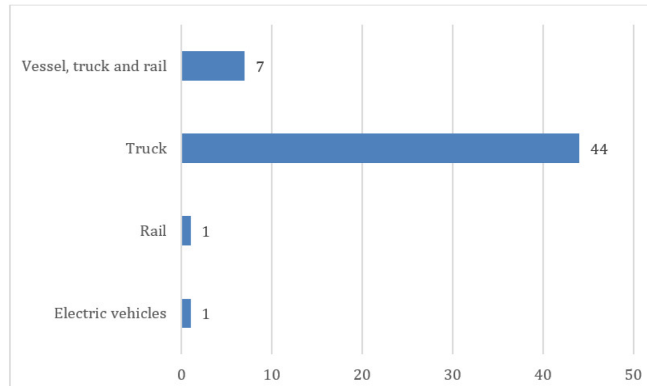
Figure 2: Port automation and digitalization programs by country (2019).




Source: Own elaboration based on data from (Merkel et al., 2020).

An interesting finding concerning the various automation and digitalization programs implemented by ports around the globe is the fact that their vast majority concerns truck operations within the port areas (83%) and only 13% relates to intermodal transport systems, including vessels, trucks and rail (Figure 3).

Figure 3: Port automation and digitalization programs by mode of transport (2019).




Source: Own elaboration based on data from (Merkel et al., 2020).

## 2.1. *Port Digitalization.*

The port sector is a highly competitive business. Shipping companies can easily change from one port to another if they are unhappy with the current level services, costs or any other factors that make ports competitive (Acciaro et al., 2020, Karaś, 2020). Nowadays, competition in the port sector is deeply related to port connectivity and automation as digitalization is clearly picking up pace (Duru, 2010). Digitalization and digital transformation, also designated as "digitalization 4.0", is more than just innovative technologies. It involves the creation of new business models, using and analyzing data science and improving the relationships with customers on this basis (Dalaklis et al., 2020).

During the last decade, various initiatives have been developed to enhance the coordination / synchronization / automatization of port operations in the era of digitalization. One of them is the International Port Collaborative Decision-Making Council (PortCDM), an international, independent entity that aims to improve the efficiency and effectiveness of activities in any port by providing a framework for data sharing and enhancing collaboration between all actors involved in port supply chain operations (xxx, 2021). The PortCDM initiative noted that "one size fits all" is not a good solution in a changing, dynamic, digital business environment. This initiative proposes to ports and their operators how to arrange collaborative processes within the port and with external actors on systems responding to the context in which they are operating (Acciaro et al., 2020).

The PortCDM initiative, among others, goes hand in hand with intergovernmental and international encouragement to the port community to reduce the administrative burden on ships during their visits to ports. For example, substantial efforts have been made by the maritime and port community to implement the so-called "single window data exchange"[2]. The IMO is also encouraging the standardization of the "just-in-time operation" concept[3] and e-navigation (Fonseca et al., 2021). Furthermore, various international requirements have been developed recently to encourage governments to introduce electronic information exchanges to facilitate international commerce and make it smoother and more efficient. Technology developers are also conceptualizing and developing tools to enhance port effectiveness and efficiency (UNCTAD, 2021).

In this context, SMPs are more than ever embraced by the growth of digitalization even if they do not have the same capabilities as larger ports. In a recent study on digitalization and automation in small and medium sized Swedish ports, which was conducted by the Swedish Maritime Competence Centre, one of the challenges identified is that most SMPs lack a dedicated IT department with personnel possessing the right skills and competences. The responsibility for IT is instead given to a person who is not fitting to the position (Merkel et al., 2020) . Another challenge is the lack of investment in technologies and innovation due to high investment costs. SMPs have limited budgets to invest in new technologies compared to larger ports. The same study points out that even when ports have implemented new systems, it is difficult to convince other external actors to use them. For example, truck drivers refuse to go beyond their traditional missions and use new devices requested by ports. Most of people interviewed for the mentioned study encourage collaborative approaches to discuss digitalization and the implementation of new digital solutions within and outside the port.

Furthermore, in the upcoming few years, the port sector will see an enhanced data stream delivered by many different sources and actors working within and outside the port. Upstream ports will provide digitally twinned information, allowing remote data streams to be collected and updated with minimal human intervention (Molavi et al., 2020, Yang et al., 2018, Yau et al., 2020).

For that, it is clear that collaboration between ports should not only focus on how to use digital devices but also on how to share instant data among stakeholders within and outside the port. Digital collaboration leads to synchronized, coordinated and harmonized port operations associated with other industries (UNCTAD, 2021). It is also a way to enable information transparency for port optimization through common situational understanding.

### *2.2. Port Automation.*

The development of automation in the port sector has taken a very slow path compared to other sectors like warehousing or mining (Poulsen and Sampson, 2019). However, since the introduction of automated stacking cranes at the European Container Terminal in Rotterdam in 1990, automation in ports has progressed significantly and is now considered as an enabler to increase competitiveness and effectiveness. Recently, automation has developed into almost all terminal functions, from remote controlled operations under safe and efficient conditions to fully autonomous terminal operations.

According to the United Nations Conference on Trade and Development Review on Maritime Transport (sfse, 2020), out of the world's 4,000 ports, 38 ports were reported to be operating 60 automated terminals, among which 14 terminals were fully automated and 46 terminals were semi-automated[4]. Several factors influence the level of port automation including technological feasibility, economic benefits, regulation and governance as well as social acceptance (xxx, 2021, Sirimanne et al., 2019).

Figure 4


Source: Transport 2040: Automation, Technology, Employment - The Future of Work, WMU, 2019.

- Technological feasibility.

Technological feasibility is mainly related to the technological readiness level of ports regarding port automation and autonomous surface vessels (ASV) (Devaraju et al., 2018). The most advanced and visible type of robots used in ports are the terminal dedicated autonomous vehicles such as autonomous straddles carriers. The implementation of these robots has significantly changed the functionality of many ports worldwide, affecting not only their efficiency but also their labor force. As regards safety, many ports have installed sensors to enable vehicles to detect objects and their position which permits management of the operation of automated vehicles, forklifts, and people in an efficient and safe manner.

- Economic benefits.

Numerous economic considerations have been driving the further development of automation in ports, including reduction of operating costs, increasing economic profits and increasing

[2] Single Window is a single-entry point for data. It is a platform that government mandates and allows for the submission of information to fulfill regulatory requirements linking economic operators and government authorities.

[3] Just-in-time concept is a lean manufacturing logistics strategy in which materials are kept off-site and delivered to the manufacturer precisely when they are needed based on the demand signals or a pre-determined schedule.

[4] A container terminal is termed semi-automated when its staking yard is automated. An automated container terminal refers to a terminal with at least an automated staking yard and automated horizontal transfers between quay and yard.

predictability. However, cost reduction is also related to labour reduction, especially reduction in the number of crane operators, cargo agents and lift truck operators (Schröder-Hinrichs et al., 2019).

- Regulation and policy.

Regulation and policy go hand in hand with the adoption of automation in ports. It can either support the implementation of automation or be a barrier to it. Without regulation and policy that allow the enforcement of technology respecting the environment, ports cannot be automated. Policy and governance also embrace the management of human resources in ports. They help to support strategic orientations of ports, specifically when it comes to upskilling workers with training, education and knowledge transfer.

- Social acceptance.

Based on different studies, workers are still employed in fully automated ports even though the working environment is completely changing. In the semi-automated ports, workers are more involved in daily operations. However, a decrease in number of jobs in ports of about 8.2 percent has been estimated (sdfs, 2022b).

Very few ports worldwide have plans and strategies in order to effectively adopt new technologies (Schröder-Hinrichs et al., 2019). Discussing automation internally in ports might be difficult as it touches the core of port operations, which are the Dockers. Port authorities and workers' unions need to negotiate the introduction of automation with the purpose of balancing job creation and job losses. Raising awareness of social acceptance and capacity building for port workers along with engagement with trade unions is vital.

## 3. Automation in SMPs.

Due to their specific characteristics, SMPs are facing several challenges in the path of adapting to the introduction of automation. One of the biggest questions that SMPs have to answer is from where to start their journey with automation. Based on the aforementioned recent study (Merkel et al., 2020), the Swedish Maritime Competence Center, one of the Swedish SMPs interviewed is considering starting with the installation of a photo gate with the purpose of inspecting the cargo that comes in and out, replacing port inspectors that physically inspect containers and trailers. Another interviewed port is looking at how they can use an autonomous ferry to transport goods between one of the production facilities for shipment, instead of having trucks every day for the same purposes.

Another question, as ever, is whether SMPs can afford automation. It is clear that in this path towards automation and innovation, SMPs are depending to the level of the implication of their regions or other local relevant public bodies, as well as by local business networks and the engagement of other relevant stakeholders working in the field, and by their connections with companies that are developing and commercializing technologies.

But again, the adoption of new and emerging technologies, including automation and digitalization, depends on the fulfillment of the factors that enable the technological adoption, which are the technical feasibility, social boundary conditions (regulation, policy and social acceptance) and economic benefit. Three scenarios could be considered by SMPs in the framework of these factors before making plans for automation.

Table 1: Three scenarios of technological adoption.

| Scenario | Economic Benefit | Technical Feasibility | Regulation and Policy |
|---|---|---|---|
| No adoption | No adoption or very limited adoption of technology | | |
| Slow adoption | Low | Major technological challenges to be resolved before applications are feasible. | Depending on the region where the technology shall be applied, it will be challenging to achieve social and legal acceptance. |
| Fast adoption | High | Applicable technology is already available, or is likely to be available soon. | In the region where the technology shall be applied, social and legal acceptance can be achieved. |

Source: WMU, 2019 (Schröder-Hinrichs et al., 2019).

In the first scenario, the assumption is that the adoption of automation is very limited. The effects on the workers are dominated by changes other than automation, like trade volume for example. In the second scenario, the assumption is that the economic benefit is low but the technical feasibility and the legal boundaries are high. In this scenario, the adoption of automation depends on social acceptance. For the third scenario, in which the adoption is fast, the economic benefit is high and the legal boundaries are low. The adoption depends mainly on the availability of the technology.

As for digitalization, SMPs need to collaborate with each other as well as with other actors in the sector to share experiences and evaluate different initiatives on automation to identify better solutions for a sustainable port business considering the protection of the environment and the existing work force (UNCTAD, 2021, Yang et al., 2020). It is also important that SMPs and their towns/regions communicate with one another. Both of them should work together to their collaboration and try to attract more manufacturing and distribution activities with the purpose of having a wider port diversification. Finally, helping port workers to upskill and adapt themselves to a fast-changing new work environment will be the new challenge for the SMPs. SMPs need to develop aggressive workforce development to address the widening gap between current skills and competences and future ones.

### 3.1. Knowledge and skills.

Based on the available information, jobs that remain in partially automated port terminals start to be more complex as the port workers have to maintain their previous workload in addition to new functions (Schröder-Hinrichs et al., 2019). More automated systems need crucial human contributions. The intervention might not be physical, but intellectual and mental contributions are essential. To provide an idea about the intervention of humans depending on the level of automation, different institutions have developed guidelines to describe the level of intervention of humans depending on the level of autonomy.

The United States Department of Defense has released an Unmanned System Road Map 2011-2036 (Yang et al., 2020, sdfs, 2022c), in which four levels of autonomy are described. The Road Map categorizes human behavior and includes human knowledge and skills.

Table 2: Levels of autonomy.

| Level | Name | Description |
|---|---|---|
| 1 | Human Operated | A human operator makes all the decisions. The system has no autonomous control of its environment, even if it may have information only responses to sensed data. |
| 2 | Human Delegated | The vehicle can perform many functions independently of human control when delegated to do so. This level encompasses automatic controls, engine controls, and other low-level automation that have to be activated or deactivated by human input and must act in mutual exclusion of human operation. |
| 3 | Human Supervised | The system can perform a wide variety of activities when given top-level permissions or direction by an individual. Both the individual and the system can initiate behaviors based on sensed data, but the system can do so only if it is within the scope of its currently directed tasks. |
| 4 | Fully Autonomous | The system receives goals from individuals and translates them into tasks to be performed without human interaction. A human could still enter the loop in an emergency or change the goals, although in practice there may be significant time delays before human intervention occurs. |

Source: US Department of Defense (sdfs, 2022a).

Depending on the level of automation, future job profiles will require new skills and competences. There is an alteration of low-skilled jobs to new types of medium and highly skilled jobs. The largest impact of automation will be on low-skilled job profiles (Schröder-Hinrichs et al., 2019). However, jobs that need a lot of physical efforts will be more accessible with the support of automation and digitalization. As an example, cranes could be operated remotely from a control room wish will allow to workers to be separated from machines and moved from physical and harsh working environment to a safe and more comfort one.

The medium and high-skilled workforce will be much more essential. For the high-skilled work activities, automation and innovation are often viewed as a crucial supporting tool. The objective is to complement the jobs rather than to replace them (xxx, 2021). In this regard, SMPs will need to compete not only with larger ports but also with other industries for skilled workforce whatever their level of automation.

## Conclusions.

The level of autonomy may vary between a port and another "competitor" depending on the regional and the local context in which the SMP is located. Beyond the role of automation and digitalization that might occur in the port sector, a long-term strategy and plan is needed for the SMPs to stay competitive in the market. Most of the automated ports are newly built, and are not the result of a renovation effort. The future of the port sector in certain countries might seek a lot of investments from regions and relevant stakeholders on the SMPs.

Cutting a long way short, SMPs are a node of economic and social development; automation and digitalization can be an opportunity for creating new jobs and/or of upskilling the already existing ones. There might also be an opportunity to bring new business to the regions where they are located.

It is also noteworthy that legal challenges might exist as far as automated vehicles in ports are operated mainly on private grounds. Some challenges might need to be addressed when it comes to operate automated vehicles that will need to cross public roads when moving from area to another in ports. Finally, there other issues that need to be addressed urgently, especially concerning the use of data of costumers as digitalization in SMPs is growing very fast.

It is clear that the growth of automation and digitalization might lead to a loss of a certain type of job profiles; on the positive side, examples like the Container Terminal Altenwerder (Hamburg) have shown that the reduction of labor can be limited by upskilling the existing workforce and by the creation of new positions, more than the average when the port was not automated.

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# Appendix 1

| Port Authority | Name of the programme | Initiative | Mode of transport | Implementation | Brief description |
|---|---|---|---|---|---|
| Amsterdam | Intermodal Planner | Digitalisation | Vessel, truck and rail | 2015 | Digital platform between transport operators and container terminals. |
| Antwerp | Central Booking Platform | Digitalisation | Vessel, Truck and rail | 2016 | Booking system for transport customers. |
| | Intermodal Solution and Connectivity Platform | Digitalisation | Vessel, truck and rail | n.a. | Connectivity platform that provides information about intermodal alternatives |
| Auckland | Vehicle Booking System | Digitalisation | Truck | 2007 | Trucks book slots in advance for picking up and dropping off containers. Encouraging off-peak truck travel and improving travel predictability |
| | Best Available Unit | Digitalisation | Truck | n.a | Cooperation between different agents to reduce unnecessary travels in and out the port, (only 20%-30% of the trucks visiting the port are carrying full loads). |
| Barcelona | EcoCalculator | Digitalisation | Vessel, truck and rail | 2012 | Website for calculating the CO2 emissions associated with a particular intermodal transport route. |
| Botany | Terminal Appointment system | Digitalisation | Truck | 2011 | Digital platform for appointment between truck drivers and terminal operator. |
| | RFID | Digitalisation | Truck | 2011 | The cost of monitoring was recouped by a newly introduced port wharfage of AUS$10 per TEU for both import and export containers. |
| | Trailer parking slot | Digitalisation | Truck | 2011 | Trailer parking slot in order to prevent early or late arrivals at the gate |
| Brisbane | Vehicle Booking System | Digitalisation | Truck | 2007 | Appointment system used by truck drivers (to deliver/collect containers), encouraging off-peak truck travel and improving travel predictability |
| Busan | Gate Automation System | Automation | Truck | n.a. | An automatic gateway management system for entrance/exit the terminal |
| Flexistowe | Vehicle Booking System | Digitalisation | Truck | 2007 | Appointment system used by truck drivers (to deliver/collect containers), encouraging off-peak truck travel and improving travel predictability |
| | RHIDES | Digitalisation | Truck | 2004 | An identity card for haulers at the port entrance |
| | PARIS-HPH | Digitalisation | Vessel, truck and rail | 2013 | A digital transport plan to reduce the number of empty containers being transported. |
| | Terminal Appointment system | Digitalisation | Truck | 2007 | Digital platform for appointment between truck drivers (to deliver/collect containers), encouraging off-peak truck travel and improving travel predictability. |
| Freemantle | Vehicle Booking System | Digitalisation | Truck | 2007 | Appointment system used by truck drivers (to deliver/collect containers), encouraging off-peak truck travel and improving travel predictability. |
| Genoa | Port Single Window | Digitalisation | Vessel, truck and rail | 2010 | Digital platform to facilitate electronic documentation |
| Guangzhou | Green truck project | Innovation | Truck | 2010 | Skirts (panels between rear wheels) reduce the amount of wind underneath the trailer and can improve fuel economy by up to 5%. |
| Hakata | Hakata Port Logistics IT system | Digitalisation | Truck | 2000 | Digital registration for all trucks and their containers in the Hi'TS |
| Haifa | New cargo gateway | Automation | Truck | 2016 | A truck passing system by automatic sensors on the terminal area |
| Hamburg | Smart Port Logistics | Digitalisation | Truck | 2011 | Logistics IT solutions for traffic management system |
| | EVE program | Digitalisation | Truck | n.a. | Digital data analysis to determine the traffic situation for road traffic in the port |
| | Parking Space Management | Digitalisation | Truck | 2015 | The mobile app of smartPORT logistics will inform truck drivers about capacities on the individual car. Parks and allow them to "book" parking bays. |
| | Port Road Management Centre | Digitalisation | Truck | 2011 | Port Road management system to make the existing road network more efficient traffic flows. |
| | The Intelligent Railway Point | Digitalisation | Rail | Pilot project (since 2015) | The Port Railway's network equipped with multi-sensor technology. |
| | The mobile all-purpose sensor | Digitalisation | Truck | n.a. | The sensor transmits its position and ID to a central system that collects this information. |
| | Smart Road | Digitalisation | Truck | Pilot project (since 2014) | Implement information technology systems in monitoring a road section in the Port |
| | Larmtelefon | Digitalisation | Truck | 2014 | Telephone connection between the staff of the terminal operator and the residents |
| Kaohsiung | Automatic Gate System | Automation | Truck | n.a. | An automatic gateway management system for entrance/exit the terminal |
| | License plate recognition System | Digitalisation | Truck | n.a. | A vehicle license plate recognition system. |
| Los Angeles and Long Beach | CAAP – Clean Truck Fee | Digitalisation | Truck | 2009 | Truck registration using data from electric gate access |
| | CAAP – Air quality monitoring | Digitalisation | n.a. | 2008 | Data collection regarding to air and weather in the harbor area. |
| | AB 2650 | Digitalisation | Truck | 2003 | Digital gate system to control truck idling times at terminal gates |
| Melbourne | Vehicle Booking System | Digitalisation | Truck | 2007 | Appointment system used by truck drivers (to deliver/collect containers), encouraging off-peak truck travel and improving travel predictability. |
| Miami | Electronic security gates | Digitalisation | Truck | n.a. | Digital gate system to reduce truck idling times. |
| Montreal | New truck entry portal | Digitalisation | Truck | 2011 | New digital truck entry portal to reduce transaction times by 80% and waiting times by 50%. |
| Nagoya | Nagoya United Terminal System (NUTS) | Digitalisation | Truck | 2005 | Digital gate system to reduce service time |
| | Screening center system | Digitalisation | Truck | 2011 | Digital tool to control containers and truck documentation |
| Napier | Vehicle Booking System | Digitalisation | Truck | 2007 | Appointment system used by truck drivers (to deliver/collect containers), encouraging off-peak truck travel and improving travel predictability. |
| Oakland | CTMP – Clean Trucks | Digitalisation | Truck | 2010 | Digital truck registration to control engine conditions. |
| Port Metro Vancouver | Traffic Management Centre | Digitalisation | Truck | 2013 | Real time monitoring of traffic conditions |
| | Truck Licensing System | Digitalisation | Truck | 2013 | Digital registration of different transport modes: fleet size, truck age, safety and environmental aspects |
| | Truck Clean Program | Digitalisation | Truck | 2008 | Radio Frequency Identification (RFID) to control trucks in the Ports. |
| | Terminal Appointment System | Digitalisation | Truck | 1999 | Appointment system used by truck drivers to reduce port access congestion. |
| Seattle | Truck Clean Program | | Truck | 2008 | Radio Frequency Identification (RFID) to control trucks in the Port |
| Sines | Port Single window | Digitalisation | Vessel, truck and rail | 2009 | Digital information system through a single window wants to avoid "double transshipping" in the port terminal. |
| South Carolina-Charleston | Clean Truck certification | Digitalisation | Truck | 2014 | Digital registration and certification for truck drivers considering their truck engine. |
| Southampton | Terminal Appointment system | Digitalisation | Truck | 2006 | Digital platform for appointment between truck drivers and terminal operator |
| St. Petersburg | Sea Port of Saint-Petersburg | Digitalisation | Truck | 2016 | Real time monitoring of traffic conditions |
| Stockton | The Port's Truck Traffic Control Plan | Digitalisation | Truck | 2008 | Real time monitoring of traffic conditions. |
| Sydney | Vehicle Booking System | Digitalisation | Truck | 2007 | Appointment system used by truck drivers (to deliver/collect containers), encouraging off-peak truck travel and improving travel predictability. |
| | Truck Clean Program | Digitalisation | Truck | 2008 | Radio Frequency Identification (RFID) to control trucks in the Port. |
| Taiwan Inter. Port Corp | Automatic Gate System | Automation | Truck | 2015 | An automatic gateway management system (RFID) for entrance/exit the. Terminal. |
| Tanger Med | Gateway management system | Digitalisation | Electric vehicles | Until 2017 | Digital registration trucks |