Smart Port as a Key to the Future Development of Modern Ports

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ABSTRACT: Technological innovations gives the opportunity to create so-called Smart Ports. However, determining which technologies to choose, how to implement them remains a challenge. The research problem presented in the article is: Is the constant introduction and implementation of the concept of intelligent ports an irreversible trend determining the direction of development of modern seaports? The aim of the article is also to analyze projects introduced in the ports of the North Sea and Baltic Sea which are successively implementing the concept of a Smart Port. The article uses the method of analysis - mainly current analysis and prospective analysis.

1 INTRODUCTION

The diverse nature of the seaport, distinguished by a wide range of enterprises and ecosystems, operating on various equipment, creates a difficult and demanding environment. Modern ports are transforming into smart ports, which is synonymous with developing solutions that meet the current and future challenges (Deloitte 2017). The difficulty is that being an intelligent port is a long-lasting process, and what is now innovative and makes the port intelligent may not be enough in the future. The existing solutions in the area of ports focus mainly on digital solutions, which are not sufficient for the ports to aspire to the role of intelligent. Intelligent solutions require integration on many levels, starting with social, economic and technological dimensions. There is still a long way to reach the mature concept of Smart Port and probably is not the final step in port development. However, there is no doubt that leaders of smart ports are European seaports, such as the Port of Hamburg or the Port of Rotterdam. The article focuses on presenting selected examples of innovations and new technologies in seaports because is the most appropriate method of research in this field. The aim of the article is also to show that intelligent ports are next step of changes in the broadly sense of functioning ports that are inescapable.

2 DETERMINANTS OF THE DEVELOPMENT OF SEAPORTS

The changes of modern seaports are affected by many factors taking place in the global economy, national policy, the environment of seaports, supply chains, but also a number of stimulants i.e. innovation, new technologies or sustainable development (Salmonowicz 2012). Seaports as integral elements of transport systems are complex objects of cooperation

for many entities (Grzelakowski 2017). Ports to deal with complexity and dynamism have to take steps to coordinate the activities of individual port stakeholders. The evolution of modern ports leads to the development of complex systems in the context of the importance of a seaport. The dimension of the importance of seaports can be expressed by assigning them to a specific generation.

In 1990, the United Nations Conference on Trade and Development developed a model for the classification of seaports based on three criteria: port development strategy and policy, the type and scope of services provided, as well as the degree of integration of port operations and organization. The model does not cover other important measures, such as port size, geographical location or organization. As a result, the model created by UNCTAD identified three generations of seaports (UNCTAD 1992) (see fig. 1). However, due to the changes that took place in seaports and their surroundings in the 1990s, UNCTAD in report from 1999 additionally described the concept of the fourth generation port, which serves as hubs or major regional ports whose activities are carried out on several levels simultaneously (UNCTAD 1999).
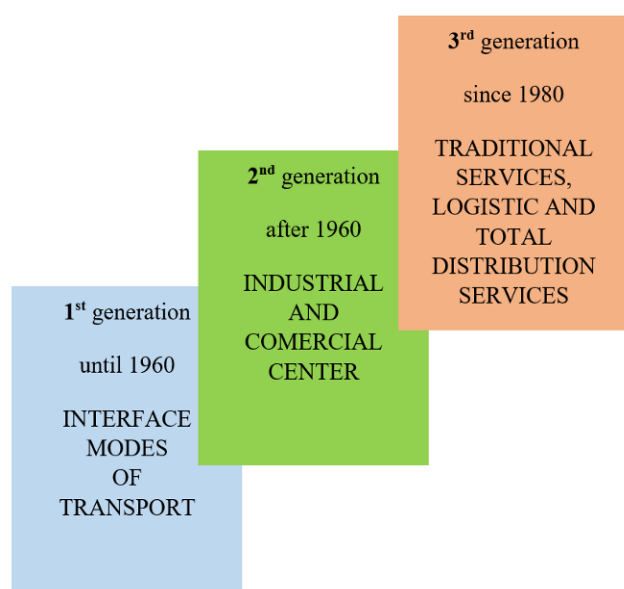

Figure 1. Evolution of seaport
Source: Own elaboration based on (UNCTAD 1991)

3   FIFTH AND SIXTH GENERATION PORTS

The rapid development of technology has resulted in changes in the port classification, therefore ports of the fifth and sixth generation are more often distinguished. Ports 5 GP provide handling services at the highest level in the world. Such ports include ports like Shanghai, Singapore, Hamburg and Rotterdam. Ports of the fifth generation focus mainly on increasing the efficiency and quality of their services, expected by port stakeholders. The role of this type of port as a logistic hub is also the ability to handle megaships without any limitations. One of the determinant of 5th generation ports is also use of advanced technologies and IT solutions (Kaliszewski

2018). Either of the Baltic ports, which aspires to be the 5th generation port is the port of Gdansk. For the purposes of achieving standards of the 5th generation, the port of Gdansk should become an important intermodal center, as well as a comprehensive logistics hub. Port infrastructure and superstructure should be a unified and integrated system managed using modern information technologies. For the Baltic Sea Region, the port of Gdansk should also play a key role as a transport interchange linking water and land passenger and freight streams (Polski Klaster Morski 2017).

Currently, neither of port in the world meets the sixth generation port criteria. Taking into account the criteria characterized by the ports of the first, second, third, fourth and fifth generation, the 6th generation ports should be distinguished by the service of container vessels with a capacity of 50 000 TEU and a maximum draft more than 20 meters (Kaliszewski 2018). The challenge for the 6th generation ports will also be to increase the surface area of storage yards, which can be achieved by developing modern storage methods, automating terminals, developing and implementing innovations in the field of technological and organizational. The task of 6GP ports will be to conduct a dialogue with port stakeholders, respond to their needs, but also planning and forecasting loading capabilities.

4   SMART PORT

Following the idea of Smart Cities, whose assumptions include universal access to information about the city, efficient communication and care for the environment has come time for the concept of Smart Ports. While the Smart City concept has been known for several years, Smart Port is an idea without a very specific definition. So this is a one of modern development perspectives in ports and shipping where nobody has the last word. The idea of Smart Ports is not only management of technological processes, but also digitalization, increasing the efficiency of operations in ports, integration of ports with cities and acquiring energy from alternative sources. Smart Port - the new model of management is a series of innovative tools used on technological and organizational level. To make the Smart Port concept an element of port strategies, it takes a lot of courage and creativity from the ports. And modern ports without intelligent solutions can not survive the intensity of competition. First of all the fundamental question remains what the port wants to achieve by becoming intelligent (see fig. 2).

The implementation of various types of innovative solutions that are not the result of a long-term strategy may turn out to be a fiasco. Due to the fact that the port is a diverse area, all activities must take place at the terminal level and at the port level. Implementations based on the concept of a Smart Port should bring benefits to stakeholders and the port authorities. While the market is full of technologies and many of them have universal applications, ports are diverse in their activities and usually need custom-made solutions. Other solutions require universal ports, and other ports that

specialize in servicing strictly defined loads, such as ports where crude oil and oil products are the main cargo. Therefore, it is important that terminals and port authorities should cooperate to implement the appropriate tools.
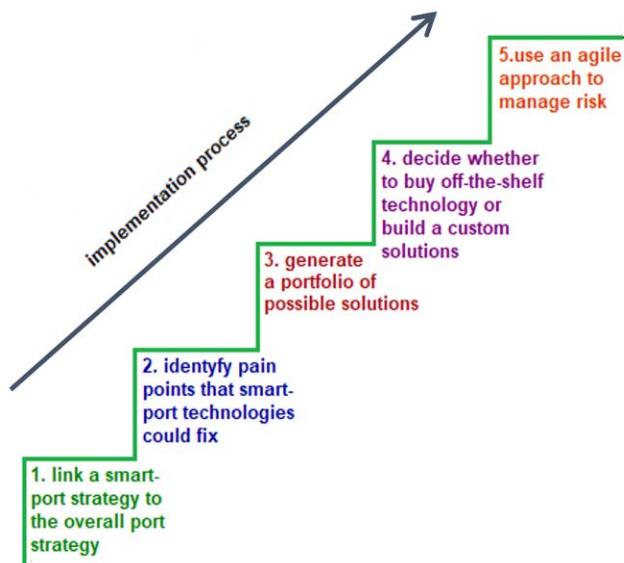

Figure 2. Steps for implementing a Smart Port Technology
Source: (Riedl, Delenclos, Rasmussen, 2018)

5 SMART PORTS IN NORTH SEA AND BALTIC SEA

Most of the large ports are involved in the implementation of Smart Port projects with different visions. Unfortunately, the lack of a strict definition of the Smart Port concept means that small operations undertaken by ports classify them to be intelligent. The following case studies present the implementation of the Smart Port concept in the key ports of the North Sea and the Baltic Sea - Port of Rotterdam, Port of Gdynia, Port of Antwerp and Port of Gothenburg.

1 Port of Rotterdam – OnTrack
In recent years, the railway has become an increasingly important form of transport, not only between the port of Rotterdam and its hinterland, but generally. Port of Rotterdam Authority recently launched a new application called OnTrack. This device provides insight in the expected time of arrival (ETA) (see fig.3) and terminal handling of trains. The application has been implemented to meet the needs of terminals and carriers, as well as to improve the efficiency of the planning process and schedule prediction. Carriers have a real insight into the specific handling of their loads in the terminal. Users receive the most accurate information such as the location of the train, destination, expected and actual time of arrival and departure and work progress related to the load in the terminal. The device presents to all users the same information in real time, reducing the number of misunderstandings and eliminating unreliable email communication. The application shows the number of containers or cars that have been loaded or unloaded and when the operation is

completed. OnTrack brings benefits to the entire railway chain - railway operators, traction suppliers, deep-sea and inland water terminals. At the beginning of April 2019 OnTrack was developed and tested with a number of different market parties under the project name HAROLD. The OnTrack app is a great example of new technologies that streamline processes, contributing to Rotterdam's ambition to become the Smartest Port in the world (Website Port of Rotterdam 2019).
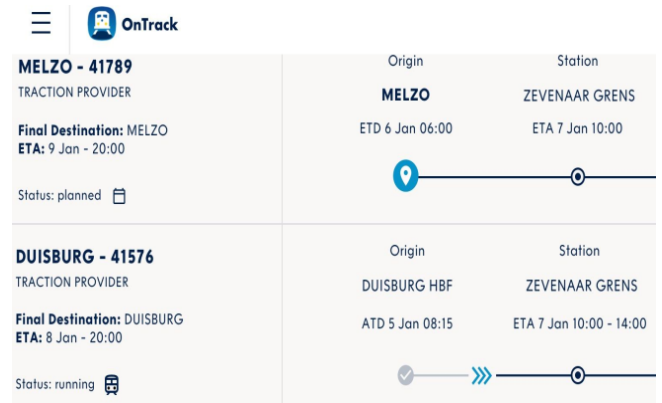

Figure 3. OnTrack Application
Source: https://www.portofrotterdam.com/en/ontrack

2 Port of Gdynia – NavSim
Port of Gdynia has the most modern mechanism for guiding ships around the world. Global Navigation Satellite System - Real Time Kinematic was implemented at the beginning of 2019. System supports pilots and captains during maneuver operations on the largest vessels that will call at the port of Gdynia in the coming years. The RTK station meets the strict requirements of the International Association of Navigation Signal Services IALA, ensures the compatibility of the amendments sent and increases the safety of navigation on the waters of the Gulf of Gdansk. Thanks to the fact this innovative technology of ship guidance, the port of Gdynia becomes one of the safest seaports in the world (Woźniakowski 2018). The tool created of NavSim makes it possible to visualize the actual movement of the ship with very high precision, with the measurement accuracy counted in centimeters, which until now was not possible (see fig. 4). In addition, the system supports the work of captains, which requires extreme precision during difficult weather conditions. Implementation of the system allows maneuvering the ship not only with limited visibility but also on fairways, where the traffic is getting bigger. NavSim Poland is a company specializing in the production of advanced electronic map systems and navigation support systems. The company is also known in the world, creates innovative solutions dedicated to marine and port pilots in the field of precise navigation (NAVCruiserPro). It is worth adding that this is the second such implementation in the world and the first beneficiary of this system is the Port of Swinoujscie (Website Port of Gdynia 2019).
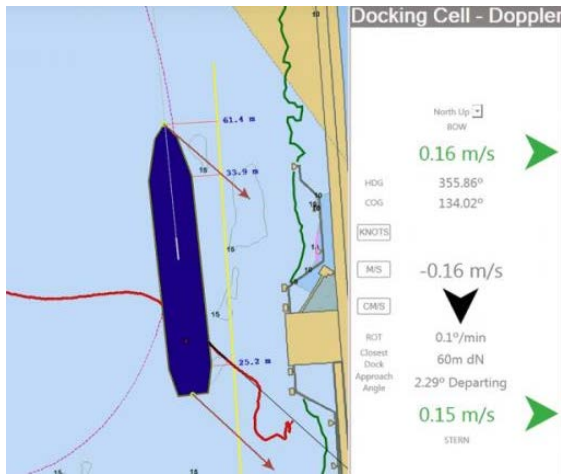
Figure 4. NavSim System
Source: https://www.port.gdynia.pl/pl/wydarzenia/aktualn
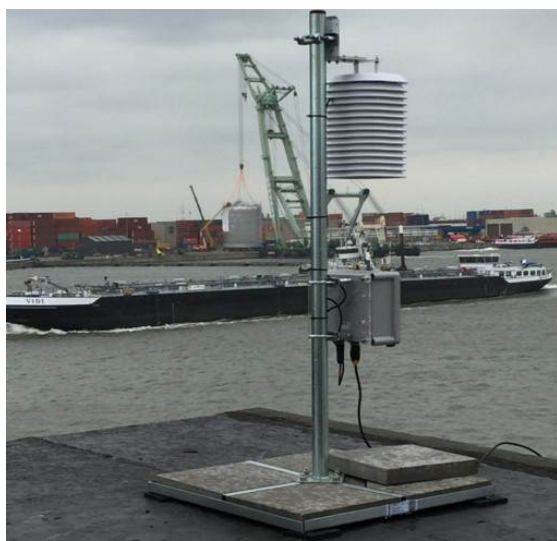osci/1236-nawigacja-co-do-centymetra-w-porcie-gdynia

Figure 5. iNoses sensor
Source: https://www.portofantwerp.com/en/energy-and-
environment-new-solutions-sustainable-future

3   Port of Antwerp – iNoses

Port of Antwerp is a key center for the development of the European chemical industry. The Antwerp is the heart of the European chemical industry from many years. Millions of tons of cargo a year passes through the port and chemicals are one of the most important product categories. 23 devices called iNoses have been installed in the port of Antwerp since 2017. These intelligent devices constantly measure and monitor changes in the composition of the air. The composition of the air is compared on the basis of patterns of known chemical substances. iNoses sensors are able to determine the type of odors coming. This technology makes it possible to take air samples - the sensors are equipped with small canisters (see fig. 5). This samples can be analysed in the laboratory, which gives a more reliable measurement. One of the goals of iNoses is create safe and healthy place to work. Chemical analysis confirms what is the type of substance and how it affects the quality of air in the port. The iNoses devices are run every day to identify the air composition and detect impurities. In fact, iNoses is a new technology that requires ful

implementation (Website Port of Antwerp 2019). Various devices for monitoring the composition of the air in port already exist. Part of them are very expensive and not suited for all different users because each of port has its own laws.

4   Port of Gothenburg – Bunkering App

The Port of Gothenburg Energy Port is the largest energy port with open access in the Nordic Region. Enegry Port handling over 2500 calls and more than 23 million tonnes of energy products each year. Advantage geographical location and investments to security have made Port of Gothenburg one of the largest bunker ports in the world. At the beginning of April the Gothenburg Port Authority launched innovation solution designed to make bunkering at the Energy Port. „Bunkering App" is one of the first in the world to offer this range of functionality. The application is dedicated to bunkering operators in the Energy Port, at the same time app eliminating reports submitted via e-mail or telephone. Notifications about bunkering are sent by the application (see fig. 6). The application synchronizes bunkering statistics, making it easier for operators to plan and carry out loading operations. The beginning of the year 2019 was a test period in which several companies joined, including Bunker One. Now company Bunker One is one of the participating companies that as part of regular operation. The implementation of the application gives Energy Port a chance to increase the efficiency and maximum use of bunker wharves. This innovative solution is next step of the Port of Antwerp in seeking to improve the digitization and automation which guides the idea of Smart Port. The first stage was to create a digital process control system. The implemented system has improved pumping through the use of a pipeline network (Website Port of Gothenburg 2019).
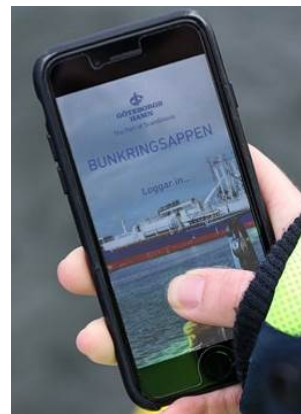

Figure 6. Bunkering Application
Source: https://www.portofgothenburg.com/news-
room/press-releases/gothenburg-port-authority-launches-
bunkering-app/

6   CONCLUSIONS

In summary, we can define a Smart Port idea as a seaport, which:
−   is equipped with devices at the highest level

- the technologies used match the business profile of terminals and types of handling goods
- is the integration of several entities - the port's authorities, port stakeholders and the surrounding, e.g. the region or the city
- strives for full automation
- manages a large amount of data - analyzed, processed and appropriately used
- implements ecological solutions
- gain a competitive advantage, but also works with the environment
- increases the efficiency and quality of services provided
- is flexible and susceptible to changes.

There is no doubt that Smart Port concept is not the last direction in the development of seaports. The constant introduction and implementation of the concept of intelligent ports is an irreversible trend determining the direction of development of modern seaports. The case studies presented above show that not only the largest ports, i.e. Port of Rotterdam, can afford to implement innovations. The Port of Gdynia also aspires to be the smart port. But for the ports to reach maturity in being intelligent, it takes time. It is also important to develop unambiguous indicators and measures of the level of intelligence for ports. Single innovative activities can not be treated as the implementation of the Smart Port concept. It is necessary to define strict frameworks and specific tools. Only on this basis can we speak about the evolution of ports. Certainly, this article does not exhaust the subject, but it is only a contribution to further discussion about Smart Port concept as modern direction of port development.

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