CONNECT2SMALLPORTS PROJECT

Digitalization in Baltic Ports – Practical approach

Within the frame of the South Baltic Programme

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	proposal		entire project partnership (direct + associated partners)
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	released	X	public in large, public distribution

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INTRODUCTION

This report is part of a deliverable assigned by the **Connect2Small Ports Project**. The report was compiled by leader – *Motus Foundation* and with the support of the partner – *Baltic Ports Organization*.

The core objectives of the present study are:

- to map the digitalisation projects in ports from the Baltic Sea Region in recent years,
- to analyse the distribution of digitalisation projects according to corresponding port processes and port areas,
- to explore the varying management's motivations for the implemented digitalisation projects,
- to detect main human resources in ports that are responsible for the implementation of digitalisation projects,
- to derive recommendations for future digitalisation projects and trainings in fellow ports.

The report is divided into **three** parts:

1. The first part concerns the analysis of results of questionnaire which was conducted among representatives of selected Baltic ports.

2. The second part describes the main operations in ports and the digitization technologies that are implemented in selected Baltic ports to improve the efficiency of the port's processes.

3. The last, third part focuses on the conclusions and proposals of future work that will allow smaller Baltic seaports to develop faster and more effectively on the market.

Key words: *digital technologies, Baltic sea ports, BSR, ports, projects*

METHODOLOGY

In order to draw a comprehensive picture about the status quo of digitalisation projects in ports from the Baltic Sea Region, the present study builds upon both collected qualitative and quantitative data. The methodology applied to conduct the research is shown in Figure 1.

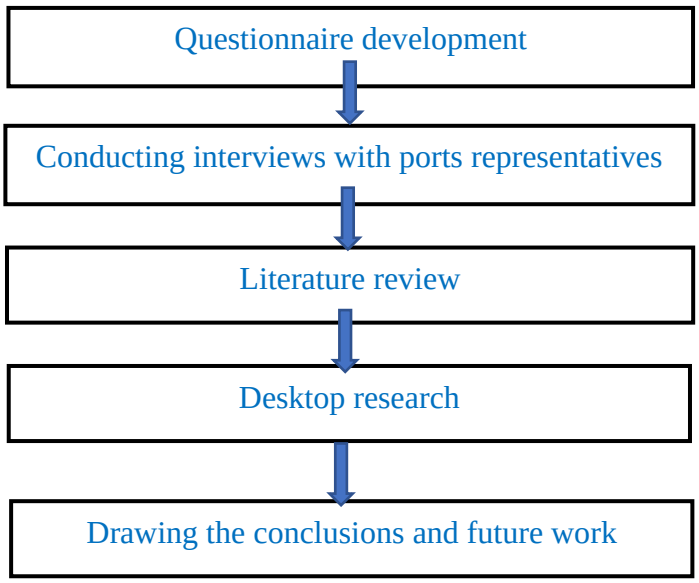


Fig. 1. Research methodology.

PART I – Digitalisation Questionnaire among Baltic Sea Ports

In 2021, a questionnaire was conducted among representatives of the Baltic ports (Tab.1). It is worth noting that at the request of one of the report's partners – Baltic Ports Organization, the questionnaire was also sent to Port of Oslo, which is not located on the Baltic Sea, but is a friendship member of the BPO. Table 1 includes only those ports that have expressed a wish to participate in the survey. Results from conducted expert interviews are presented in this part. The reason for conducting this survey was the need to know the degree of digitization readiness of the Baltic ports. Baltic ports are facing current era of ,,digitalization'' and the level of digitization readiness varies greatly between them. The questionnaire assessed how the selected ports cope with the implementation of new digitization technologies. The data was collected on the basis of questions from 5 different categories, such as:

- management,
- human capital,
- technology,
- functionality,
- information.

The **Management** category is about checking the ports' readiness to take the initiative to implement the digitization strategy and business model.

The **Human Capital** category looks into the level of employees' knowledge and their IT competences.

The **Technology** category is about checking the degree of digitalisation technology usage in the port. Ports present examples of technologies used by their ports.

The **Functionality** category looks into how the current IT systems and programs in the port are performing, e.g. IT security systems or shipment tracking etc.

The **Information** category focuses on the assessment of the amount / degree of information on digitization in the media, newspapers or social media etc.

The digitization questionnaire is strongly based on the DRIP model developed by Dr. Robert Philipp. It was created to assess the level of digitization and implemented in 50 Baltic ports, based on the same 5 categories that were used for the survey for this report (management, human capital, technology, functionality, information).

At the end of the survey, so-called AOB (any other business) questions were asked.

NAME OF THE PORT
Port of Aarhus
Freeport of Riga
Port of Ystad
Ports of Stockholm
Port of Rostock
Port of Helsingborg
Port of Kaskinen
Port of Pietarsaari /Jakobstad
Port of Roenne
Port of Klaipeda
Port of Oslo
Port of Wismar
Port of Sventoji (not shown on the map)

Tab.1 The green points represent ports where the survey was conducted.
Source: map from https://www.bpoports.com/

➢ Management

1. Does your port have a digitalisation strategy? If yes: What is the implementation status of your digitalisation strategy? If no: why?

The vast majority of ports declared that they have a digitization strategy and the strategy is in implementation or development phase. Some of the ports admitted that they do not have a digitization strategy or they do not see the need to implement one. One of the voices indicated that there is no such strategy, because usually ports do not have additional financial resources to develop it.

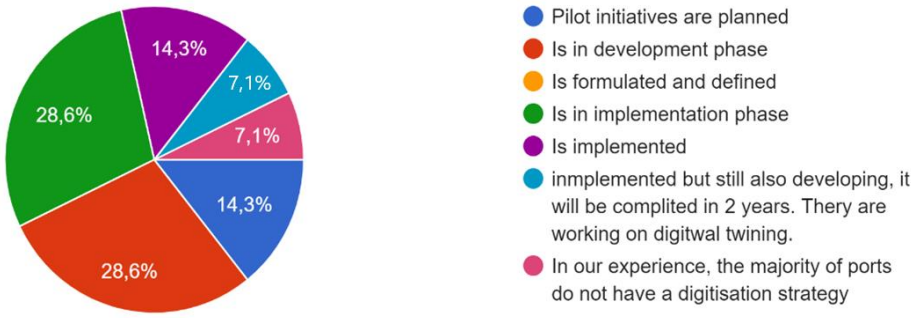


Fig.1 The implementation status of digitization strategies in ports.

2. Do you have a digital business model in your port? If yes: What is the implementation status of your digital business model? What digital technologies and solutions are used for your digital business model? If no: why?

The majority of ports declared that digital business model is in implementation phase. Port representatives say that they use following digital technologies and solutions for their digital business model: Kraken Tools, Cloud Computing platforms, information systems etc.

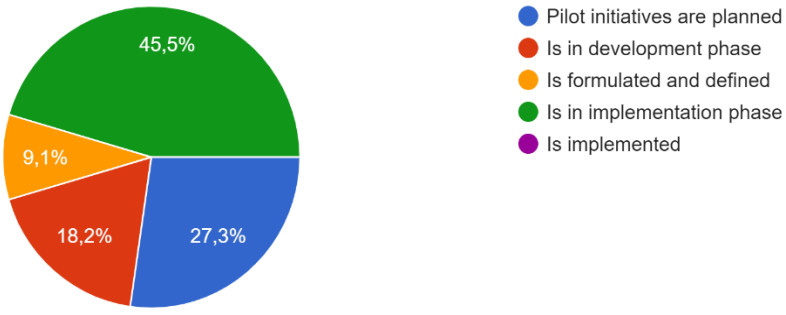


Fig. 2 The implementation status of port's digital business model.

3. Do you have R&D Co-operations for promoting your port's digital transformation? If yes: What is the implementation status of your R&D Cooperations? Which topics are covered by your R&D Co-operations? If no: Why?

Most of the ports said that they do have R&D co-operations for promoting their port's digital transformation or are in the implementation phase. 44.4% of the responses indicated that their R&D Cooperations status is in development phase. Following topics are covered by their R&D Co-operations: Blockchain, 5G Campus, Gate control system, Digital twin, Drons, Autonomous small ships, traffic optimisation on shore, optimising goods flow in the port and in/out, Interreg projects etc. 5 respondents admitted that they do not have R&D Co-operations, because they do not feel like there is a need for it yet or they do not have the tools needed for that.

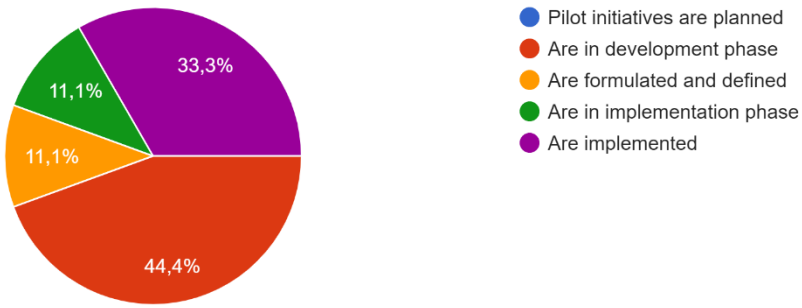


Fig.3 The implementation status of port's R&D Cooperations.

4. What is approximately the share of digitalisation investments (x) in relation to total investments per year in your port? Are there plans to increase the scope of digitalisation investments? What are the reasons for such a high/low investment rate in digitalisation?

The vast majority of respondents (62.5%) indicated that the share of digitalisation investments (x) in relation to total investments per year in their port is approximately 10%. Many of them admitted that there are plans to increase the scope of digitalisation investments, but there were also negative responses. The reasons for high investment of some of the ports is because as they say: they want to help others, come closer to industry and be prepared for the future. The reasons for low investment of some ports is because as they say: they are small ports and 10% of investment is already a high score for them, they need more time to do research about the theme, they still have other projects to implement before digital ones etc.

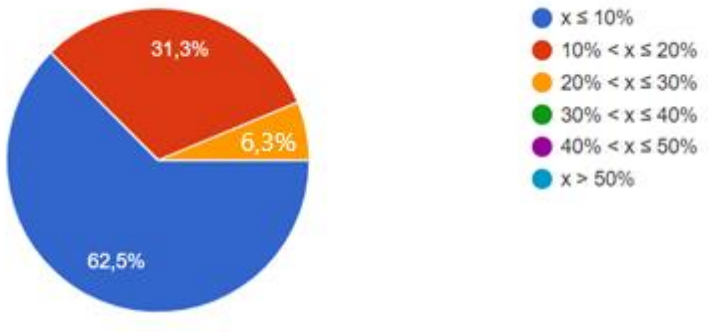


Fig.4 The approximate share of digitalisation investments (x) in relation to total investments per year in ports.

➢ Human Capital

1. What is approximately the proportion of employees in your port with an IT educational background (x)? Do you see a need to employ more employees with IT background?

The proportion of employees in their port with an IT educational background (x) is approximately 10%. Port representatives were very divided about the need to hire more people with IT educational background. Several voices were in favour of this idea. Some are considering such a need, but in the future. Several responses indicate that there is no need to employ people with IT education, because the port will train its employees in this regard.

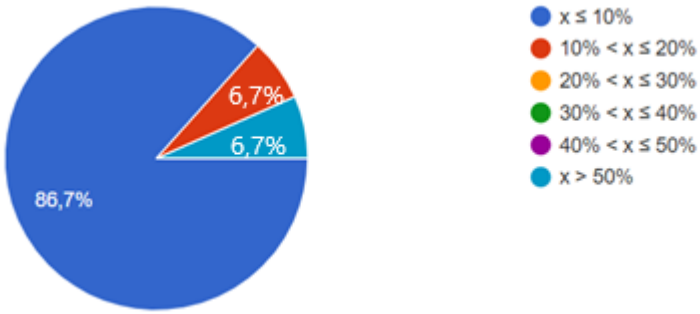


Fig. 5 The approximate proportion of employees in ports with an IT educational background (x).

2. Do you have a department/section/task force that focuses on digital technologies and their implementations? If no: Do you see the need to establish such a department/section/task force in the future? If yes: Are there plans for its expansion?

9 out of 15 responses indicate that ports do have a department/section/task force that focuses on digital technologies and their implementations. The rest declared that they do not have or they have outsourced companies that do it for them. Most of the ports who admitted that they do not have such a department/section/task are willing to have it in the future, but some of them do not have a need to establish such a department. 7 out of 12 port representatives are planning the expansion.

3. What is the skill level (capabilities) of port's employees regarding: IT infrastructure, automation technologies, data analytics, data security / communications security, development of / application of assistance systems, collaboration software, non-technical skills such as: systems thinking and process understanding.

The majority of respondents positively assessed the skill level of port's employees regarding all below categories. Collaboration software and non-technical skills were rated the highest. In both categories around 81% answers were positive (rather good, good, very good). Data analytics and Automation technologies received the lowest grade (very bad, bad, rather bad), but in both 62,5% answers, which is more than a half, were positive.

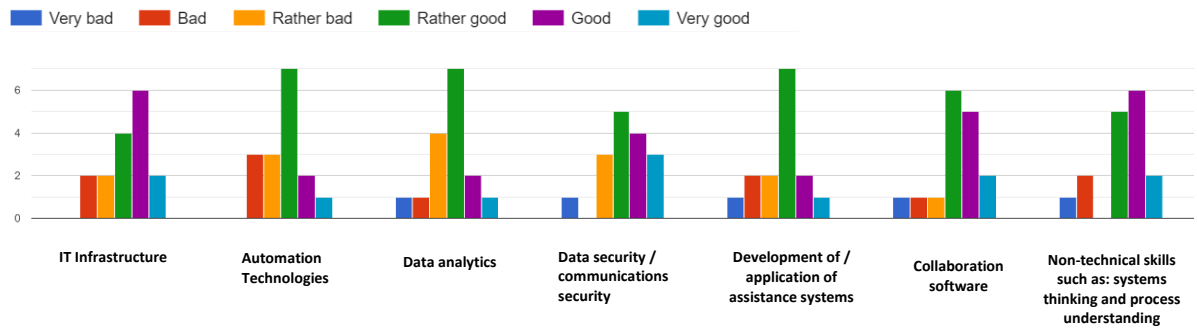


Fig.6 The skill level (capabilities) of port's employees regarding: IT infrastructure, automation technologies, data analytics, data security / communications security, development of / application of assistance systems, collaboration software, non-technical skills such as: systems thinking and process understanding.

4. How do you evaluate training and education possibilities concerning digitalisation for your port's employees?

Training and education possibilities concerning digitalisation were mostly rated as good (37,5%) and rather good (25%). Only 12.5% assess the level of training and education in this subject as bad and rather bad.

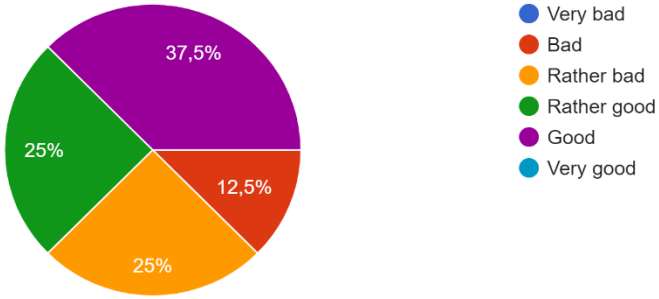


Fig.7 Assessment of training and education possibilities concerning digitalisation for port's employees.

➢ Functionality

1. How do you evaluate your integrated communications equipment?

Most ports' representatives evaluated integrated communications equipment as rather good (40%) and good (20%). There was only one voice out of fifteen (6,7%), which scored integrated communications equipment as very bad.

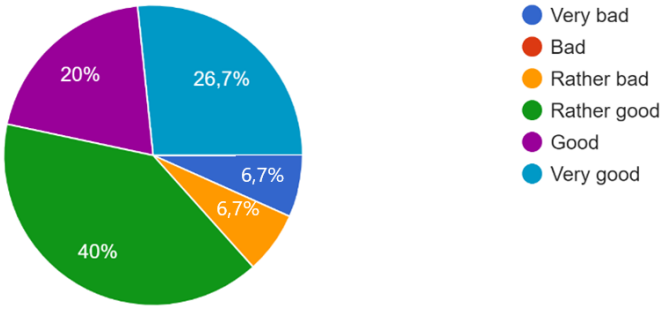


Fig.8 Assessment of port's integrated communications equipment.

2. How do you evaluate the accuracy of information regarding status of shipment?

This pie chart shows that ratings considering accuracy of information regarding status of shipment are mostly positive (73,5%), (rather good, good, very good).

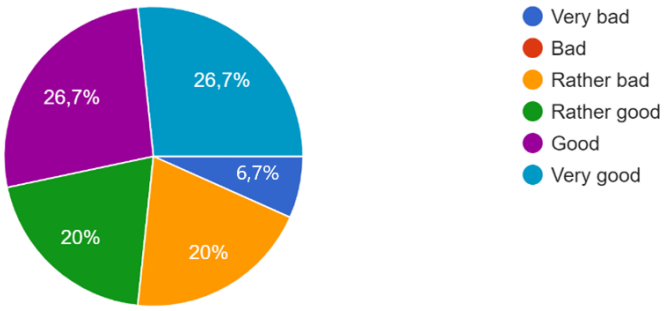


Fig.9 Assessment of the accuracy of information regarding status of shipment.

3. How do you evaluate the provision of on-time of information?

The provision of on-time of information has been evaluated very favorably. 80% of answers are very good, good or rather good, however 20% of the responses indicated the provision of on-time of information as rather bad.

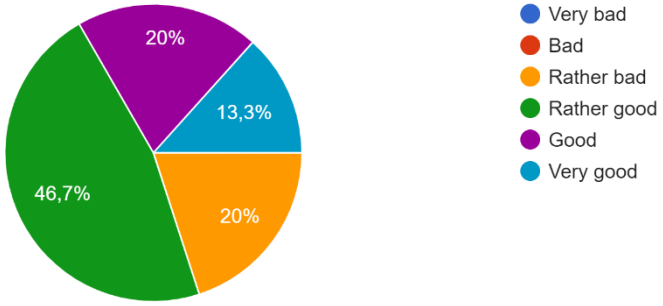


Fig.10 Assessment of the provision of on-time of information.

4. How do you evaluate the compatibility of your port operations system?

This pie chart shows that port representatives believe that compatibility of their port operations system is on high level. The 80% responses were affirmative (very good, good, rather good), however around 20% of responses were negative.

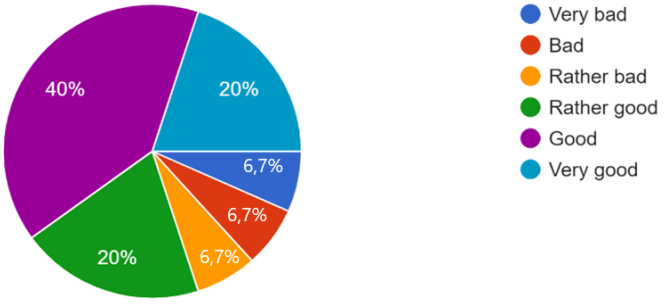


Fig.11 Assessment of the compatibility of port's operations system.

5. **How do you evaluate the degree of port's process adaptability in meeting customer requirements?**

It can be seen that 66,6% of respondents believe that degree of their port's process adaptability in meeting customer requirements is on the sufficient level (very good, good, rather good), while the rest of the respondents did not fully agree with such a high rating. 33,4% rated the port's process adaptability in meeting customer requirements as poor (very bad, rather bad).

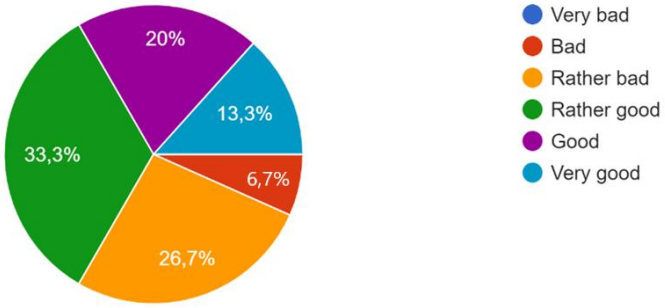


Fig.12 Assessment of the degree of port's process adaptability in meeting customer requirements.

6. **How do you evaluate the degree of IT security in your port?**

The degree of IT security in the ports most of respondents rated positively (81,3%), while only 18,7% of them were negative.

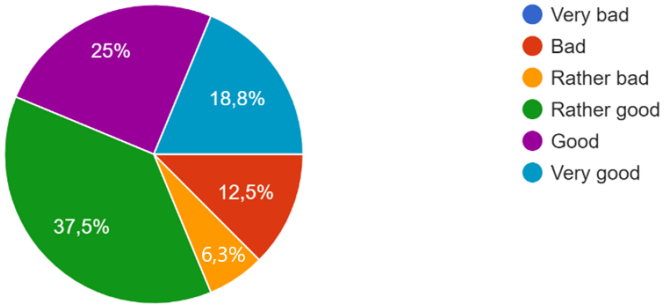


Fig.13 Assessment of the degree of IT security in port.

➢ Technology

1. **How do you evaluate the degree of digitalisation technology usage in your port? Name examples of technologies used by the port.**

Answers regarding digitalisation usage in ports are divided. Some port representatives believe that their digitalisation technology usage is on good level (56,3% of positive answers), while the rest of them think the opposite.

The ports declare that they use the following technologies:

- Artificial Intelligence solutions
- Terminal Operating system
- Digital Twin
- Internet of Things
- 5G network
- Remote Sensing Technology, such as: oil spill detection etc.
- Kraken Tools etc.

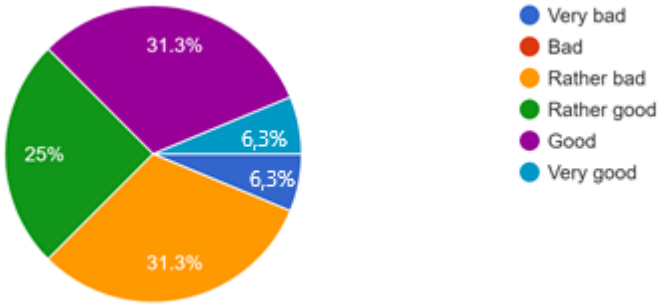


Fig.14 Assessment of the degree of digitalisation technology usage in the port.

➢ Information

1. **How do you evaluate the degree of information from: Personal Network, Printed Media, Internet, Social Media, Fairs, Conferences / Webinars, Associations and Consultancies and Scientific Institutions regarding the port digitalisation theme?**

It can be seen that most of the responders positively evaluated following sources: Personal Network, Internet, Conferences/Webinars, Associations and Consultancies and Scientific Institutions. At least 50% of answers were positive. However, sources such as: Printed Media, Social Media and Fairs were rated poorly. In all three categories, at least 50% of the responses were negative. To sum up, according to the respondents, the best sources of port digitalisation information are: Conferences/Webinars and Associations and Consultancies.

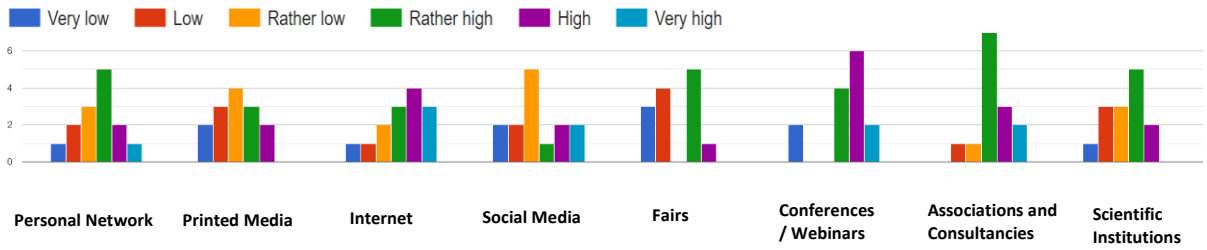


Fig.15 Assessment of the degree of information from: Personal Network, Printed Media, Internet, Social Media, Fairs, Conferences / Webinars, Associations and Consultancies and Scientific Institutions) regarding the port digitalisation theme?

➢ AOB

1. Is information sharing between ports concerning digitalisation projects needed?

The responses of the port representatives are unambiguous. Each of them believe that information sharing between ports concerning digitalisation projects is very needed.

PART II – Main operations in ports and digitization technologies

Ports have become to play a significant role in supply chains. The efficiency and safety of the cargo flows strongly depend on the related information flows [1]. ,,However, in order to increase the profitability and importance of the port in the global economy, it is necessary to implement the latest IT systems. Digital technologies provide the optimization, the management, and the automation of the port operation and the logistics processes, hence they create an effective advance which strengthens the port's position among the maritime communities. If it is not enough, they also improve the integration of governing bodies to standardize and harmonize the reporting formalities. Ports have been especially challenged during the COVID - 19 pandemic. The port enterprises, which had dynamically introduced innovative digital solutions, have maintained their position on the market. This means that applying digital technologies is the only way to maintain a high position in the international economy‘‘ [2]. According to Paulauskas V., Dawidowicz L. and Paulauskas D. (2021), seaports constitute the key nodes of the sea–land transport chains and closer integration into supply chains has a positive effect on their performance [3,4]. Therefore, the benefits of port digitalisation are also essential for the whole supply chain’s performance improvement [5]. Different types of IT system are presently implemented in seaports, both individual solutions and those integrated into complex IT architecture [6]. Over the last few years, the curiosity in digital technologies and their progress in various industrial and service sectors increases. As a result of the promising value proposition, the growing cross sectoral distribution and the value creation potential of digital technologies, they also receive more and more recognition in the maritime industrial and transport sector [7,8,9].

Baltic Sea Region large ports—the so-called core ports of the “Trans-European Transport Network” (TEN-T)— are already familiar with digital databased technologies like Blockchain or Internet of Things (IoT) and thus, continue to rely on a sustainable expansion of these advanced technologies that promise security, process optimization and sustainability. They are developing rapidly and merge into huge digital networks and platforms. By doing so, they connect and converge physical and digital worlds (i.e. machines, devices and humans). The main goal of such novel digital technologies is to optimize economic performance and energy demand, to reduce the consumption of resources and waste and to better qualify the service portfolio.

In this part of the report, we describe the main logistics processes and operations in port and present the digitization technologies that have been implemented, are being implemented or there is a plan to implement them through the Baltic ports in aim to optimize ports operations.

The key contributions of this part of the report are the following:

- To present the main port operations,
- To map digital technologies implemented in BSR and to describe their structure and aim.

Seaports, mostly small and mid-sized, are still lacking digital technologies in providing services and are thus less competitive compared to the seaports which implemented digital technologies. Currently, digital technologies which are most frequently implemented in leading seaports for providing seaports services are the following:

- Internet of Things (IoT)
- Big Data
- Cloud computing
- Digital Twins
- Blockchain technology
- Artificial Intelligence (AI)
- 3D printing

It is very difficult to identify the main digital domains in the BSR ports. However, the practice and scientific literature indicate that there are two main digital platforms used in BSR ports in recent years, which are gaining on importance – Blockchain and Internet of Things (IoT) [10]. Therefore, the report is most devoted to these two digital platforms, but not only.

Main Port Operations

This chapter introduces the main operational processes of the port, which have been defined on the basis of the literature. The literature does not clearly define the basic port processes.

Robinson (2002) listed the following roles of ports:

- Ports as places: They are places that handle ships and cargoes.
- Ports as operating systems: They are places that handle ships and cargoes with operational efficiency.
- Ports as economic units: They are places that handle ships and cargoes within an economic efficiency framework.
- Ports as administrative units: They are places that handle ships and cargoes within an efficient administrative and policy framework [15,16].

Dawidowicz and Posta (2015), defined the providing of seaports service as ordered sequence of organizational, logistical, technical, technological, economic and legal processes as well as actions and activities connected with the process of delivering goods from origin to destination [21,22].

However, most main port operations take place at the terminals. For example efficient container terminal logistic operations and processes are a need for every container terminal to maintain the business. „With ever increasing containerization the number of seaport container terminals and competition among them have become quite remarkable. Operations are nowadays unthinkable without effective and efficient use of information technology as well as appropriate optimization (operations research) methods‘‘ [17]. „The main facilities in container terminals include the quay, the container yard, the container freight station, the interchange area, the gate facility, and the railhead. The process at container terminals can be divided into subprocesses: arrival of the ship, cargo unloading and loading, transport of containers from the ship to stack, stacking of containers, and interterminal transport and other modes of transport. As containers move along the container transport chain, they can have a different status, including empty container, full container load, and less than container load. Generally, the network of nodes and links involved in the container transport chain can be classified into four principal functions, i.e., consignment assembly, consignment consolidation, carriage, and port handling‘‘ [17]. Fig.1 shows main processes at container terminals.

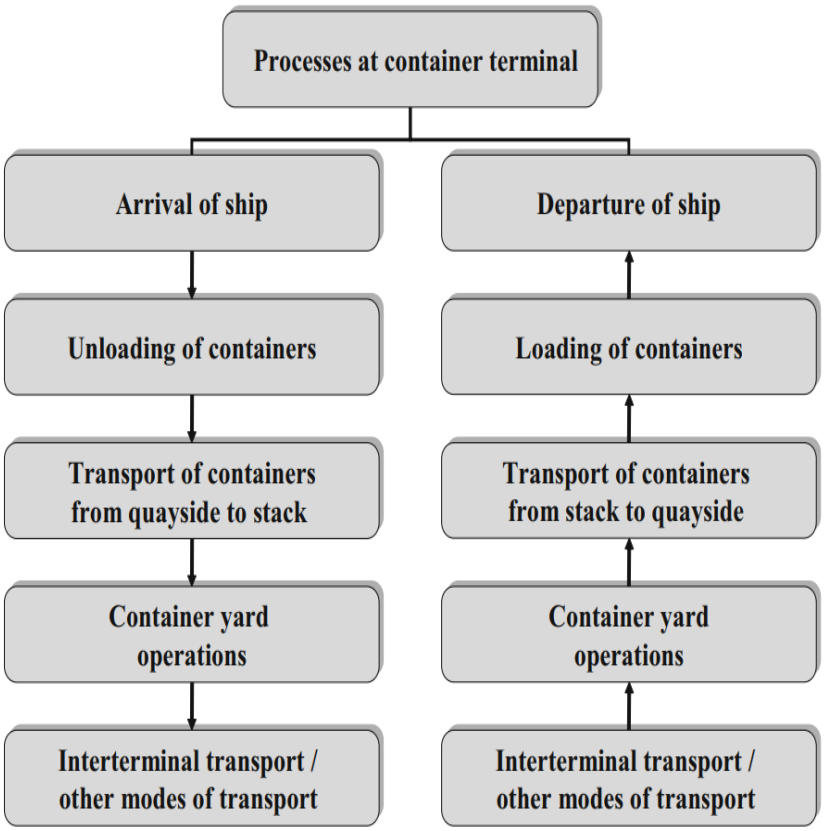


Fig.1 Main processes at container terminals [17].
Source: Voss, S., Stahlbock, R., Steenken, D., 2004. Container terminal operation and operations research - a classification and literature review. Spectr. 26, 3–49. https://doi.org/10.1007/s00291-003-0157-z.

Due to the increase in speed and volume, container terminal's operations require a better approach to regulation systems. The results of research on Blockchain and IoT can answer some of the challenges of the container terminal, enabling the permanent improvement of the capacity and efficiency of the terminal, including increasing efficiency without large investments in terminal expansion and new equipment. Currently, ports are looking for better ways in improving their productivity and offering logistical solutions to shippers of cargo. Ports no longer are handling just cargo, but more and more they are becoming "information handlers"[20].

1. Blockchain

Efficient logistics operations and port management are of particular importance to global trade and transportation services. Current port logistics systems are highly centralized and offer limited opportunities for collaboration between different stakeholders. Moreover, the existing systems do not ensure traceability, transparency, information security and the immutability of data stored and exchanged during the various operational processes. As a result, it negatively affects the performance of port terminals [11]. Blockchain is an emerging technology that provides transparency, and traceability through immutable data of the origin of trusted chain transactions, in a decentralized manner, without intermediaries or trusted third parties. Blockchain-based port logistics systems can enable heterogeneous organizations to securely exchange data with each other for collaborative decision making. For instance, in contrast to the physical exchange of trade documents, the blockchain technology can digitize documentation procedures to assist authorized users to access the information stored on the ledger [11,13]. Fig.2 presents blockchain-based data storage, access, and management in port logistics processes.

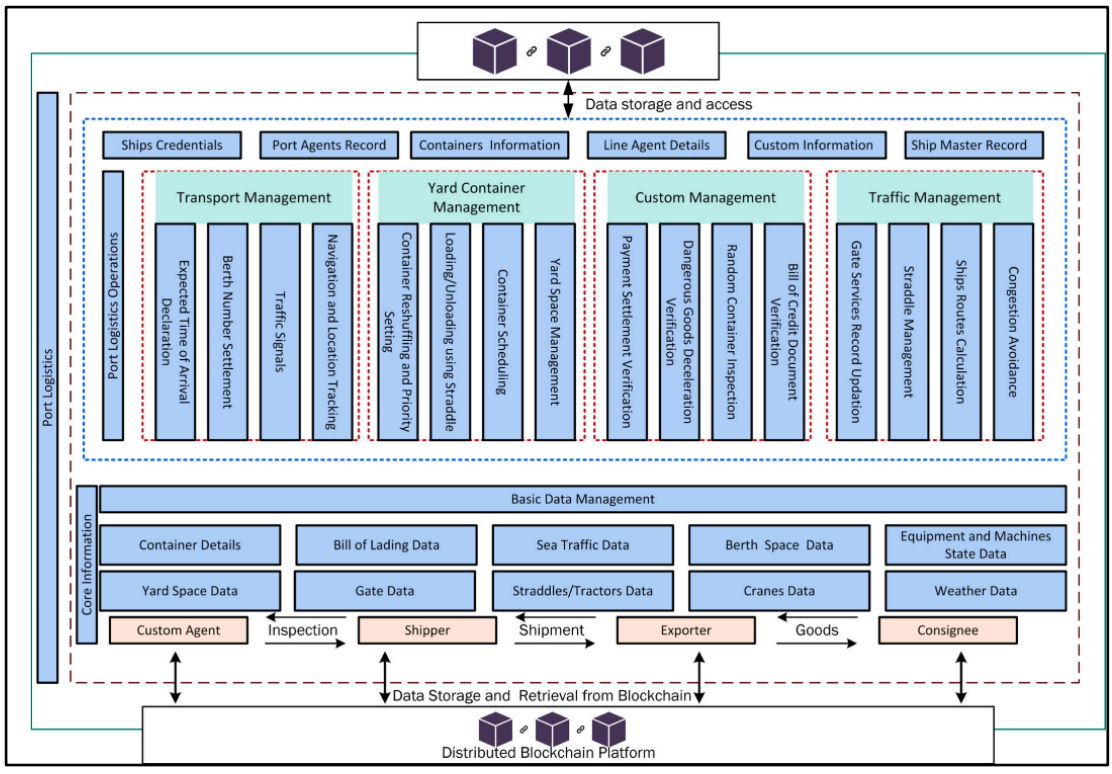


Fig.2 Blockchain-based data storage, access, and management in port logistics processes [11]. Source: Ahmad, R. W., Hasan, H., Jayaraman, R., Salah, K., & Omar, M. (2021). Blockchain applications and architectures for port operations and logistics management. Research in Transportation Business & Management, 100620. doi:10.1016/j.rtbm.2021.100620.

The implementation of Blockchain on port logistics opens the discussions on the efficiency and effectiveness of the current port inter-organizational information systems. The implementation of Blockchain implies a change in the architecture from centralized to a distributed type. By using a decentralized approach, which modifies the current processes, proposes a new set of possibilities and business opportunities.

More frequently blockchain projects are reviewed as solutions in the field of shipping and supply chain, primarily for better control over cargo handling and over time spent on transportation [18,19].

Many Baltic ports are aware of the need for blockchain technology, which is why innovative projects based on this technology have been developed in the BSR for several years. An examples of such a technology within BSR are below projects:

- **TradeLens Blockchain Platform** (Copenhagen Malmö Port , Denmark)

The Port of Copenhagen Malmö (CMP) has partnered with TradeLens, Maersk's and IBM's joint digital platform, to connect port and terminal operators, shipping lines and other actors in the global supply chain using blockchain technology. The platform supports the digitization of cargo and logistics data and documentation to replace manual processes, facilitating the secure exchange of information between different stakeholders in the logistics chain[1].

- **Portchain** (Copenhagen Malmö Port , Denmark)

The Portchain project was initiated in Copenhagen's Malmö Port (CMP). The aim of the project is to improve port control and traceability of the entire supply chain. Cloud scheduling tool with powerful optimization engine to increase the efficiency of crane, gang and mooring assignments and customer collaboration.[2]

- **Smartlog** (Port of Tallinn, Estonia)

The SmartLog is a blockchain pilot project aimed at reducing the total transport time of freight units in line with EU targets for road, rail, air and water transport networks in the Baltic Sea / North Sea region. These improvements are being made under the Trans-European Transport Networks (TEN-T) program. SmartLog tests for concept verification began in June 2017 at Muuga Harbor in the port of Tallinn, Estonia's largest container port. The project will combine some port management systems of individual operators with a blockchain solution. This is expected to raise local operators' awareness of how their performance relates to the wider

1 https://smartmaritimenetwork.com/2020/09/21/copenhagen-malmo-port-joins-tradelens blockchain/?fbclid=IwAR1j25tv0UHdPh_snSvTK-bcPR0QT43kaKVJYoNrcfmsF7VPalkkUTx1cLo
2 https://www.portchain.com/

context of port operations and provide them with solid insight on how to improve their interactions so that Tallinn Port benefits from speed gains and savings costs.

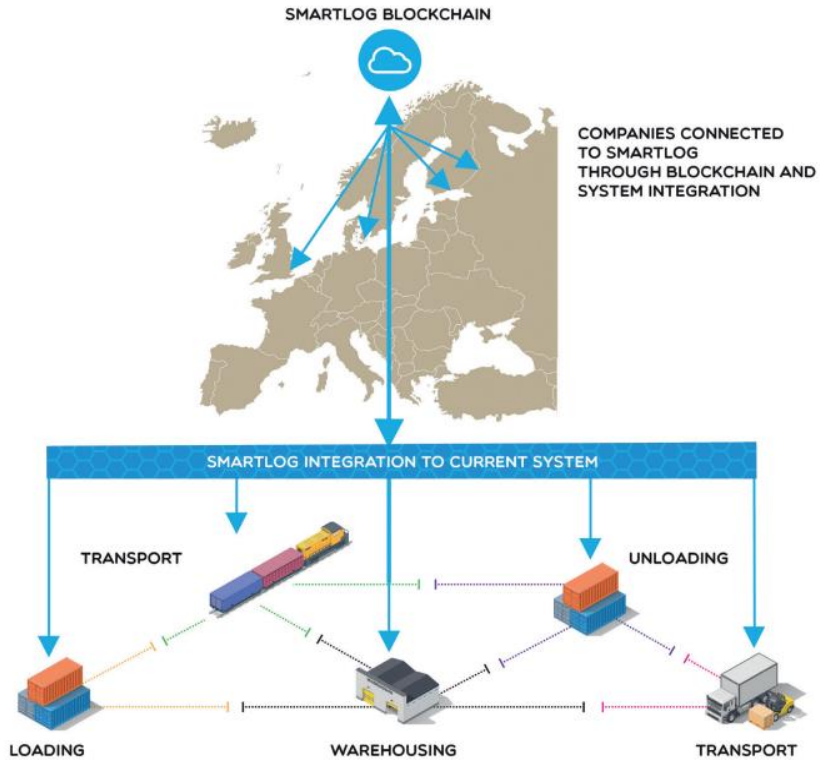


Fig 3. Example of how companies are connected to SmartLog through blockchain and system integretion[3].
Source:https://www.porttechnology.org/technical-papers/smartlog_piloting_blockchain_for_logistics/

Fig 3. shows how the project will connect some of the individual operators' port management systems together with the blockchain solution. „This is predicted to bring local operators greater awareness on how their performance ties in with the larger context of port operations, and give them solid insight into how to improve their interactions so that Tallinn Port benefits from the increases in speed and cost savings[4]".

3 https://www.porttechnology.org/technical-papers/smartlog_piloting_blockchain_for_logistics/
4 https://www.porttechnology.org/technical-papers/smartlog_piloting_blockchain_for_logistics/

2. Internet of Things (IoT)

The Internet of Things (IoT), as defined by IEEE, is a network of items, including sensors and embedded systems, which are connected to the Internet and enable physical objects to collect and exchange data [2]. IoT is enabling port equipment to transfer valuable data via sensor technology, boosting the efficiency and autonomy of regular operations[5]. With the growing dominance of IoT, sensors play a key role in measuring the physical properties of objects and converting them into numerical values that can be read by another device or by the user. The global sensor market has grown year by year in recent years and is expected to continue to grow at a high rate in the future [13,14].

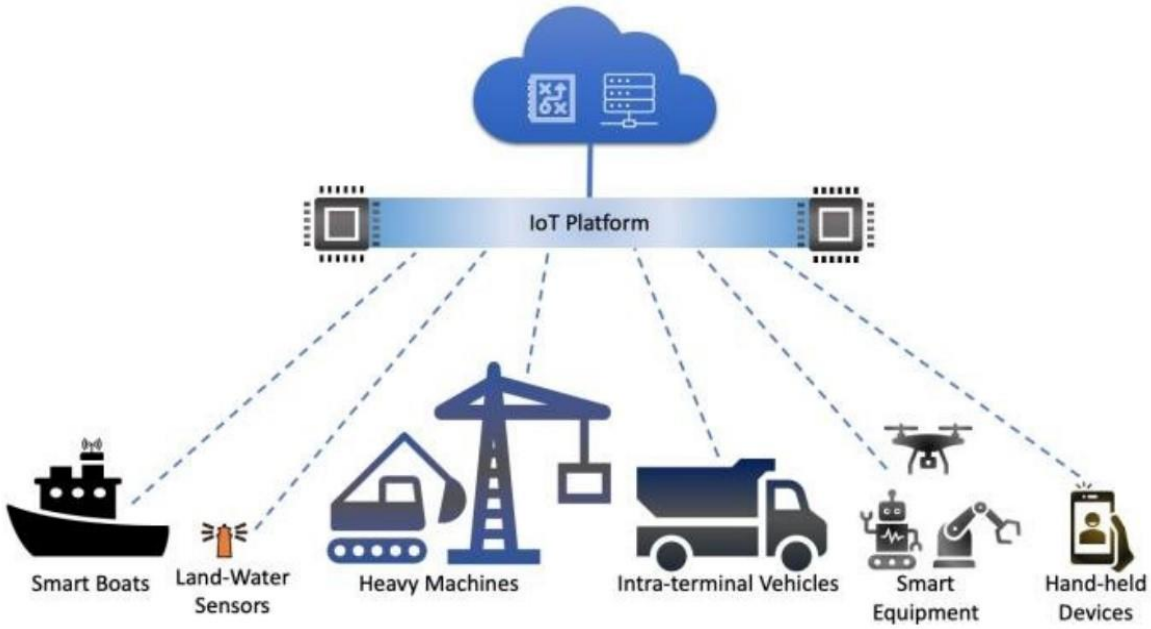


Fig.4 IoT and Device communication at Sea Port[6].
Source:https://www.researchgate.net/figure/IoT-and-Device-communication-at-Sea-Port_fig4_348269178

Shipping has acknowledged that the best strategy for the future is no longer to prioritize massive physical growth, but rather to optimize logistics flows and processes. Given this need, IoT provides the ability to manipulate, control, and monitor activities – a major step (though not the

5 https://steantycip.com/blog/top-five-port-technologies/
6 https://www.researchgate.net/figure/IoT-and-Device-communication-at-Sea-Port_fig4_348269178

only one) within a larger scheme of things[7]. ,,As the ports and related partners embrace the IoT solutions, the foreseeable future of the shipping industry appears to be moving in the direction of fewer accidents, lesser losses, more productivity, and more profits‘‘ [14]. Examples of IoT technology in the Baltic ports are presented below:

- **Feature Forest** (Port of Gdańsk, Poland)

Feature Forest is a start-up, which is not particularly intended to optimize port processes, but is worth mentioning in this report. Port of Gdańsk in Poland is working with start- to minimise harmful emissions and air pollution.

,,The system measures: air temperature; relative humidity; air pressure; ammonia (NH3); hydrogen sulfide (H2S); phosphine (PH3); wind speed; wind direction; and rain fall. The expected benefits of this project are:

- time savings thanks to the faster and easier access to reliable information on actual state of air pollution;
- increased safety of workers thanks to the implementation of the early warning pollution alert system;
- cost savings due to the compliance with air pollution regulations‘‘[8].

- **The AutoMoor** (Port of Tallinn, Estonia)

The AutoMoor installation is part of the TWIN-PORT 3 project being co-financed by the EU Connecting Europe Facility (CEF), a collaboration between Tallink, Viking Line and Eckerö Line, **the ports of Tallinn** and Helsinki and the City of Helsinki. Trelleborg’s AutoMoor solution is part of Trelleborg’s SmartPort portfolio. SmartPort powers the critical interface between ship and port, on land and at sea. It connects port operations, allowing operators to analyze performance and use data to improve decision making. The system integrates assets like fenders, mooring equipment, ship performance monitoring, and navigation systems, underpinned by cloud and Internet of Things (IoT) technologies[9]. The solution has many features, such as:

- Reduces turnaround time for vessels to berth and depart, increasing port throughput.

- Reduces the effects of passing ships in narrow waterways and the long period wave motions experienced in some ports and harbors, by damping motions of the affected vessel.

7 https://escolaeuropea.eu/blue-innovation/iot-impact-on-port-operations/
8 https://www.smartcitiesworld.net/news/news/port-of-Gdańsk-partners-with-iot-start-up-to-improve-air-quality2959#:~:text=Poland%27s%20Port%20of%20Gdańsk%2C%20one,harmful%20emissions%20and%20air%20pollution.
9 https://industrytoday.com/trelleborg-automoor-future-proofs-port-of-tallinn/

- Dampens vessel motions by reducing peak mooring loads due to surge and sway movements. Port operations can continue safely in a greater range of environmental conditions[10].

3. **HYPERCELL** (Port of Helsinki, Finland)

„HYPERCELL provides data on passengers' movement inside traffic terminals, their queue times and staying times in certain areas. This information can be used for better optimization of the terminal services to gain significant cost savings and improve the customer experience. Hypercell's IoT platform provides real-time data that can be used for deep insight into the port's dynamics, both in passenger terminals and loading platforms. The platform helps decision-making and vastly improves port logistics and services. It is possible to create a real-time view of the desired area and use our technology to provide an anonymous visual image of passenger flow or focus on cargo logistics and safety at key areas. HYPERCELL, detected passenger flow and terminal flow in Port of Helsinki and Port of Turku [11].

The technology works as presented:

Data collection is easily done using one or more of company's propriery Hyperunit-sensors.

Data processing and storage is automatically done by company's cloud services. All data that they store, is stored securely.

Data consumption is easily done using company's user interface or REST API. All data can be accessed in real-time.

Source: https://www.hypercell.ai/technology

10 https://www.trelleborg.com/en/marine-and-infrastructure/products-solutions-and-services/marine/docking-and-mooring/automated-mooring-systems/automoor
11 https://www.corealis.eu

Other Digital Projects in BSR

Table 1 presents a list of exemplary digitization projects in the Baltic ports according to corresponding port processes. The projects and technologies in this table were very difficult to classify into one technological trend (eg Blockchain or IoT), but all of them have one main aim - to improve the operational capabilities of the port.

Examples of other digital projects in BSR					
Country	**Port**	**Core/Compreh.**	**Year**	**Example of Digital Technology / Project**	**Port Processes (aim of the technology)**
Denmark	Aalborg	Compr.	2019	Maritime Block Power	Project that aims to identify the potential of blockchain technology for maritime enterprises.
Denmark	Aarhus	Core	-	Improvement of CRM-related processes.	A common portal on which data can be shared with the customers and the data can be used as a decision-making basis in ports operation.

Denmark	Frederikshavn	Compr.	2012- 2019	Port Expansion Project	The aim of the project is to improve goods handling in port and make room for larger ships. Optimisation of ports layout to minimise downtime.
Denmark	Helsingør	Compr.	2014-2022	New Smart Digital Operations	The main goal of the project is to reduce by 10% the time of - predefined logistical/maintenance port operations and lower by 10% the port energy and pollution by building on collaborative expertise and joint practice. This will be achieved by introducing, testing and monitoring intelligent technologies and processes in the storage, deployment, sharing and transmission of data related to marine conditions, sea/landside operations and energy production/consumption/distribution in ports.

Denmark	Hirtshals	Compr.	2018	Digital train in Port	With a "digital" shunting locomotive, Nordjyske Jernbaner has the opportunity to transfer their own infrastructure between Hirtshals and Skagen and at the same time they can also help rail freight operators with "analogue" trains.
Denmark	Copenhagen /Malmo	Core	2019 ; 2020	Optical Character Recognition; Smart Maritime Network	OCR technology is a "tremendously powerful technology which nicely complements an efficient gate operating system", it lets containers register digitally; Smart Maritime Network is a platform which supports the digitisation of cargo and logistics data and documentation to replace manual processes. This facilitates the exchange of information between different stakeholders in the logistics chain.
Denmark	Odense	Compr.	2018	EIVA and NaviSuite Perio	The software projects virtual buoys where physical buoys once marked out the deepest parts of the channel. The system aims to save costs and time compared to their old physical method of marking the fairway.
Germany	Kiel	Compr.	2018	PASIS-Paper Shed Information System	The system manages the preparation of the cargo, assigns loading ramps and records the status of the individual loading process in real time. An additional advantage is the fact that the truck drivers can see on their mobile devices when and where their cargo is ready for collection.
Germany	Lübeck	Core	2019	Hansalink 2 - CEF	Optimising the use of the existing terminals and improving IT and data documentation, data security and efficient communication.

Germany	Rostock	Core	2018	IHATEC	Research project not a technology, but worth mentioning. Project about the digitalisation and optimisation of pre-storage and loading processes.
Estonia	Tallinn	Core	2017	Digital and Smart solutions; SMARTLOG;	Digital solution to minimise the amount of time spent by passengers and shippers, significantly reduce the traffic load and air pollution created by trucks and eliminate unnecessary bureaucracy from the processing of logistics data. The SmartLog is a blockchain-enabled pilot project aiming to reduce overall cargo unit transport times in accordance with the EU's targets for road, rail, air and water transport networks in the Baltic/North Sea region.
Latvia	Liepāja	Compr.	2011	Port Gate Control System (PGCS)	Port Gate Control System is devoted to collecting, storing and processing data on pedestrians and motor vehicles, entering and leaving the seaport area.
Latvia	Rīga	Core	2020	The Low Carbon Mobility Management (LSMM)	The LSMM system aims to reduce noise pollution caused by road transport, reduce CO2 emissions and environmental noise, and improve road safety.
Lituania	Klaipėda	Core	2020	PortGIS	Leads to automation and digitalisation of port processes, IoT devices for, quality management, oil spill detection.

Poland	Gdańsk	Core	2020	Port Community System	The main goal of PCS is to automate the complex information flows and redirect them to relevant parties, reduce the number of errors, processing costs and time delays.
Poland	Gdynia	Core	2019-2020		
Poland	Szczecin	Core	-		
Finland	Helsinki	Core	2011/2015/2021	SMARTER; Smart Harbour	The aim of SMARTER is to digitalise harbour operations.
Finland	Kaskinen	Compr.	2020	Port of Kaskinen with Metsä Group	Digitalisation of the entire port logistics administration, including the handling of necessary shipping documentation.
Finland	Kokkola	Compr.	2019	Ukkoverkot and Nokia LTE network	The LTE network enables efficient data transmission, which includes security, equipment operation and control systems, rescue and other vehicles and control.
Finland	Oulu	Compr.	2021	GNSS – SEA SURFACE SENSING PLATFORM	GNSS reflectometry data enables continuous monitoring of sea surface properties such as sea level, sea wind speed, wave height, ice thickness etc.
Finland	Pietarsaari	Compr.	-	GISGRO	GISGRO online platform which aims to help harbor masters and the VTS crew to utilize the survey and asset data easily.
Finland	Rauma	Compr.	2020	EfficientFlow	Project objectives included better and faster information exchange between different operators in the port, time savings in port operations, shorter waiting times, more efficient use of resources and savings in marine fuel consumption.

Finland	Turku	Core	2021	SMARTER; Sea for Value	SMARTER - digitalising harbour operations; Sea for Value - sensor test station provides data for the intelligent fairway in the archipelago.
Sweden	Gävle	Compr.	2020	EfficientFlow	Project objectives included better and faster information exchange between different operators in the port, time savings in port operations, shorter waiting times, more efficient use of resources and savings in marine fuel consumption.

Tab.1 List of other digital projects in BSR region.
Source: Own elaboration.

PART III – Conclusion and Future Work

The key outcomes of the interviews:

1. The vast majority of ports declared that they have a digitization strategy or the strategy is in implementation or development phase.

2. The majority of ports declared that they have a digital business model and it is in implementation phase.

3. The proportion of employees in their port with an IT educational background is about 10%.

4. Answers regarding digitalisation usage in ports are divided. Some port representatives believe that their digitalisation technology usage is on good level (56,3% of positive answers), while the rest of them think the opposite.

5. The responses of the port representatives are unambiguous. Each of them believe that information sharing between ports concerning digitalisation projects is very needed.

Based on interviews with Baltic ports, as well as on the basis of literature, we found that the needs of small and medium ports are more about problems related to technical and ICT interoperability and management. After improving the technical and ICT base, they are able to develop softer skills and innovate. Small and medium-sized Baltic ports seem to be aware of the importance of training and education of employees to use digital technologies to achieve seaport service quality, but they are still doing it slower than the larger Baltic ports. This may be dictated by less need to implement digitization to their ports. Digital technologies are not used equally in all seaports. Small and medium ports have a lower turnover of goods than larger ports (attachment 1), so they believe that because of this, they do not need more advanced technologies (which in some cases can be true). However, it is expected that in the future, seaport service quality will be determined by digitalization and more digitalized services will be implemented, whether is it a small, medium or big port.

The analysis of digital technologies in BSR shows that, among the Baltic countries, most digitization technologies are carried out in Nordic countries, for example, Finland or Denmark. The Nordic-Baltic region is a digital frontrunner. The reason for such a high degree of digitization in Nordic ports may be the declaration they adopted. This declaration is taking its departure point from the priorities of Norwegian Presidency of the Nordic Council of Ministers in 2017 and the Digital Single Market Strategy (DSM) of the EU.[12] Their policy focuses on:

12 https://www.norden.org/en/declaration/nordic-baltic-region-digital-frontrunner

- Strengthen the capacity of their governments and societies to digitally transform, in particular by creating a common area for cross-border digital services in the public sector.

- Strengthening the competitiveness of their enterprises through digitization.

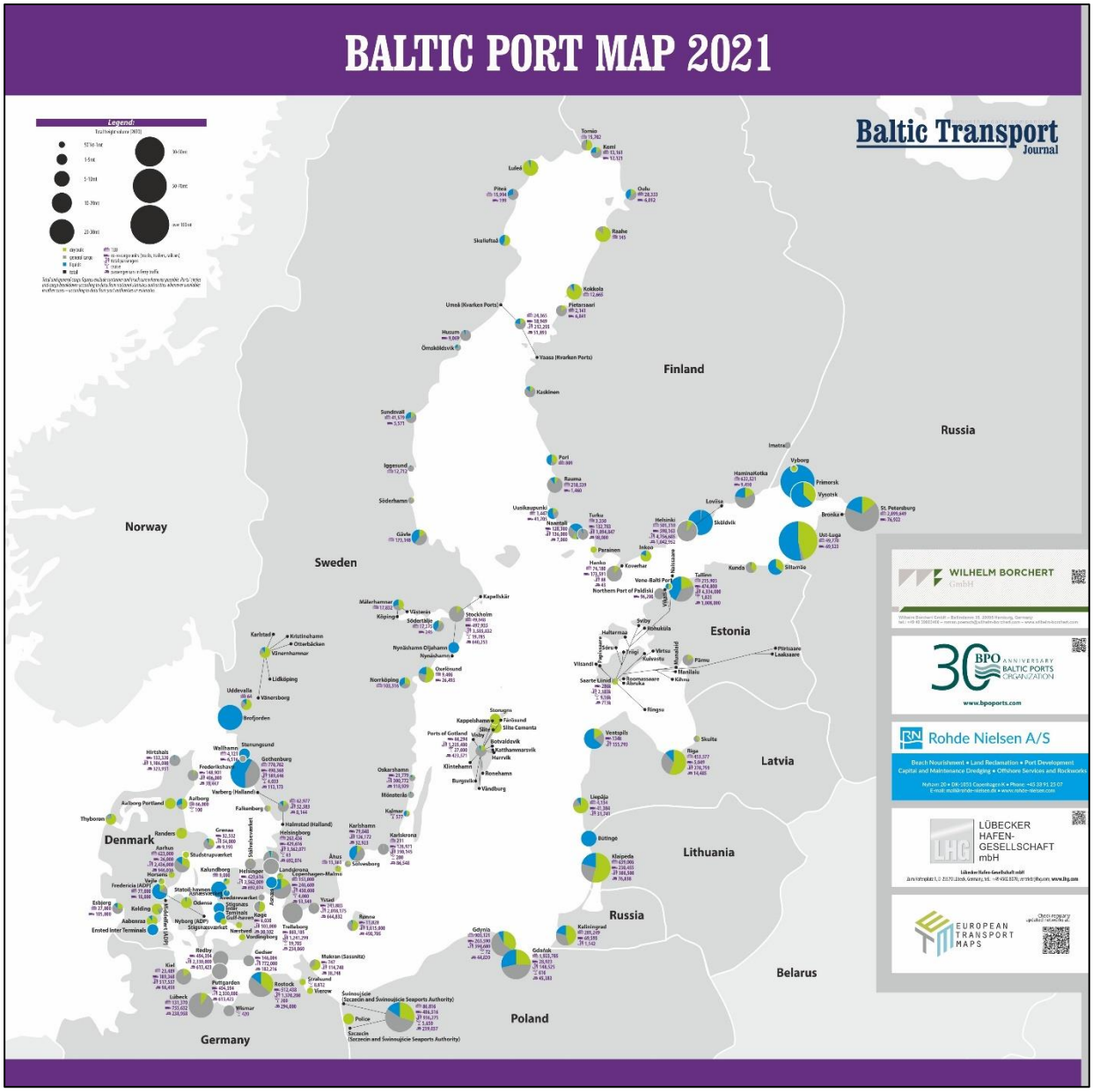
- Strengthening the Digital Single Market in the Nordic-Baltic region.

To summarize:

According to Philipp (2020c) [23], it can be implied that small and medium-sized ports have to take measures to overcome their backlogs concerning the DRIP dimensions such as: Management and Human Capital, since without a clear "Digitalisation Strategy", "Innovation Cooperation" activities, "Investments in Digitalisation", the necessary "IT Knowledge & Skills", as well as "IT Capabilities", the digital performance and transformation will not be safeguarded, since these aspects represent the essential and fundamental framework conditions. The Functionality of the IT processes and services can be ensured through an effective and appropriate deployment of the different digital technologies and solutions, both of which can only be efficaciously tackled if the basic conditions – regarding Management and Human Capital – are adequately met.

We also strongly suggest to create or enter a platform where port representatives / managers can exchange their knowledge and "good practises". An example of such a group is **BPO DigiWG** (a platform for discussing digitization projects, common questions or challenges in the implementation of digital projects in ports).

ATTACHMENTS



Attachment 1. Cargo turnover in BSR in 2021.
Source: Baltic Transport Journal.

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