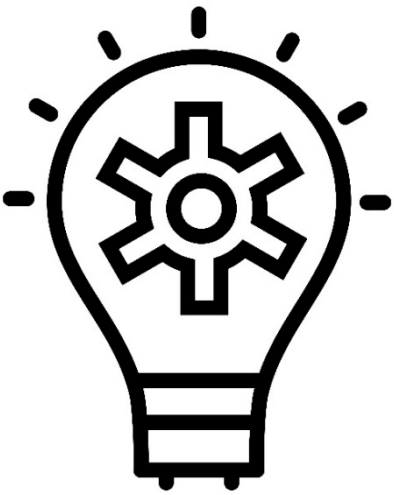
SMART EFFICIENCY ENHANCEMENT STRATEGIES

WORK PACKAGE 5

Deliverable 5.2

Date: 24/03/2023



Authors: Michiel De Meyere & Hanne Van den Berghe

Contact: michiel.demeyere@vives.be & hanne.vandenberghe2@vives.be

Vives Unversity College (Kortrijk)

Content

1) Introduction

The aim of this report is to write an action plan 'smart efficiency enhancement strategies' were the lessons learnt from the pilots and the lessons to be learnt from other transportation initiatives are gathered. This report is situated in the North Sea Connect project, a North Sea Region Interreg project, under work package 5 Learning of smart efficiency enhancement strategies.

2) Interreg North Sea Region: North Sea CONNECT project

The NSR is one of the main logistics zones in Europe: The largest seaports, but also many intermodal transportation nodes are located in the NSR. Those intermodal nodes are outstanding for the transportation of goods to and from the supply and demand markets. To increase attractiveness of a location along with its market potential, i.e. the achievable market, efficient, smart, and ecological transportation networks are needed. The intermodality should enable a concentration of transnational traffic and long distance flows, and as a result of their integration, provide for a highly resource efficient infrastructure use.

Currently, the Trans-European Network-Transport (TEN-T) policy is putting a strong focus on the development of the Core Network, the major transport axes across Europe. However, the whole trade and business network is not only depending on its major nodes but also on its hinterland. To raise the efficiency of transport flows in a holistic approach, the project will thus include both major and remoter transportation nodes to establish learning opportunities.

The overall project objective is to support smart intermodality growth in the NSR through efficiency enhancements. The detailed project objectives are:

- Implementation of new smart processes and tools (smart intermodality),
- Developing of strategies for smart efficiency enhancements (smart involvement)

In total, five pilots have been implemented during the project:

1. Autonomous loading/unloading at the Port of Oostende
2. Smart city port distribution – port of Brussels
3. Smart remote nodes development – Vordingborg Business
4. Smart seaport terminal accessibility – Port of Gothenburg
5. Slot plan integration into the rail port community system – Port of Hamburg

In the final report of WP4 'development and implementation of new smart processes' (2023), following main finding from the five pilots are given:

The pilots shows that there is a richness of ideas and willingness to work with these initiatives in all the participating ports, companies, and organizations. Logistics may be traditional sector, but digitalization and optimization efforts are parts of the agenda and development. The findings from the five pilots are categorized into four themes:

- ⇨ The size of operation:

Despite the variation in size of involved ports there is an acknowledgement that a collaboration between parties is necessary and should be encouraged to achieve a smoother logistics in the NSR.

- ⇨ The level of optimization:

The Ports of Gothenburg, Oostende, Brussels, and Hamburg, dealt with an optimization process that does not include new business areas or business ideas but rather optimizing the flows and available areas. In Brussels this is achieved by consolidating building material. The ports of Gothenburg, Oostende and Hamburg have shown that digitalization and data sharing can lead to optimized container flow (Gothenburg), handling of railway goods (Hamburg) and better utilization of a port area (Oostende).

- ⇨ The geographical position and interconnection of the port:

Among the five involved ports, the Port of Brussels is a dedicated inland port while the Port of Oostende, the Port of Hamburg and the Port of Gothenburg are mainly seaports but has connections to the hinterland through rivers and canals. While the Port of Vordingborg does not have inland waterway access it is an opportunity that could be reached.

- ⇨ The hinterland connection and its potential:

In the analyses made at the Port of Vordingborg and the Vordingborg area, there is a focus on how this port could include the companies in the port hinterland to initiate some initiatives that involve shipping opportunities in the European inland waterways. By doing this there may be some valuable insight that could be made by further knowledge sharing and interaction with the other pilots.

3) Literature study

In the first chapter, an overview of the current literature on smart ports and smart efficiency enhancement strategies is given. The literature study uses sources from scientific papers, other projects on smart strategies and peer review sessions.

Defining 'smart ports'

Many efforts have been made for developing a smart port, however, an internationally accepted and standard definition for the word "smart" does not exist in the context of ports and maritime industry. The definition proposed by Molavi et al (2019) is following: smart port gathers better-educated individuals, skilled workforces, intelligent infrastructures, and automation to facilitate knowledge development and sharing, optimize the port operations, enhance the port resiliency, lead a sustainable development, and guarantee safe and secure activities.

A definition by Deloitte (2017) describes smart ports as developing solutions to address the current and future challenges faced by seaports including spatial constraints, pressure on productivity, fiscal limitations, safety and security risks and sustainability(Deloitte, 2017).

Smart port categories

Ports are regional multimodal intersections of global supply chains. They function in the context of complex infrastructure, business transactions and regulations. With the global economy demanding maritime transportations, ports have faced increasing pressure to optimize their performance in terms of economic, environmental, energy and functional challenges that impact their sustainability. In response to the existing problems, ports are adopting technology-based solutions, as well as new approaches to port operations planning and management (Molavi et al, 2019).

Molavi et al (2019) reveals that current smart port initiatives around the world can be categorized into two groups:

- **(i) Smart port multipurpose initiatives**: practices with comprehensive long-term plans and strategies covering various aspects of port activities.
    - One major goals is to develop efficient operations and logistics through automation and technology propagation or by **modifying strategies and policies**. Topics related to **environment and energy** (implementing renewable energy, reducing energy consumption and improving operations to be environmentally friendly) have formed other pillars of these initiatives.
- **(ii) Smart port targeted initiatives:** seek to eliminate specific obstacles in ports.
    - These initiatives are largely focuses on special-purpose **information and communication technology** applications and regulation-based approaches.

The table below links the pilots to the smart port initiatives revealed by Molavi et al (2019).

Pilot	Smart port multipurpose initiatives	Smart port targeted initiatives
Ostend	x	
Brussel	x	
Vordingborg	x	
Gothenburg		x
Hamburg		x

How to be a strategic smart port?

In an online peer review session organised by the Region Hauts de France and Port Authority for Boulogne-sur-mer – Calais Port in collaboration with Interreg Europe Policy Learning Platform, a peer reviewed report was made on how to design a more innovative smart port development policy (Interreg Europe Policy Learning Platform, 2020). The peer review session was organised with a focus on the Boulogne-sur-mer – Calais Harbour complex but the main strategic recommendations are useful for other port authorities as lessons for strategic port development and smart port solutions.

Below, a list of **strategic governance recommendations** on how to define a strategy is derived from the Interreg Europe Policy Learning Platform (2020):

- Develop **a long-term strategy** (10-15 years), mission-oriented with defined priorities, under the direction of the Port Authority;
- Involve very broadly the **stakeholders**, once the strategy's main priorities have been determined. The success of the approach depends on the end use. For this, it is essential to involve the stakeholders **from the start in a bottom-up approach** with a strong management of the port authority;
- **Share, understand stakeholders' motivation** and identify small scale projects, that fully meet the needs of the port area and comply with the priorities, to stimulate their involvement and a "project community";
- Use EU **funds** (Digital Europe programme 2021-2027) to initiate the involvement of stakeholders and learn to work together and understand each other;
- **Set up a think tank involving stakeholders** in various fields and not just technological ones.

Besides the strategic recommendations, the peers also made specific recommendations regarding the development of smart port strategies, digital tools, monitoring tools and approaches:

Development and smart port strategies:

- Develop **port identities** and complementarities built on the strengths / assets of each port;
- Include entrepreneurial and innovation dimensions, the plan should not focus only on technological aspects. It is about ;**including new areas of activity** in the implementation of technological solutions
- Invest in **research and innovation**, the port needs to anticipate innovation, always remaining on the "technological frontier" and focused on strengths and potentials;
- Develop an **innovation centre** for HDF (Haut-de-France) ports, it can rely on initiatives such as hackathons led by local authorities;
- Develop an **approach focused on strategic objectives** to establish a specific roadmap. Ensure that digital tools do not replace objectives;
- Include the **determinants of the transition** as pillars of the strategic project: innovation, circular economy, territorial impact, human resources and skills.

Digital tools:

- Avoid duplicating the databases, **create common databases**, virtualize data and ensure that everyone has access to the same data (while respecting confidentiality through restricted access);
- Develop **digital tools**, owned by the port authority but jointly developed with local stakeholders;
- Develop a Port Community System to share information: connect all the individuals IS to a central platform allowing the port to act as a single entity. It is fundamental and prior to a smart port;
- Avoid technological locks and make sure you have ownership or availability of the source code of digital solutions (favour open sources);
- Invest in cyber security.

Monitoring:

- Develop tools for port monitoring and management: real-time detection of operating indicators, emissions, etc.;
- Select the right indicators in line with the defined missions and priorities to map the initial state and then establish quantitative or qualitative benchmarks;

- Use a limited number of indicators: 10 or 12 main indicators focused primarily on productivity, efficiency and / or impact;
- Information must be shared with stakeholders and promote actions and good practices of stakeholders.

The above mentioned recommendations can be helpful as a basis for port authorities to develop strategic port development plans and smart port solutions.

4) Method

In order to capture data on smart efficiency enhancement strategies, five semi-structured interviews were conducted with the pilot managers. These interviews, together with the pilot reports conduct insights following:

- Lessons learnt: overall pilot specific lessons learnt
- Pilot process lessons: insights in the process that the pilots followed and how this effected the end result
- Cross-border lessons: cross-border analyses of the qualitative data in order to better understand transnational issues and solutions

In order to capture as many data as possible from the pilots, the interviews have been conducted near the end of the project (January and February of 2023):

- Vordingborg: 20/01/2023
- Ostend: 20/01/2023
- Brussel: 23/01/2023
- Hamburg: 9/02/2023
- Gothenburg: 17/02/2023

The interview consisted of 12 questions subdivided into 5 indicators. To measure these, adequate questions per indicator were asked during the in-depth interview. An overview of the different indicators and the data captured per indicator is given in the table below:

Indicator	What
Capacity building	Skills, engagement, commitment
Organisational skills	Structure, leadership
Effectiveness procedure	Outputs, inputs, academic knowledge
Performance pilot activity	Progress, delay, reflectance, efficiency
Added benefits	Overall impact (economic, technical, societal, environmental)

An overview of the questions can be found in “annex 1: Interview questions”.

5) Results and discussion

a. Lessons learnt from smart efficiency enhancement strategies in North Sea Connect

Below a brief explanation of the five pilots in the project is given together with the main findings on the lessons learnt from the interviews and the pilot reports.

Port of Brussels

Overall challenges, activities and conclusions:

The port of Brussels has successfully implemented solutions for the challenges they encountered being (i) efficient transport of goods between seaports and their hinterland and (ii) mobility of goods within urban areas. Tackling these challenges has been done by following activities:

- Analysis of current situation CCC North and suggestions for improvement(including exchange with Wilson James London)
- Policy and regulation study to increase the use of the CCC's in Brussels
- Feasibility study CCC South (including business model)
- Test operation shuttle CCC North and South
- Test operation CCC South (including temporary stocking facilities)

From these activities it can be concluded that The extension from the CCC North to the CCC South is needed to make the transport of goods between the Flemish Sea Ports and their hinterland connection more efficient and to optimize the mobility of goods within Brussels.

The existence of both CCC's and the connection in between will make it possible to supply most part of the city in a consolidated way, making use of the waterway.

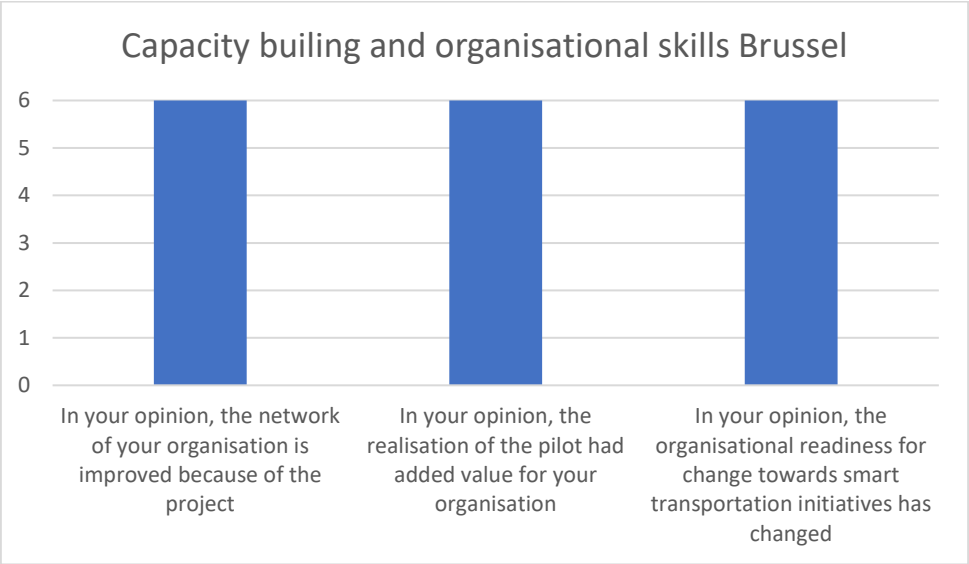
This will reduce road traffic and emissions. Building materials will remain the focus for the near future, but other types of goods such as FMCG's belong within the possibilities on a longer term.

Capacity building and organisational skills

In terms of capacity building, **extra knowledge** gained on the topic of construction sites (timing, product & materials, logistics,…). Also, a more extensive network has been created.

The readiness to change, towards smart transportation initiatives was already on a high level for both the port of Brussels as for the Shipit, although this project helped to realise some steps that wouldn't be possible otherwise.

The table below gives an overview of the qualitative answers on the questions related to capacity building and organisational skills. It is clear that the port of Brussels scores very high on both of these indicators, implying that the pilot has been very successful for the organisation as well.



The port of Brussels can be seen as an innovator in the topic on construction consolidation centres. Since the CCC has been implemented, they get questions about this topic from other interested ports

Added benefits

The main added benefits of the pilots in the opinion of the pilot manager are:

- Economical saving in terms of congestion
- Less trucks on the road
- Implementing the project in other sectors next to construction (fast moving consumer goods,…)
- Navigation between the north port and south port

Port of Oostende

Overall challenges, activities and conclusions:

The main goal as originally planned in the project was to improve operations of charging and discharging inland barges/pontoons by utilizing automatic vehicles. However, due to some delays and a very ambitious pilot, the goal has been reframed into a digital twin simulation of an autonomous forklift (un)loading cargo from a ship.

Three main initiatives were part of this pilot:

- Study into the opportunities for automation in the logistics value chain of ports
- Digital twin simulation of an autonomous forklift at the Vlotdok in the Port of Oostende
- Adapting the quays and routes to the port for autonomous ships to be monitored and docked safely. This includes installation of camera's, LED lightning and shore power.

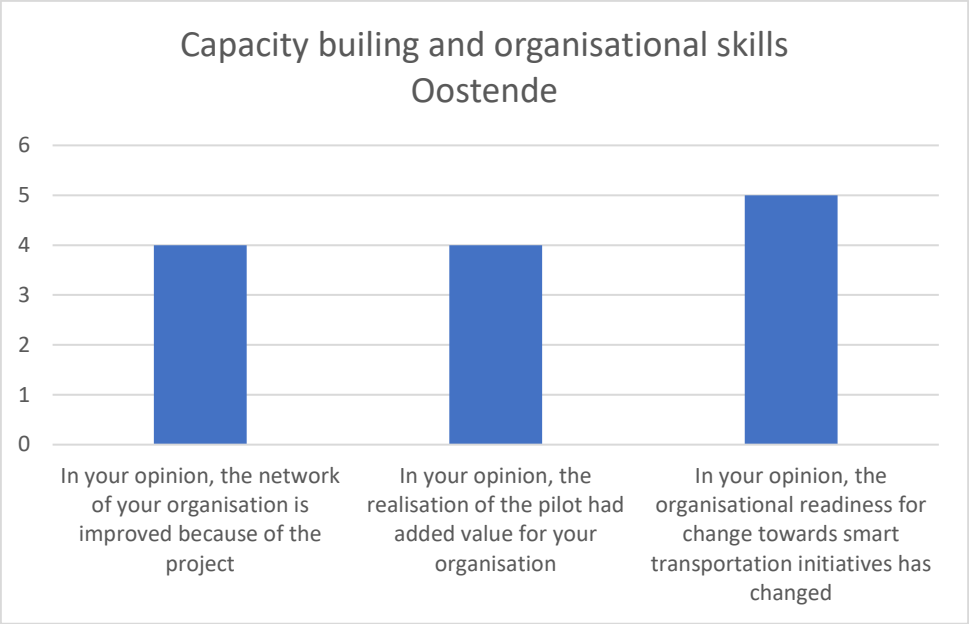
Results of the two first initiatives can be found in the report of WP4.

Capacity building and organisational skills

In the opinion of the pilot manager, extra knowledge and skills around automation and digitization have been acquired during the project. In addition it is clear that those skills will become more important in the future and the awareness around them is growing at a rapid pace. That awareness has become more clear in the port of Oostende during the project.

The project helped to accelerate the digitization transition of the port. More and more projects are involved in ICT and digital twins. This helps the port to change mindset into digitization.

The table below gives an overview of the qualitative answers on the questions related to capacity building and organisational skills. In the opinion of the port of Oostende, it is mainly the awareness that has risen during the project. As the pilot was not entirely finished by the time of the interview, the scores below reflect the opinion of the pilot manager at that time.



Added benefits

The main added benefits from the project are new opportunities for other projects. It makes it possible to have talks and convince potential costumers to come to the port of Ostend. Furthermore the project also helps to mitigate climate change as the autonomous vehicles will be powered by electricity and no fossil fuels will be used.

Port of Hamburg

Overall challenges, activities and conclusions:

Currently, mainline train operations from hinterland towards seaport are planned mostly on the national rail network, sometimes also on the trans-European rail network. Besides, maritime port terminals typically focus on their planning first on the maritime side. This in turn leads to the situation that the public rail infrastructure within the port area (comprised of mainline sections and shunting yards and operated by the HPA) needs to handle not only mainline trains and shunting consists, but also needs to serve for temporary freight wagon storage. This mandates an efficient usage of the existing trackwork in vicinity of or surrounding this point – the public port railway network.

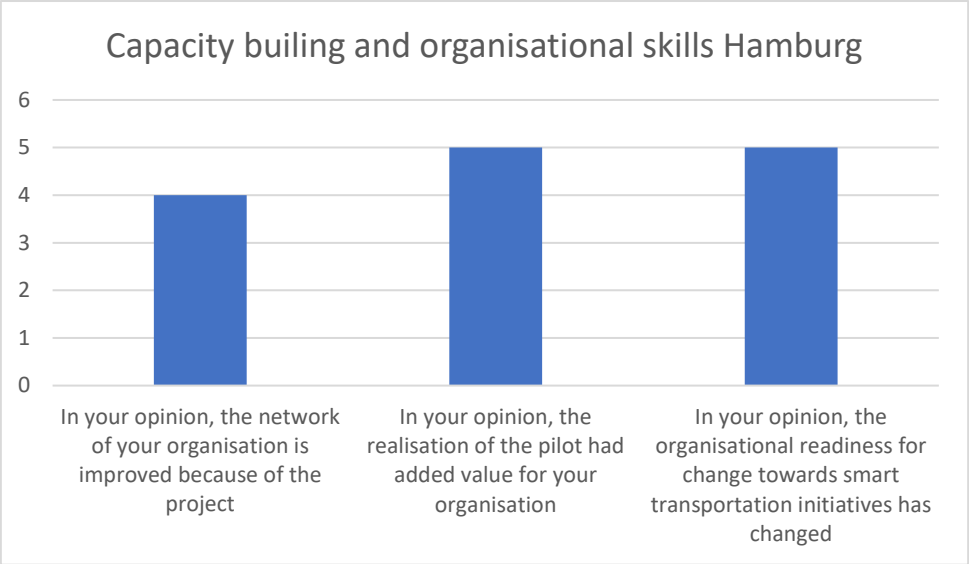
The scope of this pilot to integrate the slot plan data structure of multiple intermodal seaport terminals into the common rail port community system

A demonstrator has been developed at the moment. The implementation needs extra time and negotiation to convince stakeholders. Thanks to the demonstrator it will help the port to make better decisions and for the organisations to see how the program will look like and to make them more enthusiastic.

Capacity building and organisational skills

New insights and knowledge in understanding the interlinking of all the roles in the railway system was one of the main skills acquired by the pilot. Furthermore, The port will be able to make better decisions thanks to the demonstrator.

The table below gives an overview of the qualitative answers on the questions related to capacity building and organisational skills.



The scores on the first question are a bit lower as the port of Hamburg already had a large network before the project

Added benefits

The main added benefit of having a demonstrator is that it makes it possible to tackle future adjustments. They can first carry out tests with stakeholders which wouldn't have been possible otherwise.

Port of Gothenburg

Overall challenges, activities and conclusions:

Accessibility issues of getting containers to and from the hinterland transports at seaports is connected to long turnaround times, as well as slow and unnecessary administration due to inefficient port operations. Inefficient operations are in turn related to poor information exchange among the actors (terminal operator, road and rail operators) and poor quality of real-time information due to various non-connected information systems. An incompatibility follows when each actor uses its own information system that is not able to communicate with other information systems. These issues hamper ports throughput and shift towards intermodal transportation.

In the pilot of Gothenburg, the implementation of a the truck appointment system (TAS) has been scrutinized. This constitutes an attempt to manage truck arrivals. The specifics of the TAS vary and depend partially on the terminal's intended use case of the TAS. The first use implies improving information on trucks' arrival time (in comparison to when unscheduled access is deployed) to schedule terminal capacity and thereby increase yard operations efficiency. The second use implies that schedules, limiting the number of trucks that arrive during certain time intervals throughout the day, are imposed to level truck arrivals and thereby increase terminal operations efficiency. As the

second use also implies improved information on truck arrivals in comparison to when unscheduled access is deployed, it also facilitates scheduling of terminal capacity.

By evaluating access management, the project has contributed to knowledge regarding smart seaport terminal accessibility in three ways:

- Increased understanding of stakeholder perspectives

Firstly, putting together the actors and discussing the issues in various workshops during the project, combined with semi-structured interviews with experts at the project partners and another port have provided several insights. This has generated understanding between actors around different prerequisites for access management. Due to that the access operations are in the interface between different actors' activities, that therefore are sequentially dependent on each other, this understanding provides value for why some actors act in a certain way. The technical conditions in place at the various actors is an example of understanding other actors' viewpoints.

- Comparison of different ports

Secondly, by adding other seaport terminals with truck appointment systems to the scope have lifted outcomes for recommendations around access management.

- Increased understanding of drivers and barriers of access management and specially a truck appointment system (TAS)

To understand the benefits and barriers around access management, the focus on truck appointment systems (TAS) was chosen to study. This focus comes from the understanding from the study pilot of various viewpoints around a possible implementation of TAS. TAS was examined for four European container ports (including pilot) with initialisation of TAS and the current pilot without appointment booking for trucks. Three of the four container ports are included in the North Sea Connect project and the fourth is outside the project partners. Empirical data was collected via eleven semi-structured interviews and relevant documents were reviewed. For one container port, a study visit was arranged to understand their access operations. This resulted in understanding barriers and drivers of a TAS with the purpose of improving access management for trucks. The result is put in relation to TAS design and cover the perspectives of both terminal operator and hauliers.

- Recommendations for other North Sea Region seaport terminals

On the terminal side a TAS can provide planning benefits, but these benefits can only be achieved with a TAS that provide reliable information. For the hauliers the flexibility of a TAS is questioned and additional administration is needed, that need to be offset by the potential benefits of more efficient

access management. The information exchange between the actors therefore needs a commitment from all actors and understanding regarding other actors' activities and need for various information types. It should be noted that understanding implications of access management service, such as TAS, depends on the context.

The context could be exemplified with the specific challenges for a seaport terminal. If the main motivator of TAS is to reduce TTT and truck emissions in port area a TAS that control the arrival of trucks in a strictly manor is needed. If other drivers are the main reason behind TAS, such as terminal yard and capacity planning, a scenario for a less restrictive TAS for the hauliers could be introduced. A less restrictive TAS can build in flexibility for hauliers, such as adopting arrival information for different time stamps before actual arrival (planned arrival a day before or planned arrival hours before arrival). Such a type of TAS could be implemented in phases, where the first phase includes hauliers to give best estimate (a certain time before arrival) of their arrival times but missed appointments are not penalised. With this information the terminal operator cannot steer the access operations but rather plan yard operations better. The terminal operator can also get an understanding on accuracy on arrival information given from hauliers, which is important to understand to set reasonable windows for time slots and provide feedback to hauliers regarding their accuracy if there is need for further advancements of TAS to provide more accurate information. Nevertheless, the extra administration needed from hauliers for TAS indicate need to provide value for access operations connected to gate, for hauliers to also benefit from improvements and not being limited to terminal operator, such as improvements in yard operations.

Additionally, information prior access operations can provide benefit for terminal planning, such as transport mode information when vessel arrival to seaport terminal. With regards to type of information to share and at what point in time.

Capacity building and organisational skills

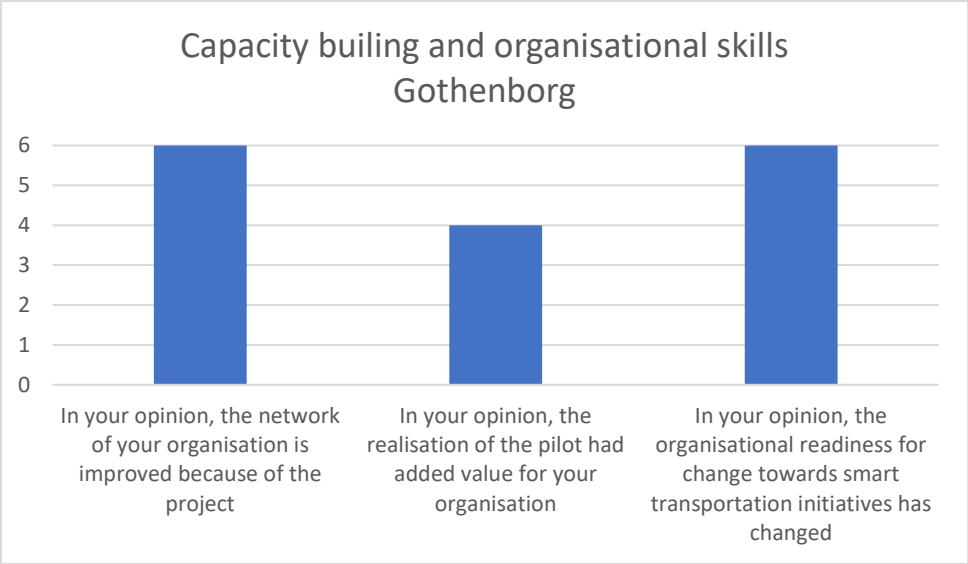
In the opinion of the pilot manager, the main skills that have been acquired are getting more insights in operations about access management in the port. Furthermore, new skills were gained on other actors which were not directly involved.

The network of the pilot manager's organisation has also improved by getting in contact with other actors linked to the same topic. Overall, they gained knowledge about access management operations much more than if they wouldn't have been involved in the project. Also the port of Gothenburg is now more aware of other systems, drivers and barriers of access management systems.

Mainly all the initiatives planned by the pilot of Vordingborg are completed. They were also planning on creating a network to connect businesses from Vordingborg with the Northern part of Germany but that did not succeed yet. The main reason for this is that it is too early at the moment. The Fehmarnbelt tunnel is planned to open 2029 which is too far in the future for the companies.

In the opinion of the pilot manager, the benefits of the pilot are a more efficient container flow (economical benefit) and less waiting time for trucks, which reduces their environmental impact.

The table below gives an overview of the qualitative answers on the questions related to capacity building and organisational skills. The first and third question score high, the middle question a bit lower. The lower score is mainly due to the COVID-19 impact, this changed a lot about what was expected.



Port of Vordingborg

Overall challenges, activities and conclusions:

The Trans-European Network-Transport (TEN-T) policy puts a strong focus on developing the core network, the largest transport points in Europe. But world trade and business networks depend not only on the major traffic hubs but also on its hinterland.

Vordingborg is located on the TEN-T corridor but not on the core network. With the coming Fehmarn fixed link, the transportation between Denmark and Germany will be improved and Vordingborg has a good location to benefit from this increased activity. Business Vordingborg therefore wish to improve its position and become a green logistics hub on the TEN-T corridor. To improve the chances of succeeding with this purpose, Business Vordingborg has initiated studies and initiatives as a part of the participation in North Sea Connect:

- Baseline study: An analysis of the relevance of sustainability in the new Fehmarn Belt Corridor
- Business Case – Vordingborg Dry Port - Preparing the business for the Fehmarn fixed link
- Road Map – Potential of inland waterways for the Port of Vordingborg
- Study trip to understand and connect with German logistics operators.
- Seminar on "Strategies for building a sustainable future for ports and logistics corridors."
- Examine the basis of a logistics business network across the border to Germany.

The development of infrastructure along the TEN-T corridor has commissioned the development of the Fehmarn fixed link and the Vordingborg area is expected to see an increase in road transport on the highway passing by the town and through the municipality. This opportunity was the driving force for the Vordingborg Business to engage in the North Sea Connect project. However, it has been challenging to make a clear identification of how to realize a potential of this new opportunity caused by the increase in the traffic.

That was one of the first major challenges to Vordingborg Business and a starting point to identify what steps to take.

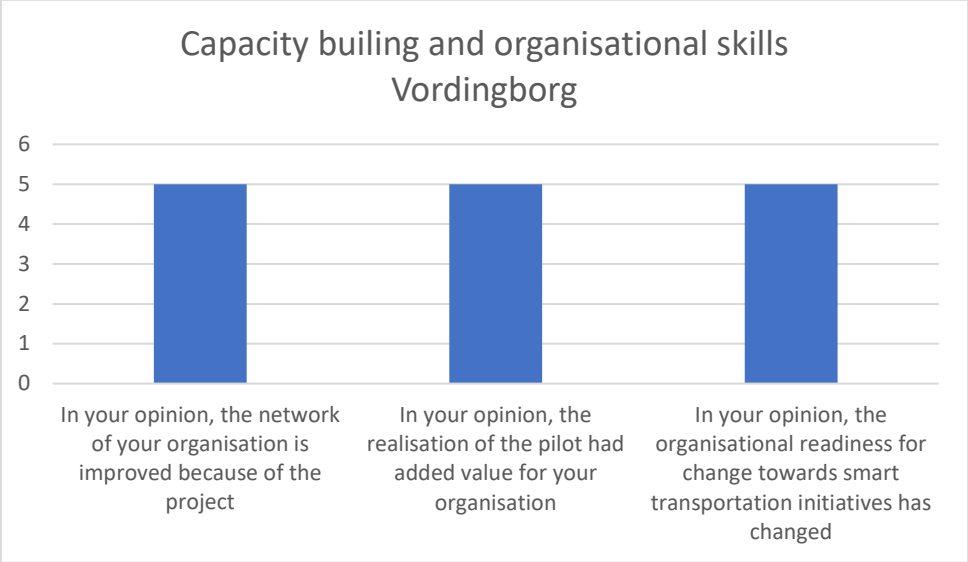
The identification of the right foci of the studies to be made was a longer process than anticipated and many discussions were taken to find the right approach. One of the leading causes for the identification of the right angle towards the studies was achieved during a workshop at the seminar on "Strategies for building a sustainable future for ports and logistics corridors" that was held in October 2021. All project partners were asked to provide their view on challenges and opportunities of the increase traffic that the Vordingborg area investigated and through a careful analysis of the results, the formation of the objective of two studies "Road Map- Potential of inland waterways for the Port of Vordingborg" and "Business Case – Vordingborg Dry Port - Preparing the business for the Fehmarn fixed link" was taken.

North Sea Connect has been very beneficial for Business Vordingborg in sharpening the understanding of the business potentials that the Fehmarn fixed link will suffice and providing tools and concepts to embrace, and hopefully implement, to achieve the benefits of the fixed link.

Capacity building and organisational skills

In the opinion of the pilot manager, the main skills that have been acquired are more insights & knowledge in the actors involved (logistics sector) and more knowledge on the topic of hydrogen. Also the inland waterways are looked into as an opportunity. However, no conclusions have been made up so far on this topic.

The table below gives an overview of the qualitative answers on the questions related to capacity building and organisational skills.



Added benefits

The main added benefit of the project is that they have made calculations for the potential in their business area. They can make 500 new employees in those areas.

b. Process analyses

In this chapter, outcomes of the process analyses from the different pilots are given.

Port of Brussels

Pilot process

In response to the question 'What would you have done differently', the port of Brussels would have:

- Involved other actors from the beginning
- Set up a working group and do a stakeholder mapping

This in order to collect people that are busy on the same topic in order to learn from each other.

Setbacks

Despite the fact that all predetermined activities have been carried out successfully, some setbacks and delays have been encountered during the project. These are:

- Delays due to internal issues on decision making
- Delays in permits
- Unforeseen circumstances on terrain: pollution of the pilot terrain

Port of Oostende

Pilot process

One of the main things that would have been done differently in the pilot process is making sure to have enough human resources. Due to the fact that it was hard to find correct profiles for creation of the digital twin, too little time was left to create a result.

Setbacks

In the opinion of the pilot manager, the main setback that occurred were:

- A late start-up of the project resulting in delays from the start
- The Covid-19 crisis
- budget changes in the last phase of the project
- A lack of skilled human resources

Port of Hamburg

Pilot process

The process that was followed in order to achieve the main goal was very straightforward. In that sense that the same process would be followed if it had to be done again. The idea is that you do not have to re-invent the wheel. It makes sense to have an integrated tool rather than make a new tool for everything in the port.

Setbacks

Overall not many setbacks have been encountered. The main setback was related to technical issues. The pilot involved a lot with IT which caused a delay of 4-6 weeks. Also, because this pilot entered the project later there was some overall lack of time to finish the pilot.

Port of Gothenburg

Pilot process

Due to COVID-19, several delays occurred in the process of data collection and in organising workshops with stakeholders. The steps in the pilot process have been a good base, although some IT related problems could have been taken more into account from the beginning. This was however not the initial focus of the project.

Setbacks

The main setbacks encountered by the pilot are:

- COVID-19 crisis
- IT-issues
- Sensitivity of data sharing

Port of Vordingborg

Pilot process

Mainly all the initiatives planned by the pilot of Vordingborg are completed. They were also planning on creating a network to connect businesses from Vordingborg with the Northern part of Germany but that did not succeed yet. The main reason for this is that it is to early at the moment. The Fehmarnbelt tunnel is planned to open 2029 which is to far in the future for the companies. In the opinion of the pilot manager, it is mainly this part that could have been tackled differently. Probably, they should have researched more on the network thoughts earlier in the process so it could than grow during the project.

Setbacks

The main setback in the pilot has been the lack of interest by the local companies to create a network with companies from Northern Germany.

c. Cross-border analyses

In this chapter the result of the process analyses are analysed in a holistic way. We try to find connections between the different pilots and to capture cross-border lessons learned from the process analyses.

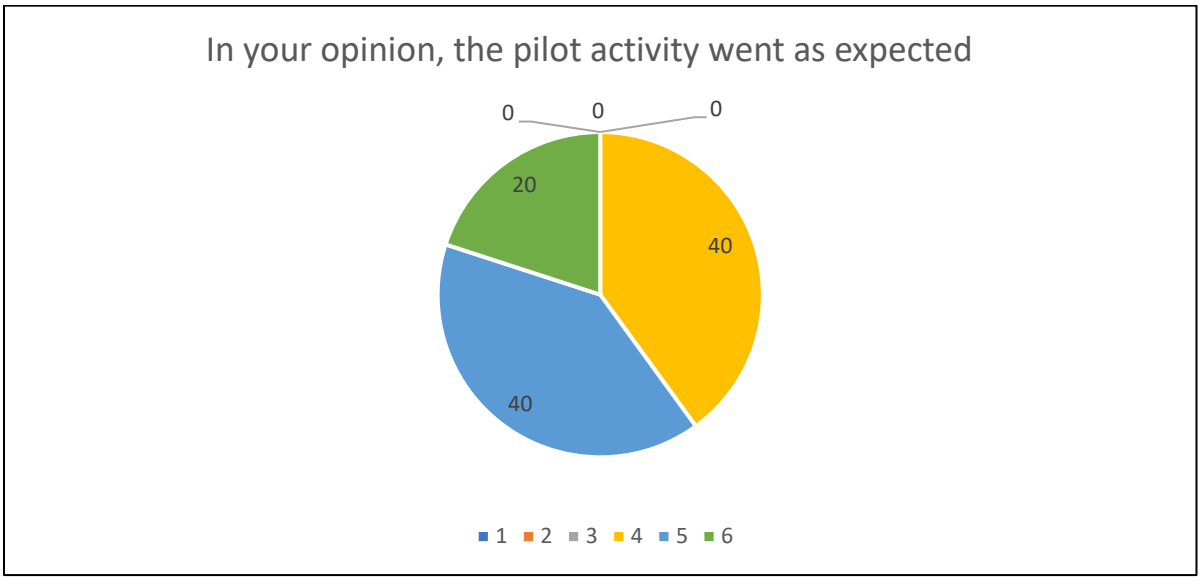
Indicator averages

During the interview several quantitative questions have been asked that reflect a score on each indicator. In the table below the average scores on each indicator an their related question(s) are given.

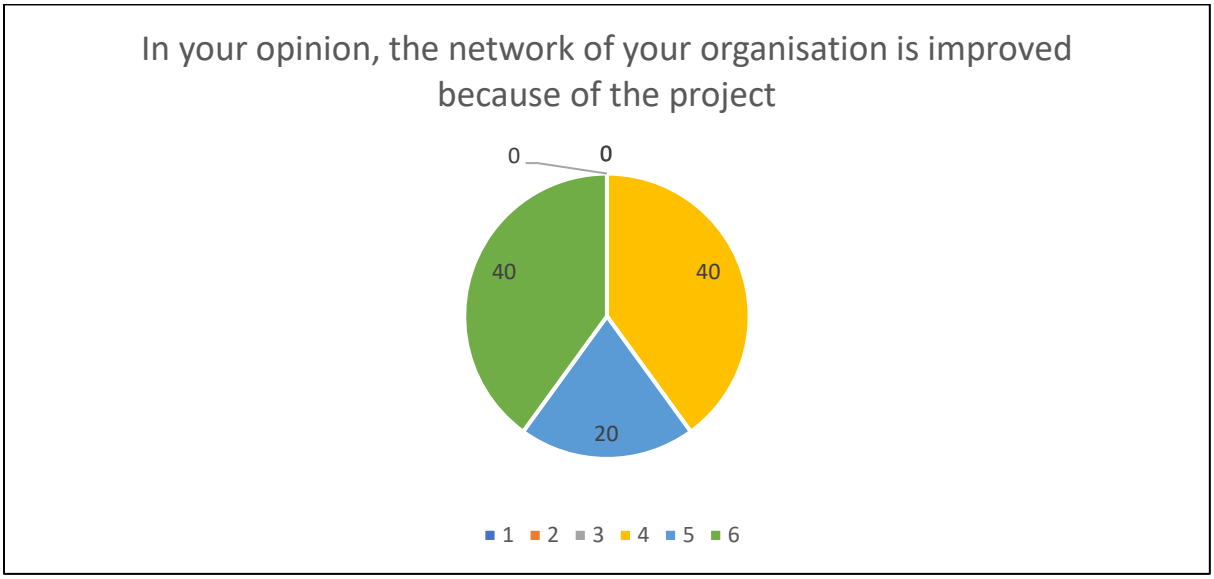
Indicator	Question	Average	Average (%)
Performance pilot activity	In your opinion, the pilot activity went as expected	4,8	80
Capacity building	In your opinion, the network of your organisation is improved because of the project	5	83
	In your opinion, the realisation of the pilot had added value for your organisation	4,8	80
Organisational skills	In your opinion, the organisational readiness for change towards smart transportation initiatives has changed	5,4	90
Effectiveness procedure	In your opinion, the implementation of the pilot was effective	4,4	73
	In your opinion, the desired outputs have been achieved	5	83

One conclusion that can be made here is that all averages are high. The averages however do not reflect all scores that have been given on that question. The figures below give a more detailed image of how the scores were distributed on each question:

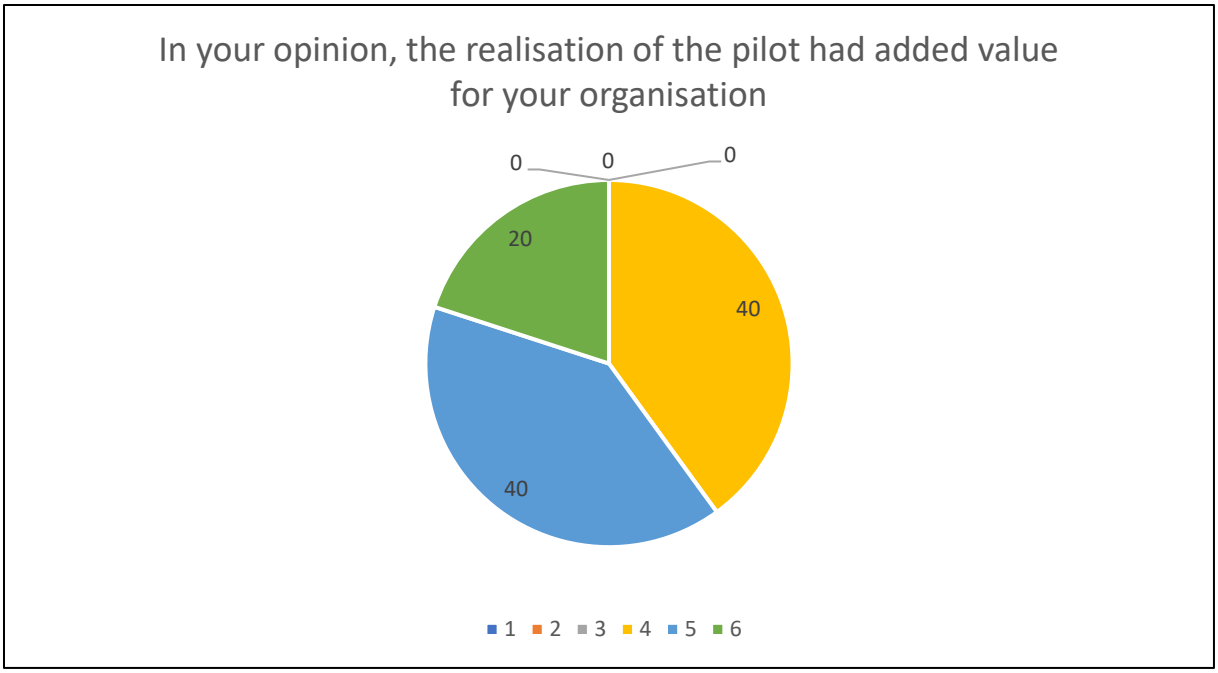
- Question 1: In your opinion, the pilot activity went as expected



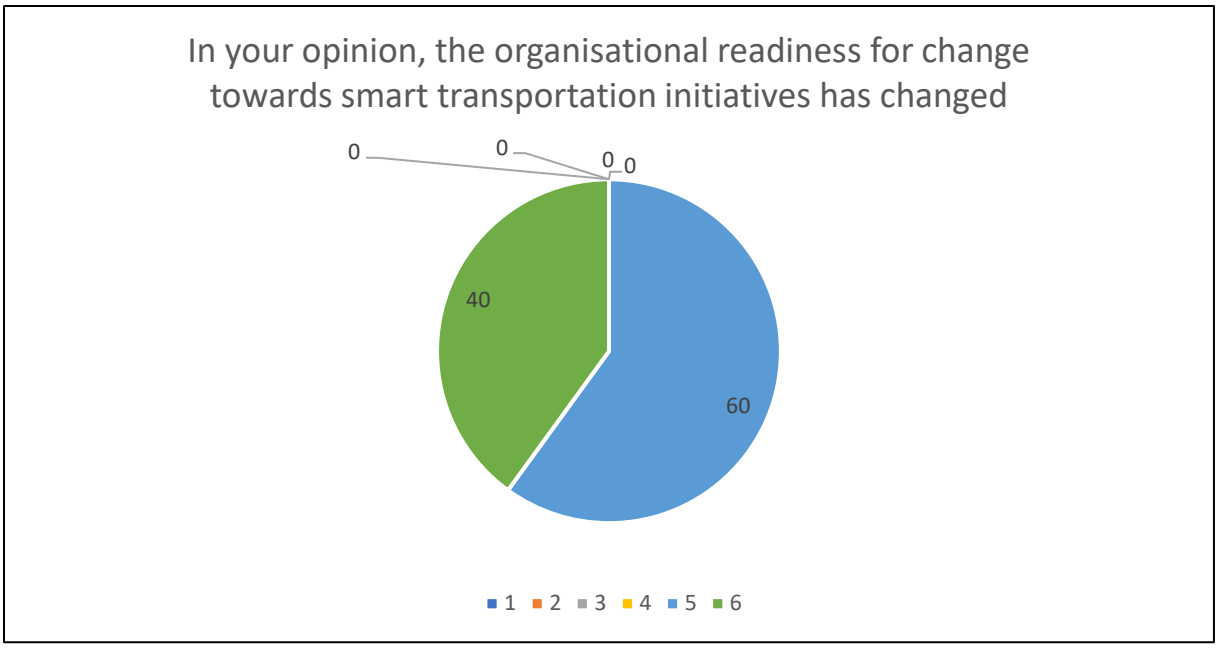
- Question 2: In your opinion, the network of your organisation is improved because of the project



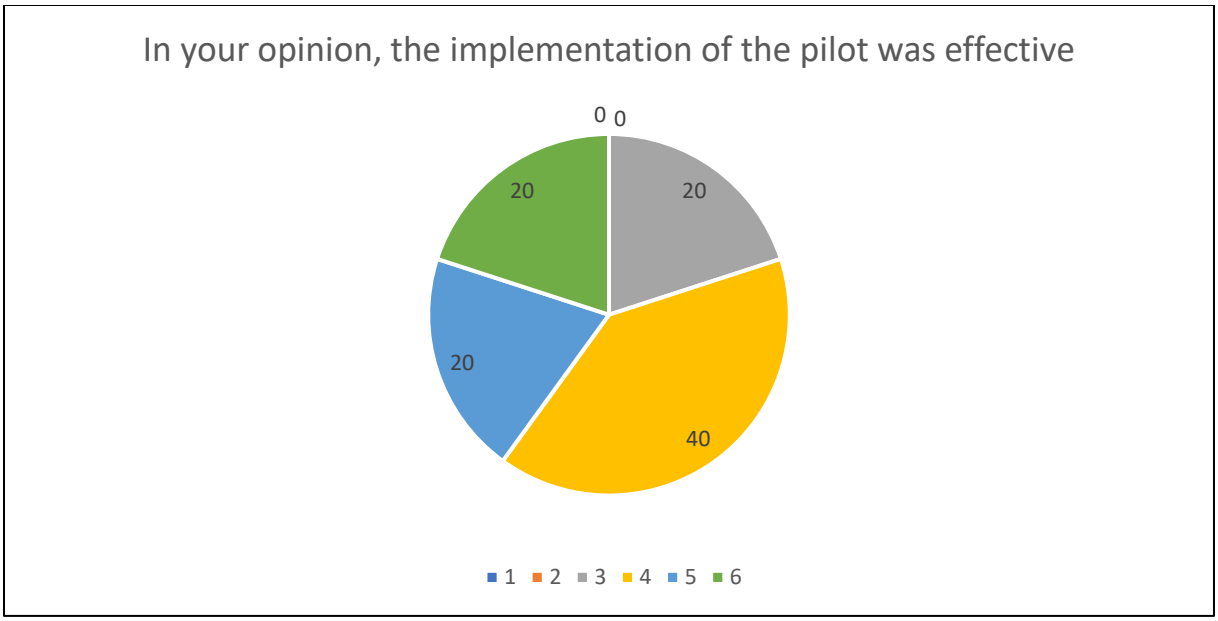
Question 3: In your opinion, the realisation of the pilot had added value for your organisation



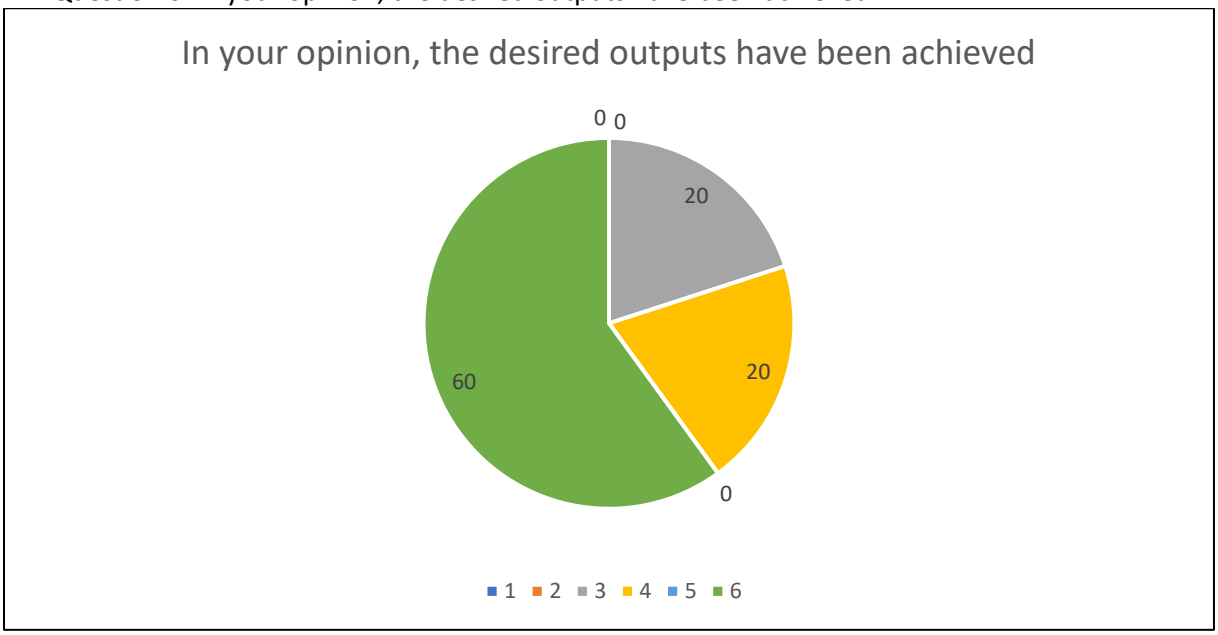
- Question 4: In your opinion, the organisational readiness for change towards smart transportation initiatives has changed



- Question 5: In your opinion, the implementation of the pilot was effective



- Question 6: In your opinion, the desired outputs have been achieved



The answers on the effectiveness of the procedure (implementation was effective & desired outputs have been achieved) are some of the lowest given during the interview. The scores on this indicator were heavily **influenced by the setbacks** that have been encountered by the different pilots. The reasons of the delays can be seen in the table below. This table gives an overview of all the delays mentioned during the interview and the amount of times it was mentioned by different partners

Times mentioned	Delay
3	COVID-19
2	IT issues
1	Internal problems, permits, unforeseen circumstances, opportunities to far in the future, late startup, budget issues & human resources

The two main reasons being given are **COVID-19** (Gothenborg, Vordingborg & Oostende) and **IT issues** (Gothenborg, Hamurg).

Despite the fact that all pilots have encountered delays and setbacks, sometimes resulting in less effective implementations and outputs, **the capacity building and organisational skills of all pilots have a high score.**

With the **organisational skills** and readiness for change scoring the highest (average of 90%, only answers 5/6 and 6/6 have been given). This implies that this project has influenced the organisational skills in such a way that these organisations are more ready, or were already busy with new innovations concerning smart port initiatives. Also, pilots mentioned that they are more aware of all the systems being used thanks to the project.

On the **capacity building** indicator, the two main new skills that have been acquired by the different pilots are:

- **Insights in how other stakeholders work** (Brussels, Gothenburg, Vordingborg & Hamburg)
- **New knowledge in technology** (Vordingborg, Oostende)

It can thus be concluded that, despite the fact that not all outputs have been achieved and some setbacks and delays occurred, the capacity building and the organisational skills have been positively influenced by conducting the pilots.

d. Smart port strategies

In the literature study, an overview of strategic port development and smart port solutions has been given based on the peer review session of the Interreg Europe Policy Learning Platform (2020). In this chapter, an attempt will be made to give an overview of smart port strategies for each pilot port and give some recommendations on how to achieve them in the future based on the learnings from the peer review session.

Below, an overview of the **strategic governance recommendations** (Interreg Europe Policy Learning Platform, 2020) is given linked with how each port has tackled each recommendation:

- Develop **a long-term strategy** (10-15 years), mission-oriented with defined priorities, under the direction of the Port Authority; => as this was not specifically asked in the interviews we are not aware of this
- Involve very broadly the **stakeholders**, once the strategy's main priorities have been determined. The success of the approach depends on the end use. For this, it is essential to involve the stakeholders **from the start in a bottom-up approach** with a strong management of the port authority; => In the pilots conducted by the pilot managers, stakeholder insights has been mentioned by Brussel, Gothenburg, Vordingborg and Hamburg. Oostende also mentioned involvement of stakeholders on the topic of autonomous cargo for a future project.
- **Share, understand stakeholders' motivation** and identify small scale projects, that fully meet the needs of the port area and comply with the priorities, to stimulate their involvement and a "project community". => This has been the case for the pilots of Brussel, Gothenburg, Vordingborg and Hamburg. Oostende also mentioned involvement of stakeholders on the topic of autonomous cargo for a future project
- Use EU **funds** (Digital Europe programme 2021-2027) to initiate the involvement of stakeholders and learn to work together and understand each other. As this project is a EU funded project,
- **Set up a think tank involving stakeholders** in various fields and not just technological ones. => As this was not specifically asked in the interviews we are not aware of this

The report also gave recommendation on **development and smart port strategies.** Again we will try to link each pilot to the recommendation**:**

- Develop **port identities** and complementarities built on the strengths / assets of each port => As all the ports in the project linked their pilot with their specific problems and challenges, strengths/assets have already been identified

- Include entrepreneurial and innovation dimensions, the plan should not focus only on technological aspects. It is about **including new areas of activity** in the implementation of technological solutions. => This has been the case for all the pilot projects
- Invest in **research and innovation**, the port needs to anticipate innovation, always remaining on the "technological frontier" and focused on strengths and potentials. => As all of the pilots mentioned an increase in organisational readiness for change, they are ready to anticipate innovation
- Develop an **innovation centre** for HDF (Haut-De-France) ports, it can rely on initiatives such as hackathons led by local authorities. => As this was not specifically asked in the interviews we are not aware of this
- Develop an **approach focused on strategic objectives** to establish a specific roadmap. Ensure that digital tools do not replace objectives => As this was not specifically asked in the interviews we are not aware of this
- Include the **determinants of the transition** as pillars of the strategic project: innovation, circular economy, territorial impact, human resources and skills => As this was not specifically asked in the interviews we are not aware of this

Based on the data above, an overview is given with recommendations on both the strategic governance and smart port strategies in the table below. The table also includes those recommendations that already have been tackled by the pilots

Pilots	**Strategic governance**		**Smart port strategies**	
	Tackled	**Recommendation**	**Tackled**	**Recommendation**
Brussel Oostende Hamburg Gothenburg Vordingborg	- Involve stakeholders - Understand stakeholders motivation - Use EU funds	- Develop a long term strategy - Set up a think tank involving stakeholders	- Develop port identities - Include new areas of activity of technological solutions - Invest in research and innovation	- Develop an innovation centre - Develop an approach focused on strategic objectives - Include the determinant of the transition

Because the pilots in the project all were related to smart port initiatives, the recommendations of the pilots to become smart are all similar. For other port It might be interesting to check all the recommendations from the peer report.

6) Conclusions

Three major conclusions can be given from the lessons learnt derived from both the literature and the project pilots:

1. Despite the fact that not all outputs have been achieved and some setbacks and delays occurred, the capacity building and the organisational skills have been positively influenced by conducting the pilots.
2. The main setbacks for the pilots have been the COVID-19 crisis and IT-related issues.
3. All the pilots tackled some directions in order to create a smart port strategy. Nevertheless, some recommendations are given in order for them and for other ports to create a smart port strategy.

References

- Anahita Molavi, Gino J. Lim & Bruce Race (2019): A framework for building a smart port and smart port index, International Journal of Sustainable Transportation, DOI: 10.1080/15568318.2019.1610919
- Business Vordingborg & GEMBA Seafood consulting A/S (2023): Reports of pilot WP4: development and implementation of new smart processes
- Deloitte Port Services (2017) : Smart ports, point of view
- https://www.interregeurope.eu/find-policy-solutions/expert-support-reports/strategic-port-development-plans-and-smart-ports-solutions (accessed on 8/02/2023)

Annex 1: Interview questions

Indicator: Performance pilot activity

- What steps have been taken so far to achieve the main goal?
- What did or did not get implemented that was planned?
- Did you encounter delays? If yes, what were the main factors, setbacks?
- In your opinion, the steps taken to get to the main goal where efficient?
    - What would you have done differently?
- In your opinion, the pilot activity went as expected (1 not agree - 6 agree)?

Indicator: Capacity building

- In your opinion, what new skills have been acquired by your organisation?
- In your opinion, the network of your organisation is improved because of the project (1 not agree - 6 agree)?
- In your opinion, the realisation of the pilot had added value for your organisation (1 not agree - 6 agree)?

Indicator: Organisational skills

- In your opinion, the organisational readiness for change towards smart transportation initiatives has changed (1 not agree - 6 agree)?

Indicator: Effectiveness procedure

- In your opinion, the implementation of the pilot was effective (1 not agree - 6 agree)?
- In your opinion, the desired outputs have been achieved(1 not agree - 6 agree)?

Indicator: Added benefits

- In your opinion, are there added benefits associated with the implementation of the pilot? (Economic, technical, societal, environmental)?