Dream big, start small

AI in transport & logistics

Opportunities for business, government and science

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Dirk Koppenol PhD
Hannah Mosmans MSc LLM

AI PORT CENTER

UPT Erasmus

ERASMUS CENTRE FOR URBAN, PORT AND TRANSPORT ECONOMICS

Foreword

We started this research to explore the application of artificial intelligence (AI) in the transport and logistics sector within and around ports. It has resulted in this report that dives into the definition, challenges, opportunities and the relation between research and practice, showing the positive attitude towards AI and its applications. Moreover, it gives a first glimpse of what the port of the future will look like. However, as it is explorative research, this research project has its limitations. We do not show the mechanics behind AI or do a thorough investigation of all scientific literature. Nonetheless, we hope this paper sets the basis for further research and the implementation of useful AI tools in practice now and in the future.

We want to express our gratitude towards all the interviewees for their relevant and interesting insights. Furthermore, we also thank participants of the organized sessions for their feedback and ideas. Moreover, we want to thank SmartPort for their hospitality in hosting the 3 interactive sessions. Lastly, we would like to thank the financing partner for this research: AI Port Center. AI Port Center, a research and innovation partnership between Delft University of Technology (TUD), Erasmus University Rotterdam (EUR), and Leiden University (LEI), asked Erasmus UPT to create an overview of application opportunities and use cases for AI in logistics and transport in and around the port area for both researchers and companies.

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Summary

This research underscores that while Artificial Intelligence (AI) is seen as a means rather than a goal, its application in future ports raises questions about its purpose and beneficiaries. AI proves crucial in addressing present and future challenges by not just describing and predicting environments but also prescribing actions based on data. Its unique capabilities—self-learning, pattern recognition, and innovation—make it invaluable for the transport and logistics sector amidst energy transitions, climate change, regulatory demands, and workforce ageing.

Some sectors have seen considerable development and application of AI-driven solutions. In the context of seaports, such developments and applications are promising, leaving many opportunities for both port communities and universities and knowledge institutes to make progress. Notable barriers are data scarcity, a lack of trust in AI, data quality issues, and unclear communication about AI's value, leading to difficulty in setting concrete goals encompassing sustainability, safety, and efficiency.

To aid AI adoption, a step-by-step approach is recommended, involving data organization, sharing, determining AI's utility, developing use cases, defining boundaries, and continual evaluation. However, a mismatch between the industry's preference for incremental research and academia's focus on larger trajectories is observed, with industry interest largely centered on select fields.

Concrete suggestions for an AI Port Center include:

- Supporting research for a shared understanding of future ports
- Tailoring cases to industry demands
- Fostering transdisciplinary research collaboration

Dream big, start small

Contents

Word list

Algorithm	a procedure for solving a mathematical problem (as of finding the greatest common divisor) in a finite number of steps that frequently involves repetition of an operation
Artificial intelligence	the ability of intelligent computers to use algorithms to describe the current environment, predict the future environment and prescribe future actions based on data. In this process AI is self-learning, can recognize patterns on its own and can generate new ideas and solutions
Big data	data sets, typically consisting of billions or trillions of records, which are so vast and complex that they require new and powerful computational resources to process
Digital twin	a digital model of an intended or actual real-world physical system or process (a twin) that serves as the effectively indistinguishable digital counterpart of it for practical purposes, such as simulation, integration and testing
Machine learning	a branch of artificial intelligence and computer science which focuses on the use of data and algorithms to imitate the way that humans learn, gradually improving its accuracy.
Model	a system of postulates, data, and inferences presented as a mathematical description of an entity or state of affairs
Physical Internet	aims at transforming the way physical objects are moved, stored, realized, supplied and used, pursuing global logistics efficiency and sustainability
Singularity	a hypothetical future point in time at which technological growth becomes uncontrollable and irreversible, resulting in unforeseeable changes to human civilization
Technological Readiness Level	a method for estimating the maturity of technologies during the acquisition phase of a program

List of abbreviations

AI	Artificial intelligence
PI	Physical Internet
SOL	Self-organizing logistics
TRL	Technological Readiness Level

1 Introduction

November 30th, 2022, ChatGPT (Chat Generative Pre-trained Transformer) was launched – an Artificial Intelligence (AI) chatbot that became a sensation. ChatGPT was able to write and generate new texts and answer questions based on a large language model. In February 2023, within two months after the launch, ChatGPT had already 100 million active users (Dutch IT Channel, 2023). Early December 2023, a new AI model from Google, Gemini, introduced fresh competition for OpenAI's ChatGPT, and raised the bar. For example, this chatbot can also generate images based on text and it offers developers of apps to use the model as a basis. All in all, AI models are gaining momentum and popularity among the general public. This raises the question how new AI models will influence businesses and business models in the future. In this paper, we will focus on the transport and logistical sector, and more specifically the activities in and around the port of Rotterdam.

1.1 The gateway of Europe faces challenges

Rotterdam is often referred to as the Gateway to Europe. It is by far the busiest port of Europe. In 2022, the total throughput was 467,4 million tonnes (Port of Rotterdam, 23 February 2023). This is more than the direct competitors Port of Antwerp-Bruges (145 million tonnes) and Port of Hamburg (119,9 million tonnes) combined. Approximately 30,000 seagoing vessels call at the port of Rotterdam annually (Port of Rotterdam, 17 February 2023). Moreover, every day thousands of trucks and dozens of barges transport goods to and from the hinterland. Furthermore, it is expected that the transshipment will keep on growing in the decades to come (Port of Rotterdam, 5 October 2022).

The transport and logistics sector is faced with a number of challenges: (1) regulation to decrease emissions (energy transition), (2) the need to adapt to climate change, such as extreme high and low water on the river Rhine (climate change), (3) the development towards more autonomous modes of transport and (4) the loss of knowledge as a result of aeging personell. In order to stay competitive and efficient, digitalization is an important pillar of innovation. Digitalization is defined in this paper as the transformation of manual processes such as paper and telephone communication to a digital process (Encyclo.nl, n.d.). This transformation enables more efficiency, while making processess more predictable and plannable.

The challenges of climate change, the energy transition, autonomation and aeging personell require the use of such an enormous amount of data from different sources, that standard digitalization does not suffice any longer. This is where Artifical Intelligence (AI) enters the stage. What if an algorithm could become your supporting colleague? What if that colleague could think of radically new solutions and ideas based on a wide range of data-sources, what would this mean for the transport and logistical sector? The working definition of AI, before working towards a more specific definition lateron in this paper, is that is it an algorthim that is as smart as a human being (see chapter 2: defining AI).

1.2 Focus and research question

The focus of this report is on transport and logistics revolving in and around seaports with a focus on barges and trucks. The activities in the port of Rotterdam are the main case. The goal of this report is to create an overview of application opportunities and use cases for AI in logistics and transport in and around the port area for both researchers and companies. What are the visions of researchers and companies on the future port (2030-2050), what is the current role of AI and, what is the current phase of research and application of AI?

This research is based on circa 30 interviews with experts from port companies and universities and desk-research. Furthermore, we organized three sessions with participants from both knowledge institutes and companies. During the first session, which focused on the development of a net-zero AI Port there were 10 participants. In the second session, 25 participants learned more about the opportunities and threats revolving around AI in the transport and logistics sector. In the third session, 23 participants worked on dreaming big, but starting small.

The main research question is:

Why and in what form is there a need for the application of AI in the port of the future and how can universities contribute?

To answer the main research question, we have formulated the following sub-questions:

1. What is AI and what is its use?
   In chapter 2 we delve into the different phases of AI, being narrow, general and super. Then, we discuss the difference between data-driven and theory-driven models. Based on the capabilities of AI and historical definitions, we come to a definition of AI for this report.
2. What are the challenges of the transport and logistical sector?
   In chapter 3 we present the four main drivers for change within the transport and logistics sector: the energy transition, climate change, automation and ageing personnel. Physical internet and self-organizing logistics are introduced as means towards a new approach.
3. Is AI an opportunity or a threat?
   In chapter 3 we also discuss threats and opportunities revolving around AI. Here, needs and dreams of participants to our workshop are presented as well.
4. What are the opportunities for the transport and logistical sector?
   Chapter 4 revolves around all the already existing cases for AI, algorithms and smart solutions within the transport and logistics sector in the port of Rotterdam. Along six main themes, these opportunities are presented: enhanced supply chain visibility, self-organizing fleets, port call optimization, climate adaptive and zero-emission shipping and lastly, autonomous shipping and trucking.

5. What are the hurdles from research to practice?

   Having discussed opportunities, threats, dreams and needs – the final chapter rhymes everything together by presenting a step-by-step plan to implement and adapt AI from research to practice.

2 Defining Artificial Intelligence

The concept of AI was first introduced by the American computer scientist John McCarthy (1955) who defined AI as: *"the science and engineering of making intelligent machines"*. Even though the definition is over 65 years old, it gives us a relevant starting point: AI involves the creation of intelligent or smart machines. However, now that we have those 'smart machines', what can they do and what do they contribute?

2.1 Types of AI

AI can be categorized into three types, based on the human characteristics it can replicate, as is displayed in Figure 1. Narrow AI, also known as weak AI, is focused on performing one or few specific tasks (IBM, 2023a). Examples of narrow AI include Apple's Siri and Amazon's Alexa, which are specifically designed to perform simple tasks like putting on music and calling contacts. The second type, General AI, is a theoretical form where a machine is intellectually equal to humans. General AI can be applied in many areas. General AI can solve problems, learn and plan for the future. Super AI, also known as superintelligence, would be superior to human intelligence. The three types are also interpreted as phases. We are now entering the phase of general AI.

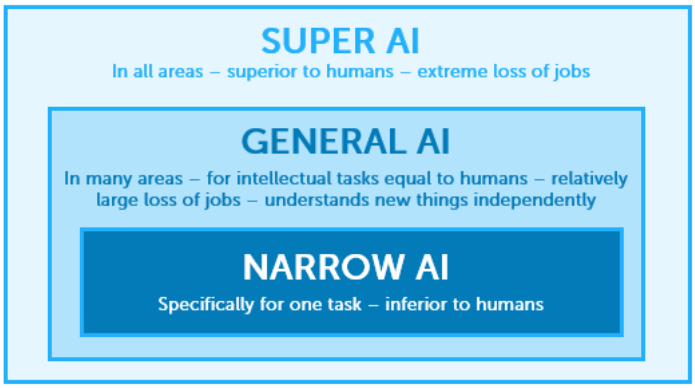

Figure 1 Three types of AI (adapted from Kopalle et al., 2022)

2.2 Types of models and capabilities

Another important aspect of AI is that is not theory-driven, but data-driven. Both theory- and data-driven models have the same goal, but the method is entirely different. Whereas theory-driven models combine available models and data, reaping benefits of established knowledge, data-driven models, use patterns, without the formalization of such mechanisms (Hoffer et al., 2022). In other words, AI can distill its own pattern out of data. For that reason, it does not need human input, such as earlier developed theories. As a result, the process is faster, and it can produce radically new solutions.

The solution that AI can offer can be divided into describe: describing or reproducing what is seen or perceived; predict: applying the model in situations where it has not modelled yet, seeing if the model still works and trying to predict based on this model; and prescribe: employed as a diagnostic device as a prescriber of future actions. Whereas descriptive models solely reproduce what is seen or perceived in the environment or within the input, predictive models take it a step further. AI is also capable of prescribing future actions to take, by using data.

2.3 Developing a definition

Overall, AI as a concept and application has developed fast since the first definition made by John McCarthy. Firstly, the field of AI has expanded enormously over time from a focus on the engine to the application in practice and science. Secondly, AI has become increasingly more intelligent. To get a glimpse of the development: a couple of decades after McCharthy, Nilsson (2009) defined AI as a term that can be used to indicate any technology (whether that is software, an algorithm, a robot or a set of processes is irrelevant) that is able to function appropriately with "*foresight of its environment*". This definition entails two different elements of AI: it is a technology that is both responsive to and learns from its environment. AI uses inputs to create and predict new outcomes.

Franken et al. (2020) add the aspect of "*autonomy*": AI is relatively autonomous in showing intelligent behavior by analyzing the environment and performing various tasks. In 2019 the European Commission expanded its definition of AI to clarify the concept as a scientific discipline and as a technology. The new definition is rather detailed and complex, touching upon multiple aspects of AI. It contained elements, such as: (1) software systems that act in the physical or digital dimension by perceiving their environment through data acquisition, interpreting data, reasoning, processing information and ultimately deciding the best action(s) to take to achieve the given goal and (2) able to adapt their behavior by analyzing how the environment is affected by their previous actions.

Based on the above, we can conclude that AI can be defined by its phase/intelligence, its ability to distill patterns and solution based on data. For our purpose it is important that we focus on the general AI type/phase. Based on this overview, we will use the following definition in this report:

Artificial intelligence is the ability of algorithms to describe the current environment, predict the future environment and prescribe future actions based on data. In this process AI is self-learning, can recognize patterns on its own and can independently generate new ideas and solutions.

2.4 Conclusion

When referring to AI we concluded that three dimensions must be considered. Firstly, the ability to help by describing, predicting, and prescribing. Secondly, the fact that AI can recognize patterns in data by itself, without using pre-programmed theory. With makes it both easier to implement AI and makes it possible for AI to produce completely new ideas and solution. Finally, AI is self-learning, which distinguishes it from ordinary algorithms. It can improve its descriptions, predictions, and prescriptions as it goes. This final element makes it unique, as it can solve complex issues and adapt to it. One of those complex systems are transport and logistical chains.

3 Challenges of the transport and logistics

Without seaports global trade would not be possible. Seaports are accessible for both seagoing and inland waterway vessels. Seaports do not only have the infrastructure to welcome ships like rivers, canals, quay walls, but also offer all necessary services to call upon the port safely and efficiently (Munim & Schramm, 2018). Pilots direct ships into the port, tugboats assist vessels to maneuver in the port and rowers assist the ship to moor and unmoor. While the ship is being loaded or unloaded, it can also use bunker services. To transport goods to the hinterland four different modes of transport can be used: trucks, barges, short-sea ships, trains, and pipelines. To coordinate all the different handlings and processes of goods, information management comes in place. It is eventually the interaction between the infrastructure and the modes of transport that determines the efficiency and safety of the transport operations (Alamá-Sabater, Márquez-Ramos & Suárez-Burguet, 2013). Logistics deals with the efficient forward and reverse flow of goods, services, and related information from the point of origin to the point of consumption according to the needs of customers. To stay competitive availability and quality of information is key, especially as ports are facing new challenges.

3.1 Challenges

Ports are facing numerous challenges in the coming decades of which four will have the most profound effect on its competitiviness. Firstly, ports around the world are going through an energy transition. In the coming decades ships and trucks will nog longer be powered by fossile, but more and more by electricity and renewable fuels. This also effects the production of fuels in ports, as refineries will have to transform their current production processes from conventional to renewable fuels, producing for example green hydrogen and methanol, instead of diesel and marine fuels. This immense transformation impacts the entire production chain and the pressure is high. Especially, as the current pace is below the set goal of 55% CO_2 reduction in 2030 and zero emission by 2050 (European Commission, 2021). In 2023 researchers assessed the impact of the current logistical measures to reduce CO_2 emissions on the corridor of Rotterdam -Venlo for barging, rail transport and heavy trucking. They concluded that even in the most positive scenario a reduction of only 16% can be achieved by 2030 (Rondaij, van Meijern, van Adrichem, van Kempen & de Jong, 2023). The reason: solo or bilateral initiatives will not help to achieve the goals 'an effective approach (...) would involve active participation of *all* stakeholders in the design, planning and execution.' This will require data sharing of all stakeholders and calculating power.

Secondly, climate change pushes the need for digitalization. Ports are already facing more extreme weather and it is expected that this will become more frequent. For example, in 2018 draught and subsequent extreme low water on the river Rhine crippled the transport by barges. This had effect on the entire logistical chain. From the terminals and industries in the port and hinterland, to truck operators that had to move more goods to compensate – every actor needed to anticipate on this sudden change. Scholars estimated the economic impact on the Dutch and German economy- to

be respectively 295 million and 2,4 billion euros (Streng, Van Saase & Kuipers, 2020). This is just one example of extreme weather, excluding extreme rainfall and winds. To make both strategic and tactical/operational decisions a vast number of factors must be considered, ranging from logistical and infrastructural factors to ecological influences like water and wind.

Thirdly, the technique of autonomous transport is rapidly evolving and advancing (SmartPort, 2019). Besides autonomous ships, techniques are also developed for truck platooning (semi-autonomous driving of 4 to 5 trucks in a column) (Yara, 2021; Janssen, Zwijnenberg & Blankers, 2015). Although these models are currently not operational yet, it raises the question: how can an autonomous vessel safely sail in the busiest port in Europe? Furthermore, it begs the question how one can organize and plan a platoon of autonomous trucks? To make this work, a system approach is needed as trucks of multiple brands and owners must cooperate. Moreover, autonomous and non-autonomous trucks and vessels must navigate and communicate with infrastructure and other traffic participants.

Lastly, due to an ageing labour market, the number of employees will decrease in both absolute and relative numbers (Eurofound, 2023). Knowledge is also lost with people retiring. Especially from the point of view of continuity of knowledge and security, this is an important driver to see as a challenge. At the same time, nowadays not only a larger pallet of knowledge but also of skills is expected, so the knowledge gap will only grow more. To cope with this challenge a knowledge base must be developed to both save this implicit and explicit knowledge in an organized manner as well as make this knowledge easily accessible and usable for new and current employees. This driver can be classified as a systematic challenge: the solution must be found within cooperation and thinking in systems.

To sum up, the challenges show a need for (1) more and diverse data, (2) strong computing power and (3) stakeholder support within companies but also in and along the logistical chain on a system-level. AI could be of use to face these (and future) challenges, making it relevant to look at the status of AI: is it considered to be a thread or an opportunity?

3.2 Threat or opportunity?

To determine the opportunity for the application of innovative technology, it is essential to define what the perception of AI is. Is AI seen as an opportunity or a threat? During the interviews conducted for this research it became clear that the possibilities and opportunities outmatched the expected threats, but this did not entail that the respondents were not able to name several threats. The first, and most, mentioned threat did not so much relate to AI itself, but the competition in adoption. It is the fear of being overtaken by competitors or bigger AI companies. 'If we don't do it, someone else will, and that doesn't necessarily have to be someone (...) from our sector' (Interview #10, Appendix 1). The second most mentioned threat was the influence of AI on the way of working, meaning that efficiency will become the dominant factor in comparison to social components. Or as an interviewee

put it: 'If we approach the entire truck handling process as efficiency? Yes, then I know that road carriers are going to reward all drivers like Amazon delivery drivers, so to speak' (Interview #12, Appendix 1). Aspects also mentioned were safety, geopolitics, and the *unknown unknows.* As AI will become progressively more intelligent, what to expect?

Nonetheless, the opportunities are regarded more highly than the threats. The most mentioned aspect is the power of AI to predict. Or as a respondent remarked: '[AI is] one of those that has also been in our strategy for a while, with that predictive nature' (Interview #25, Appendix 1). This is followed in ranking by opportunity to describe and prescribe. Or as an interview stressed: 'I just want to be able to plan automatically' (Interview #18, Appendix 1). Finally, the role of AI to fight labor shortage, which related to its ability to describe, predict, and prescribe. An interviewee described it as AI becoming a co-worker (Interview #9, Appendix 1). How do these outcomes relate to earlier research done?

In 2021 related research was done by Erasmus University and TNO on the effect of booking platforms as a disruptor and enabler in the logistics industry (Zomer, Hoesen & Zuidwijk, 2021). This study underlines the findings. Based on a survey they concluded that AI is, next to digitalization, in general the biggest game changer in the sector. 36% strongly agreed and 40% agreed that AI is going to be a game changer. More importantly, on the question if fundamental changes in competition are expected because of new entrants and vertical integration, a substantial portion agreed or strongly agreed. New entrants: 23% strongly agreed and 45% agreed; and vertical integration: 34% strongly agreed and 39% agreed.

3.3 Usage by businesses

Research by the Central Bureau of Statistics (CBS) (2021) found that in 2021, within trade 11% and transport 8% of companies use one or more AI technologies (see table 1). There is limited use of AI technologies in these sectors. Furthermore, mainly larger companies use these technologies. Finally, it can be concluded that the techniques used are quite simple, such as machine learning and face recognition. Also, it is difficult to properly identify the providers of AI (CBS, 2022).

Table 1 One or more AI technologies used by companies (size of companies)

Company size	Used (%)*
500 or more persons employed	45
250 to 500 persons employed	33
100 to 250 persons employed	23
50 to 100 persons employed	16
20 to 50 persons employed	12
10 to 20 persons employed	8

*One or more technologies used

Table 2 One or more AI technologies used by companies (sectors)

Industry sector	Used (%)*
Information and communication	34
ICT-sector	32
Financial institutions	25
Academic research institutions	28
Consultancy and research	19
Real estate	14
Energy & water	13
Industry	12
Trade	11
Healthcare	10
Other services	9
Transport	8
Construction	5
Hotels and restaurants	3

*One or more technologies used

Table 3 AI technologies applied by companies

AI technology	Used (%)
Machine learning	6
Pattern or face recognition	4
Robot-assisted process automation	4
Speech recognition	3
Virtual agents or chatbots	3
Data mining	3
Deeplearning	3
Service robots or autonomous vehicles	2
Other AI technologies	2

3.4 Conclusion

Overall, four developments push the need for more digitalization and AI: the energy transition, climate change, autonomous transport and ageing personnel. These developments are, however, so complex to solve that a system approach is needed. Moreover, according to the interviewees the opportunities of AI outmatch the threats. AI is seen as one of the biggest game changers and, as a result, the use of it is seen as pivotal, mainly because of the fear of being outmatched by competitors and new entrants.

4 Opportunities for the transport and logistics sector

One of the most ambitious initiatives in Rotterdam using an algorithm is Nextlogic (2023). Its goal is to make an integral planning tool for the handling of container barges. Currently 60% of the barge volume (17 barge operators), 76% over the terminal volume (5 terminal operators) and 33% of the empty depot volume (4 empty depot operators) share data with Nextlogic to achieve an integral planning. On a good and busy day, the algorithm makes 120,000 planning improvements (Interview #22, Appendix 1). The algorithm used is not yet self-learning, since it only focuses on the speed and efficiency of container barging handling within the port. It shows, however, the first glimpses of what the use of an AI application within the transport and logistics sector may look like. To get a better view of future transport and logistics in and around the port we interviewed a dozen scholars in the field of transport, logistics and ports. Based on these interviews we made a general overview of the current research field. We started with the meta-concepts of physical internet & self-organizing logistics that offer a completely novel approach to the current system of the transport and logistic sector. An important sidenote is, that we focus specifically on the application of AI in transport and logistics and not so much on the infrastructure. Nonetheless, we want to stress the fact that maintenance of physical port infrastructure (quays, terminals, waterways) can benefit from AI-supported technology.

4.1 The need for a new approach: physical internet & self-organizing logistics

Since 2006, world-wide research is being done on the concept of physical internet (PI) (PI Events, n.d.). The PI vision describes the future of logistics in an advanced state of coordination and collaboration, mainly driven by digitalization. It promises to transform the way physical objects are moved, stored, realized, supplied, and used, pursuing global logistics efficiency and sustainability. The general thought is the need to develop towards large scale sharing of assets and system level optimization of logistics processes. For example, currently every company has its own transport and terminals with often low utilization. By sharing access, fewer assets would be needed, and efficiency could be improved dramatically, also allowing sustainability improvement in the system. Clearly, AI could play a central role in the PI.

To make this happen, three things are needed: (1) the sharing of data, (2) employees and (3) resources. The general idea is that one company should be able to share anything with other companies at any moment (Interview #28, appendix 1). When it is busy at company A, A should be able to use cranes and employees from company B, whereas when it is less busy at company A, company B can use their cranes and employees. The ultimate goals are that companies will be able to react to demand more swiftly and are consequently more flexible. AI is essential in such integral planning because it will need computing power, as it will have to consider many variables.

The basis of PI is self-organization, in this case self-organizing logistics. The general principle of self-organization is that goods and modes of transport will become so 'smart' (via sensors) in the future,

they there are able to communicate with each other without human interference. As they will be able to communicate, they can also cooperate and create a planning together. The big question is how they will communicate and interact. TNO made an overview of four archetypes, with on one axis how information is shared and on the other who decides (TKI Dinalog, 2020). Every case will have its how optimum, but what all types have in common is that all goods and modes are able to communicate.

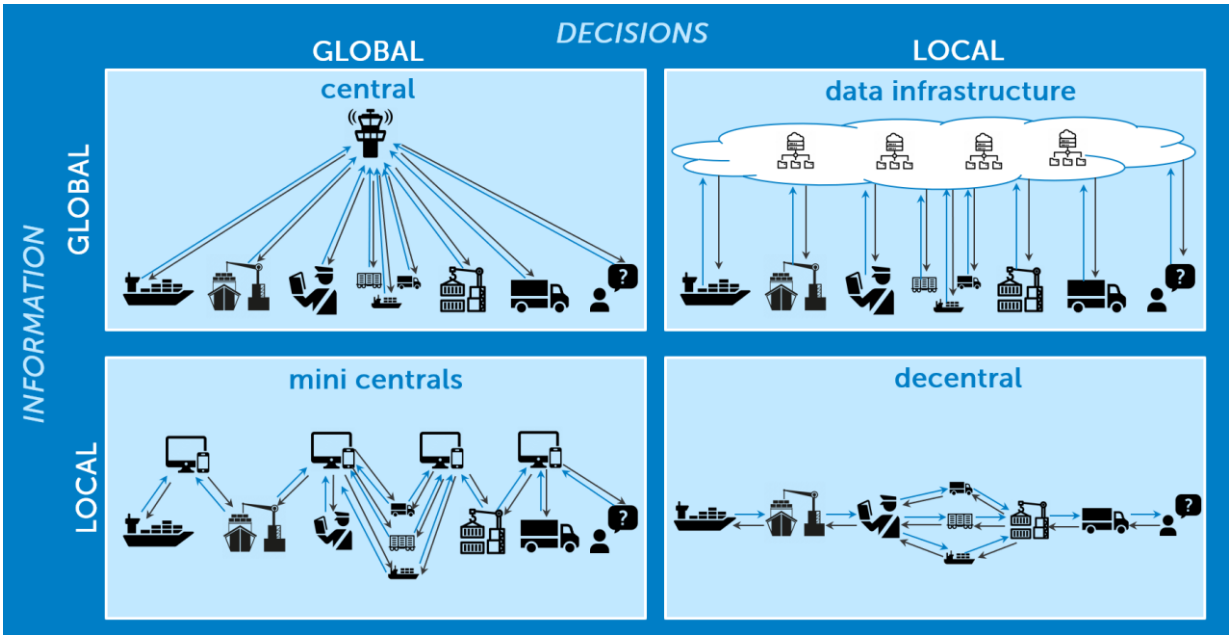

Figure 2 Types of self-organizing logistics (adapted from TKI Dinalog, 2020)

4.2. Enhanced supply chain visibility

The next five research fields focus more on specific parts of the transport and logistical process. The first topic can be described as enhanced supply chain visibility, which refers to 'the extent to which actors within the supply chain have access to timely and accurate information that they consider to be key or useful to their operation' (Somapa, Cools & Dullaert, 2018). To react to increasing consumer expectations, fluctuation in demand and inventory cost a paradigm shift is needed (Kashem, Shamsuddoha, Nasir & Chowdhury, 2023). To make this work pioneering activities take place using sophisticated analytics such as AI. According to Kashem et al. the goal is to 'provide fairer views and options for managing forecasting, planning, monitoring, and reporting across the supply chain.' Besides the focus on the improvement of the visibility, research is also done on the effect on the companies within the logistics chain. Digital platforms, for example, could make the freight forwarding process more efficient and therefore also contribute to supply chain visibility. Zomer, Hoesen and Zuidwijk (2021) concluded that digital platforms are both a threat and opportunity. On the one hand they can take market share from 'traditional freight forwarders that slowly digitize their processes and fail to adapt their business model.' On the other hand, it can also be a 'blessing in disguise for (...) forwarders that embrace the digitalization transformation,' as it will help them to become more

customer centric and expand their service portfolio. Research projects such as these give concrete suggestions for companies in the supply chain to up their game.

4.3 Self-organizing fleets

Traditionally, planners have been the key figures responsible for managing the logistics operation process. The digitization and automation of these planning processes not only offer efficiency and reliability but also provide opportunities for alternative management of logistics operations. But does this self-organizing logistics approach offer added value compared to the traditional method? TNO, investigated whether added value is created when trucks make their planning together (van Ommeren, van Kempen & van Meijeren, 2022). In the project trucks could exchange information among one another. In this process, the planner was responsible for setting the rules, such as delivery time windows for customers, monitoring and potentially adjusting the fleet. Based on three practical experiments, it was concluded that the digitization of the planning process is valuable if the planner can monitor the process and provide guidance and adjustments to drivers when necessary. For example, an algorithm does not know, which driver is willing to work an extra hour or if a customer is fine with a slightly delayed afternoon delivery. Nonetheless, technology is ready. Moreover, there are already ideas to research whether this 'new way of planning' can also be used on a fleet-level, including barges, trucks, and trains.

4.4 Port call optimization

Port call optimization as a research field focusses on the efficiency of a specific part of the logistical chain – ships entering, visiting, and leaving the port. Many different actors are needed to serve a ship and to achieve an efficient port call. A major concept is SwarmPort. By enhancing comprehension of the sequence of nautical services provided to vessels in seaports, it can simulate the operational procedures within ports using agent-based modeling from a perspective of complex self-organizing systems. In other words, the goal is to coordinate activities of actors executing the traffic management, towage, pilotage, and mooring activities without human interference. Based on the existing patterns in which port calls are handled, a model was developed. This model or tool can help to improve both safety and efficiency of the port call. In 2023 a 4-year study into the concept was finalized by the creation of a model (TU Delft, 2023). Scholar of TU Delft Shahrzad Nikghadam concluded that the "study brought shared awareness among all stakeholders about the benefits enhanced cooperation can bring, backed up by numbers" (Nikghadam, 2023). Currently the scholar works at the Port of Rotterdam to bring this lab environment research to practice in the port.

4.5 Climate adaptive and zero-emission shipping

A lot of effort is put in accelerating the introduction of zero emission fuels and adaptation measures to face periods of extreme high and low water levels on the rivers. In 2018 there was only a single PhD-research focusing on climate change and inland shipping, but with the extreme low water on

the Rhine in the summer of 2018, the research field took off. Firstly, a consortium of TU Delft and Deltares together with a handful of barging companies started research into a digital twin of the Rhine as a decision-support tool. What new ships should be bought (smaller of large ships)? How to react to periods of high and low water (tactical)? In 2022, this research was followed by Path2Zero (Paving The way towards Zero-Emission and Robust inland shipping). In this research by the TU Delft and Erasmus University Rotterdam and more than 20 parties, including port companies and governments, the goal is to create breakthroughs in the transition to emission-free inland shipping (TU Delft, 2022a). To make this work a digital twin is developed – a digital version of the real world - that can help assess which solutions have the most promising outcomes. An important aspect of the research is to include a variety of data sources to match the real time situation as good as possible. This is where AI comes into play.

4.6 Autonomous shipping and trucking

Autonomous shipping has the potential to significantly lower the cost of shipping, solve anticipated crew shortages, enhance safety, improve working conditions, and better integrate shipping in the transport system. To make this work, decision support algorithms and systems that can deal with the specific challenges of (semi-) autonomous ships such as limited situational awareness and interactions with conventional ships are needed. Moreover, an ethical and legal framework is needed around the decision-making of autonomous ships (NL AI Coalitie, 2021). Furthermore, it requires a methodology for determining whether a (partially) autonomous system uses 'good seamanship' practices and adheres to waterway rules (Yzewyn & Verduijn, 2023). Without adjustments to current laws and regulations, autonomous vessels cannot be deployed in practice on waterways. Finally, the port must be equipped with smart systems on the quay side (NL AI Coalitie, 2021). A prerequisite for this is real-time condition monitoring and real-time control of ships, both on board and from the quayside. Not only can this improve the process in the port, but it can also make choices for future investments in quay walls easier. This research field focuses on all these aspects to make the port call of an autonomous vessel possible. Another form of autonomous transport is (semi-)autonomous trucking. Truck platooning is such and innovation in which trucks automatically follow each other in convoys of 3 to 4 trucks (Van den Berg, 2023). Although this technique has been stalled by the OEMs (truck producers) and policy makers, it is still a viable technique as it can not only increases road safety and saves fuel (up to 16%), but also improves traffic flow.

4.7 State of the technique

AI has developed rapidly and offers an opportunity to describe, predict an prescribe, based on a variety of data. As a result, it will be possible to better determine what future options are, how to organize and what the best strategic, tactical and operational choices are for port companies in transport and logistics. From the conversations we have had with professors, lecturers and researchers from Erasmus University, TU Delft and Rijksuniversiteit Groningen, it became clear that many first

applications of AI as a theory and technology are already at level 8 or 9 of Technological Readiness Level (TRL), but implementation of AI in port practice is the next step (see Appendix 1 for a specification of the different TRLs). One of the interviewees mentioned that "*the technique of AI can already have a very high TRL, but the system change that is required, is in an entirely different pace of development*" (Interview #28, Appendix 2). Another person confirmed that "*AI as a theory and technology is already in level 8 or 9 of TRL, but application of AI into the real world is the next step*" (Interview #26, Appendix 2). We are currently in an "*experimental phase of implementation, demanding a bridge between science and practice*" (Interview #30, Appendix 2).

4.8 Conclusion

The different research fields show that AI is an important means to transform the system in such a way that it is climate adaptive, can transform to zero emission and become more automated. Moreover, based on the interviews we concluded that AI as a theory and technology is already considered to be on a high TRL. Nevertheless, in practice, insufficient use cases in the port environment display the difficulty to adopt AI in real life. This brings us to the question: why are the number of examples so limited, why is the adoption level so low?

5 From research to practice

Containers that choose their own route through the logistical chain, fleets of autonomous trucks, barges and trains that make their own efficient planning and terminals sharing, not only, data, but also employees and cranes will be involved. This is just a brief summary future projects of the current research fields in transport and logistics. And all these applications need some form of AI. The question is, however, why according to the researchers and scholars the TRL is already high, but the adoption level so low? To investigate this, we interviewed companies all over the logistical chain and organized a session in which they had to write down the 'dreamed' application of AI for their company. Moreover, we asked them to respond to the dreams of others by adding opportunities and challenges. Especially, the latter gave a good inside into the difficulties the increase the adoption level of AI.

5.1 Needs and dreams

We collected dreams of companies during the second workshop, and overall, they were big, but not very concrete as can be seen in Figure 3 (Appendix 3 contains the dreams). An example of a dream moderate in size and concreteness is:

"a transport image of all relevant information and data needed to organize efficient and low-emission transport to maintain and strengthen the leading position."

More concrete dreams were for example:

"a self-learning system that analyses damage or defects to assets (quays or jetties) and reports them to colleagues and companies so that damage can be prevented, and ships can always be moored"

and

"better estimation of future port (land) use, so that better (…) decisions can be made [in a world of] spatial challenges and the energy transition (…)".

The predominant topic of the dreams was enhanced supply chain visibility (62%), for example AI assisting as a planner for the transport tasks within the supply chain. Zero-emission and climate adaptive transport came in second (14%). Furthermore, there were several topics that were only addressed once: spatial planning, port call optimization, predictive asset management, securing knowledge and experience and autonomous transport.

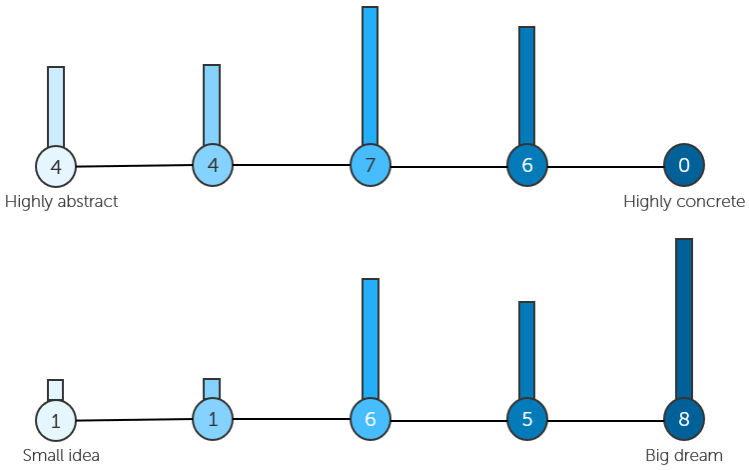

Figure 3 AI application dreams concreteness and size

Table 1 and 2 display the mentioned opportunities and threats by the participants of the workshop. Increase in competitiveness and a stronger revenue model with less costs were the most named opportunity. The ability to develop a stable data infrastructure and data standards comes in second. An increase in operational efficiency, reliability and cooperation are also seen as major opportunities.

The most named challenges were related to collaboration and cooperation, more specifically the difficulty of getting (all) stakeholders aboard, sharing data amongst each other and poor translation to the customer. Furthermore, undefined, or unclear (common) goals and the unsuitability of infrastructure and technology have also been addressed multiple times.

It is interesting to note that some opportunities can also have a shadow-side as challenge. For example, on the one hand, AI could make better use of personnel, but on the other hand personnel can also struggle with staying up to date with innovation. Another example is the fact that AI might kickstart a drive for creating and implementing law and regulations, on the other hand, the lack of law and regulations can be perceived as a challenge.

When implementing and developing AI within a company, a group of stakeholders or within an entire supply chain, it is particularly important to bear these challenges and opportunities in mind to accomplish the full potential of the transition.

Table 1 Mentioned opportunities for AI application in the port

Opportunity	Number of mentions
Increase in competitiveness and revenue model, less costs	8
Ability to develop a stable data infrastructure and data standards	6
Increase in operational efficiency	6
Make better trade-offs and be more reliable	4
Supporting cooperation (which creates more understanding)	4
Be an attractive employer	3
Connection with EU initiatives	3
Reduce emissions and increase sustainability	3
Fewer human errors / less dependency on people	3
Increased safety and being better armed against calamities	2
Flexibility to better control the logistics chain	2
Better use of personnel	1
Facilitating young companies	1
Ability to exchange real-time data	1
Ability to predict	1
Reward participants and stakeholders	1
Move towards stricter and clearer regulation	1
Faster learning and generating new ideas	1

Table 2 Mentioned challenges for AI application in the port

Challenge	Number of mentions
Getting many stakeholders on board (you cannot be everyone's friend)	9
Lack of willingness to share data	8
Poor translation and/or communication to the customer / value for the customer	7
Lack of explainability	6
Undefined or unclear (common) goal	6
Unsuitability of infrastructure and technology	5
Competition and cost/benefit trade-offs hampering the transition	4
Inability to set priorities within AI	4
Innovate while the company is open	3
Inability of personnel to stay up to date with innovations / ageing staff	2
Inability to secure and communicate knowledge from the past to new employees	2
Fault sensitivity of data or of AI / lack of data quality	2
Inability to differentiate	2
Lack of trust	1
Lack of control	1
Unhealthy competition	1
Being too dependent on international stakeholders such as large organisations	1
(Lack of) laws and regulations	1

The relatively high level of TRL of AI with a relatively low degree of adoption, can be explained by the various challenges. More specifically, three main challenges summarize the problem of low adoption.

- Firstly, the lack of data and the lack of willingness to share data hamper the speed of adoption. Here, the lack of trust in AI and the lack of data quality also play a role.
- Secondly, lack of clarity regarding the added value of AI, forms an important challenge to face. This might cause poor translation and/or communication to the customer, as well as the fact that employees will have difficulty understanding the implications of AI.
- Lastly, it can be difficult to determine boundaries in the sense of concreteness of goals. It can be difficult to weigh the different aspects that need to be considered, such as sustainability, safety and efficiency.

5.2 Conclusion

From the sessions with experts, it became clear that no one could name a concrete dream with AI application in transport and logistics, indicating that the market is not delivering. Of all the dreams, 62% fall in the supply chain visibility category, 14% in climate adaptive transport and 24% is a residual category. This suggests a slight mismatch between science and practice for a few reasons. First, of the 5 fields of research shown in chapter 4, only 2 resonate during the session. Secondly, whereas companies argue the need for small steps - because changes must implement 'while the shop is open' -, universities and other knowledge institutes argue that there is a need for a system approach and large transdisciplinary research trajectories. However, how can this gap be bridged?

6 Step-by-step: towards the use of AI

Companies in port logistics and transport are increasingly confronted with the need to increase efficiency to stay competitive. This development also entails technological savviness. As an interview remarked: 'actually every company is becoming an IT company, because if we are in the office and the Wi-Fi is offline, that is a big problem' (Interview #13, Appendix 1). However, whereas the back office can be firmly digitalized the front office is not. In 2022 Keijl and Moonen wrote the SmartPort whitepaper *The what, how and why of data sharing*, in which a 'pretty sobering picture' emerged from interviews in the transport and logistics sector. Keijl and Moonen concluded that even if electronic communication takes place most of the time it is in the form of interaction via a web interface or email. In other words, most of it is still manually. As a result, there is still a way ahead of standardizing digitalization and the step towards AI. In the following sections, we present a step-by-step process to implement and adapt AI.

AI as an employee or colleague

When implementing AI, a good metaphor is hiring a new employee/colleague. First, the desk and all shared folders should be in order. Secondly, there have to be clearly defined capabilities and skills. Thirdly, a clear job description is needed. Fourthly, the norms and values should match those of the company. Fifthly, like every employee there should be a constant evaluation. Especially the fourth step is crucial, because in contrary to a human being, an AI trained algorithm was not nurtured, did not have any education and, as a result, needs to receive norms and values by design.

6.1 Step 1 Arrange your data

The first step towards digitalization and successfully implementing and using AI, is to arrange your data. For arranging the data, it is necessary to share data with other organizations. Data sharing is not a new thing, but developments are rapid. It is a logical consequence of increasing digitalization of logistics. The whitepaper on data sharing (Keijl & Moonen, 2022) recommended five steps on how to get started:

1. Work on digital awareness of the organization

   New technologies keep emerging and digitalization goes beyond traditional IT, offering opportunities to improve business processes.

2. Think in processes, not in technology

   Not only the processes the company is involved in, but also their role within the entire chain need to be understood.

3. Get your own data management in order

   Proper data management is crucial when data is shared more intensively, but also to become more data driven.

4. Seize the innovation opportunities out there and start sharing data

Start experimenting, innovating, and extracting value from data sharing.

5. Don't do it alone

   Collaborate with other parties, such as chain or technology partners, knowledge institutions and researchers.

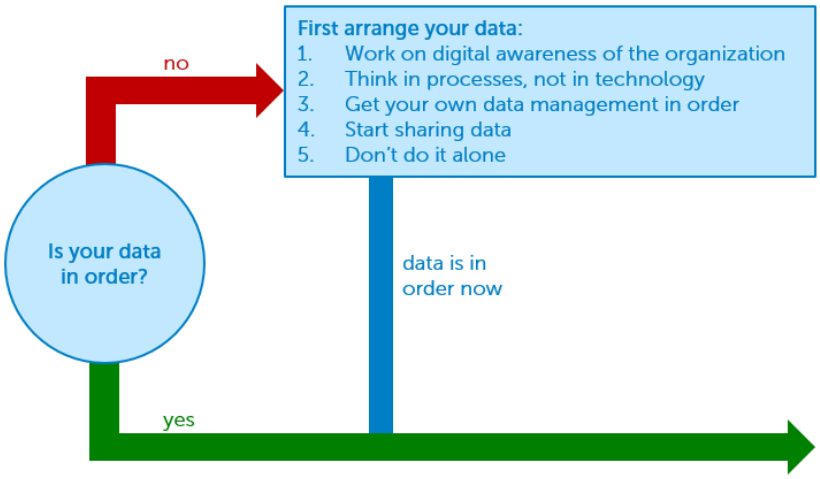

Figure 3 Step one towards implementing AI: arrange your data

6.2 Step 2 Use for AI

Once data has been arranged and shared properly, the second step is to determine the use of AI. If a company solely wants to execute simple modelling or complex modelling (not based on AI), there is no need to proceed, at that point in time, with the implementation and adaptation of AI. Examples of simple modelling are logical data and physical data models. Logical data models can be useful in highly procedural implementation environments or for data warehouse design and reporting system development (IBM, 2023c). Physical data models, on the other hand, provide a schema for how the data will be physically stored within a database, for example for database management systems.

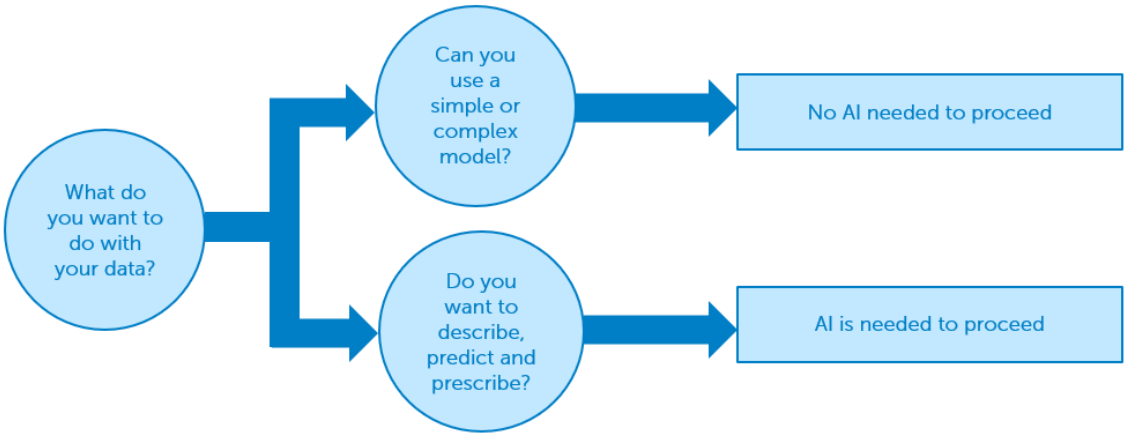

Figure 4 Step two towards implementing AI: determining the use of AI

If not simple data modelling, but rather description of the current environment, prediction of the future environment and/or prescription for future actions, is the objective, AI implementation and adoption is advised. The next step can then be divided into two parallel operations: developing cases and determining boundaries.

6.3 Step 3 Developing cases

Through a transdisciplinary approach, next level levels of applications of AI can be achieved. Through integration of academic insights and insights from practice, the implementation of solutions for a complex problem from practice can be expediated (Huutoniemi, Klein, Bruun & Hukkinen, 2010). Combining the capabilities and competencies of computer scientists, mathematics, behavioral scientists, philosophers, legal experts, entrepreneurs and engineers, all relevant disciplines can be combined and extrapolated (Interview #28, Appendix 1). This explicitly does not entail a multidisciplinary approach, because in that case disciplines do not intertwine with each other (Interview #30, Appendix 1). We understand that this will require a particular amount of organization from both the business field and the knowledge field, but the pay-out (in terms of TRL) will be higher compared to not working together. Development of cases will be far easier and more efficient.

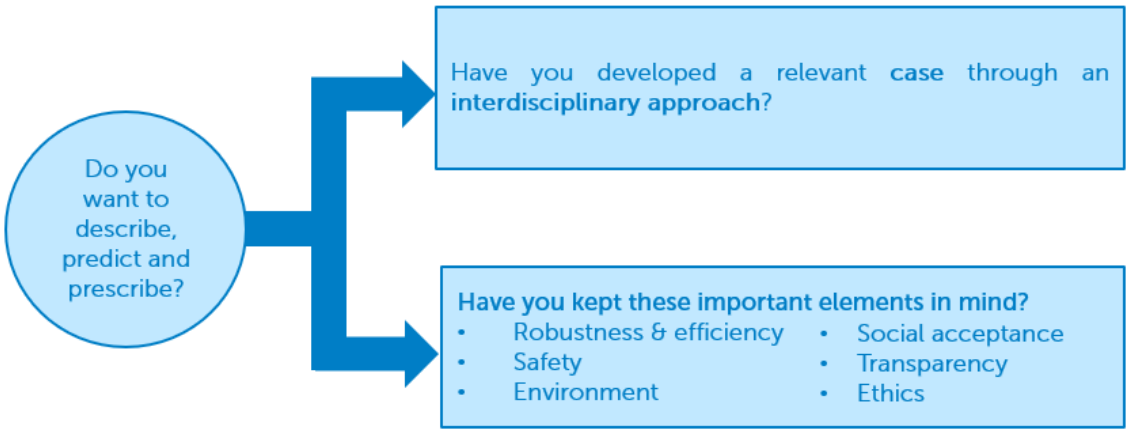

Figure 5 Step three towards implementing AI: development of cases and determination of boundaries

6.4 Step 4 Determining boundaries

While developing a relevant case to apply AI, it is essential to always keep the following elements in mind (Interview #26, Appendix 1) (session #2 feedback):

1. Robustness and efficiency: ensuring a smooth operating process, ensuring high efficiency.
2. Safety: adhering to legal, regulatory and standards for safety of employees, machinery, equipment, worksite and environment.
3. Environment: addressing nature and its inhabitants, from land-, water- and air-perspective.
4. Social acceptance: recognizing the interplay between social norms and the public opinion.

5. Transparency: towards every actor, from supplier to customer and from authoritative organizations and partners.
6. Ethics: without ethical guardrails, AI risks producing real world biases (such as discrimination).

These boundaries always need to be kept in mind simultaneously. It is, however, a consideration of which weights one wants to attach to each element. By focusing more on one element, for example the environment and sustainability, other elements will be less accounted for, such as efficiency and safety. Currently, legislation on AI is developed on a European level, which will have a tremendous impact on the further implementation of AI models (European Parliament, 2023).

6.5 Step 5 Evaluate

Finally, reflecting and providing feedback are important pillars of implementing AI. Periodically checking and looking back to see if the set goals have been achieved allows learning from things that have gone wrong and determine if the algorithm is still helps to reach the set goal. This step can be recognized in the roadmap in Figure 6 as a feedback loop and goes back to step 2. In this loop is important to realize the roles of different types of companies. For instance, the port authority can play a more facilitating and leading role, while at the same time smaller companies should not be forgotten. At all times, it is necessary to include and weigh the opinions and positions of all organizations, however influential or small, in joint choices being made.

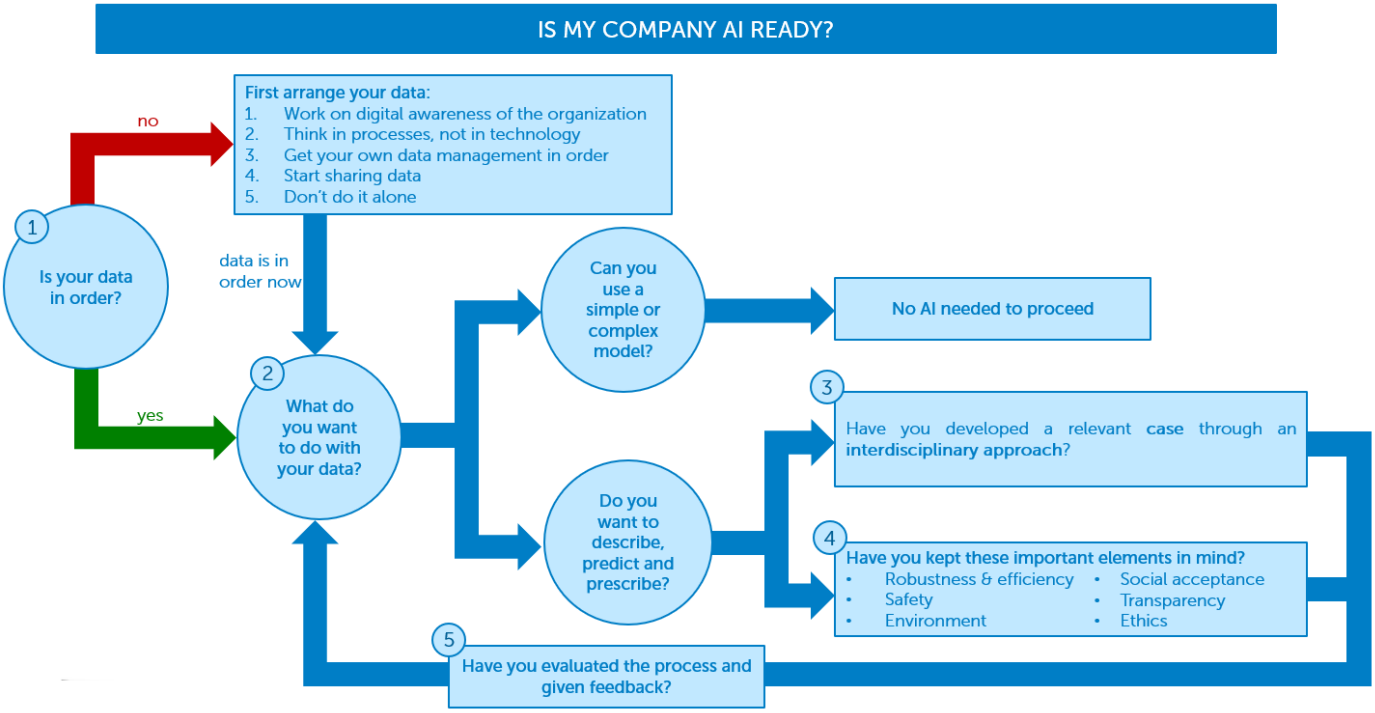

Figure 6 Roadmap to AI

6.6 Applicability of the step-by-step process to AI challenges

In section 5.2 the perceived challenges of the industry in regard of AI were presented. The step-by-step solution for implementing AI tries to address these challenges. Getting stakeholders on board and the lack of willingness to share data, fall within the first step of the solution: whether one's data is in order, and sharing data is a component of that, can address these problems. Communication towards the customer, explainability and defining a clear goal are examples of challenges that can be solved by determining the use for modelling within the company. When the goal and the means to get there are clear, lack of explainability and unclear goals can be circumvented. Developing real life cases can map out whether the infrastructure and technology is up to date. Defining boundaries in terms of ethics and safety help to set priorities with AI. Lastly, ensuring there is a constant feedback loop ensures the ability to innovate while the company is open and explain the use of AI.

6.7 Conclusion

In summary, there are a few steps that need to be taken for a successful implementation of AI in a company, group of companies or in an entire logistics chain. First, it is important to get data in order, which includes the aspect of data sharing. Not only, must the data be in order, but companies must also agree with data sharing. After this, the task is to define a purpose: for what do they want to use AI? If concepts like description, prediction and prescription fall within this common goal, AI is a suitable candidate to achieve it. Next, a viable case needs to be created, keeping in mind boundary conditions such as security.

7 Concluding remarks

That 'Artificial Intelligence (AI) is a mean, not a goal', was mentioned regularly during the different interviews for this research. The question is, however, for which goal and for whom? That is why the main question of this paper was: why and in what form is there a need for the application of AI in the port of the future and how can universities contribute?

First, AI is an important technique that seems vital to overcome todays and tomorrow's challenges. AI is unique in its sort as it cannot only describe the current environment and predict the future environment, but it is also capable of prescribing future actions based on data. AI is self-learning, can recognize patterns on its own and is able to generate new ideas and solutions. In this sense, AI can come in helpful for the transport and logistics sector to stay competitive in an ever-changing environment. The energy transition pushes ports to transform old fossil fuel chains towards new alternative fuels, forcing production patterns and processes to change. At the same time, climate change demands for more accurate predictions of potential trade disruptions like low and high-water levels on inland rivers. The surge for automated transport, demands regulatory and legislative responses – while the ageing workforce makes the need for efficient knowledge exchange essential.

Second, researchers from universities and knowledge institutions are already working on an elaborate combination of solutions to face the current challenges and to develop towards the port of the future. In a smart, efficient, safe and carbon-zero port, AI could well have a prominent position. Port calls can be optimized, fleets can organize themselves and shipping can be characterized by being climate adaptive and zero-emission. However, whereas the Technological Readiness Level (TRL) seems high, the adoption level is low.

Third, the adoption level is low because of lack of data and the lack of willingness to share. Here, the lack of trust in AI and the lack of data quality also play a role. Lack of clarity regarding the added value of AI, forms an important challenge to face. This might cause poor translation and/or communication to the customer, as well as the fact that employees will have difficulty understanding the implications of AI. Moreover, it can be difficult to determine boundaries in the sense of concreteness of goals. It can be rather difficult to weigh the different aspects that need to be taken into account, such as sustainability, safety and efficiency.

We created a step-by-step approach as method to support to adoption of AI. By arranging data (step 1) in a clear and consise way, while also sharing information with other companies, companies will be ready to determined what use there is for AI within their organization (step 2). Through developing cases (step 3) and determining boundaries (step 4), guardrails are laid down to ensure that all relevant aspects of implementation are adressed. Evaluation (step 5) and keeping a feedback loop, will ensure that best practices are further developed and mistakes can be learned from.

Fourth, the results of this exploration seems to suggest that there is a slight mismatch between science and practice. To start with, companies request for small research steps, whereas knowledge argue for the need of large research trajectories. Secondly, the interest of the companies we interviewed and participation in our sessions only centers around two of the 6 presented fields of research (62% of the participants specifically showed interest in supply chain visibility and 14% of the participants in climate adaptive transport). We would like to stress that this conclusion is based on a limited amount companies and will need more in-depth research to verify.

Concrete suggestions for AI Port Center:

1. Keep supporting the development of research that gives a better understanding of what the port of the future will look like, as it helps to created a shared vision and offers a shared language for both knowledge institutes and companies. For example, during the research, terms such as self-organizing logistics were used by both scholars and employees of business.
2. Create clearly defined cases that directly match with the demand of companies and help companies to determine whether AI should be useful or not. Moreover, show companies how valuable there input is for further research. For example, during the second session a company downplayed the value of a future contribution, whereas a researcher completely disagreed.
3. Research done into the implementation of AI needs transdisciplinary research, as it related to many fields of research. AI Port Center can play a crucial role in bringing scholars of different disciplines together and help them to work on specific cases together with companies.

Dream big, start small

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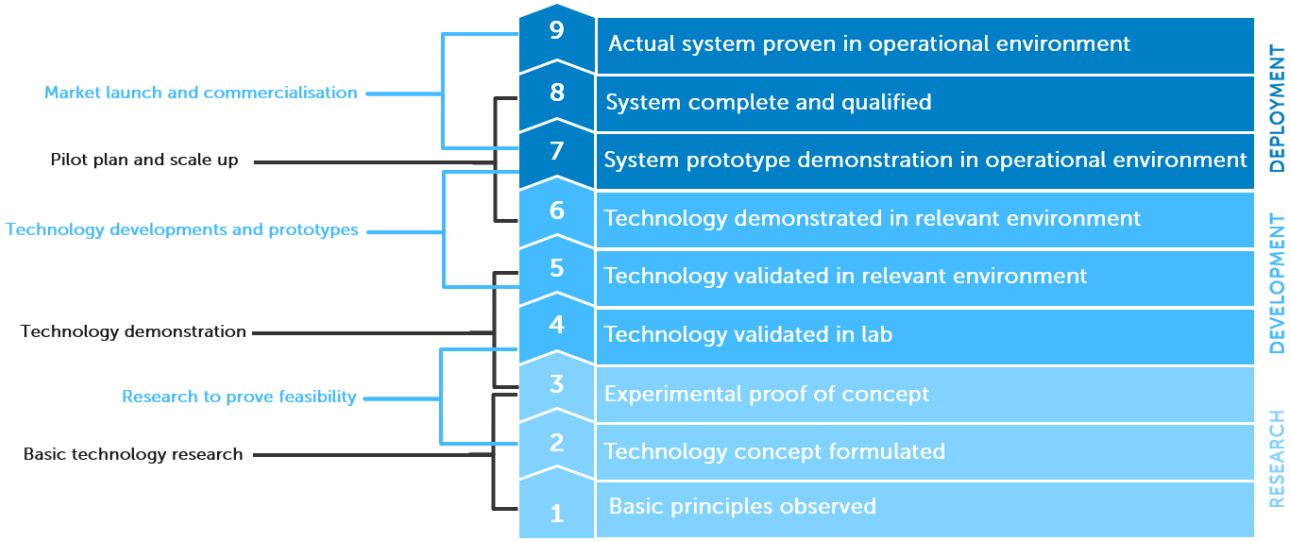
Appendix 1 Technology readiness levels – European Union

Where a topic description refers to a TRL, the following definitions apply, unless otherwise specified (European Commission, 2015):

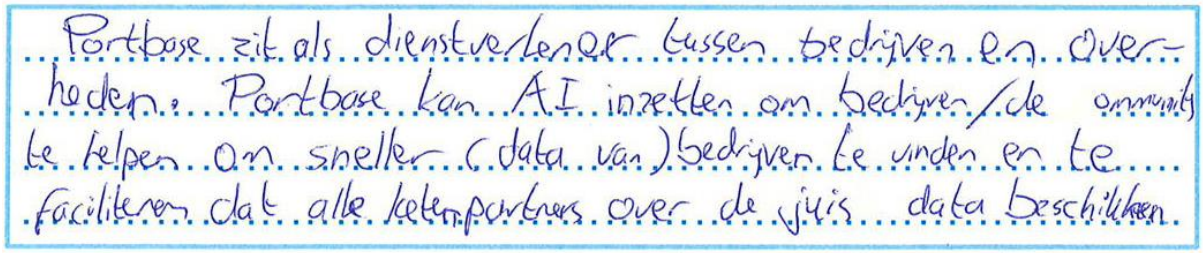


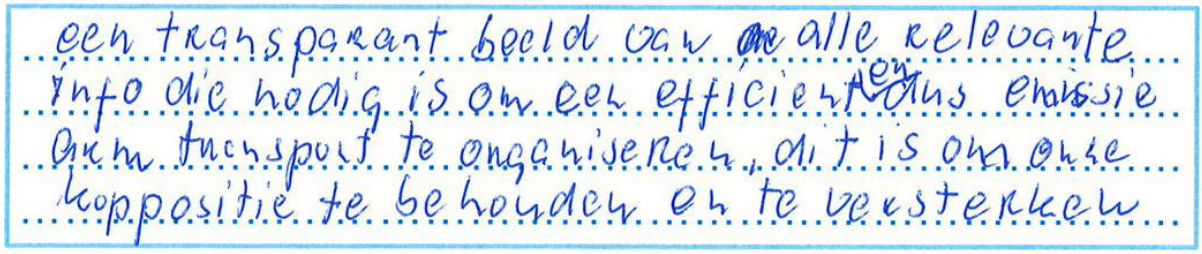
Appendix 2 List of interviewees and participants

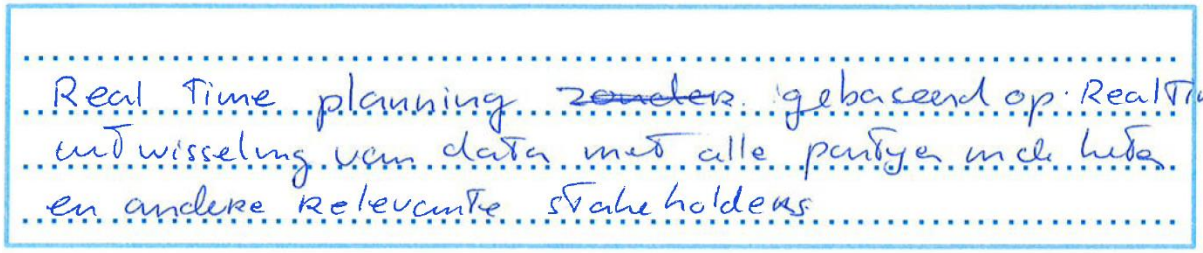
Interviews were conducted from July till October 2023. The names displayed in the table below are arranged alphabetically by order of surname.

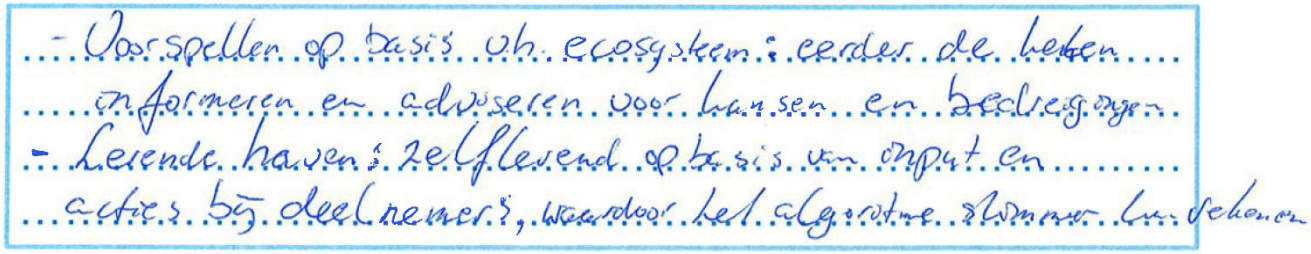
Name	Organisation
Niels Agatz	TKI Dinalog
Donald Baan	Portbase
Fedor Baart	Deltares
Bas van Bree	TKI Dinalog
Wiebe de Boer	SmartPort
Johan Boon	Deltares
Dennis van den Bos	Blockbax
Bob Dodemont	Port of Rotterdam
Harmen van Dorsser	Havenmeester
Patrick Everts	Kotug
Johan Gille	Port of Rotterdam
Joop Halter	Port of Rotterdam
Jacqueline Heinerman	Port of Rotterdam
Marjolein Hulsebosch	Port of Rotterdam
Sjoerd de Jager	PortXchange
IJsbrand Kaper	TNO
Mark van Koningsveld	Technical University Delft
Ben Maelissa	Danser
Jaco van Meijeren	TNO
Rudy Negenborn	Technical University Delft
Michiel Nijdam	Port of Rotterdam
Sijbrand Pot	Nextlogic
Frederik Schulte	Technical University Delft
Marlies Sikken	SmartPort
Dalibor Stojakovic	NPRC
Lori Tavasszy	Technical University Delft
Judith van der Valk	Nextlogic
Iris Vis	Rijksuniversiteit Groningen
Pieter de Waard	Port of Rotterdam
Rob Zuidwijk	Erasmus University Rotterdam

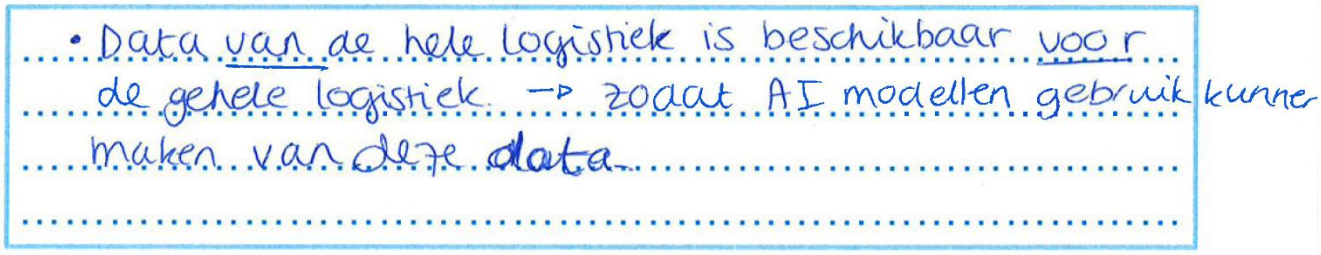
Appendix 3 Dreams scans

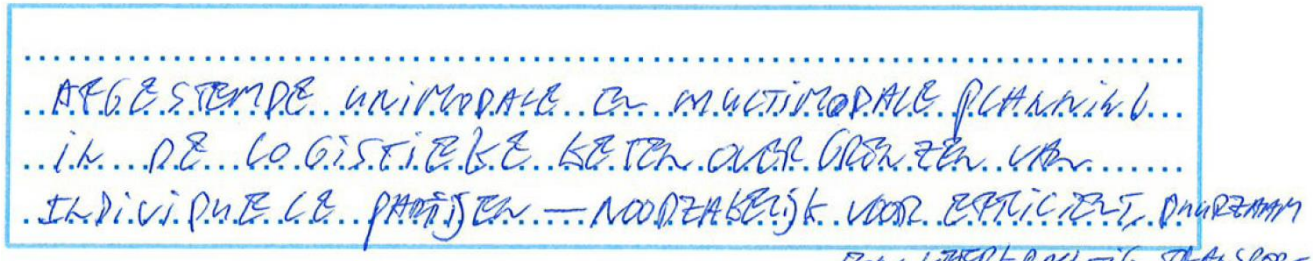

Portbase zit als dienstverlener tussen bedrijven e.n. overheden. Portbase kan AI inzetten om bedrijven/de overheid te helpen om sneller (data van) bedrijven te vinden en te faciliteren dat alle ketenpartners over de juiste data beschikken


een transparant beeld van de alle relevante info die nodig is om een efficiënt(er) en duurzame emissie arme transport te organiseren, dit is om onze koppositie te behouden en te versterken


Real Time planning ~~zonder~~ gebaseerd op Real Time uitwisseling van data met alle partijen incl. hub en andere relevante stakeholders


- Voorspellen op basis van ecosysteem: eerder de keten informeren en adviseren voor kansen en beslissingen
- Lerende havens: zelflerend op basis van input en acties bij deelnemers, waardoor het algoritme slimmer kan reken


• Data van de hele logistiek is beschikbaar voor de gehele logistiek → zodat AI modellen gebruik kunnen maken van deze data


AFGESTEMDE UNIMODALE EN MULTIMODALE PLANNING IN DE LOGISTIEKE KETEN OVER GRENZEN HEEN
INDIVIDUELE PARTIJEN — NOODZAKELIJK VOOR EFFICIËNT, DUURZAAM EN VEELZIJDIG TRANSPORT

AI moet leidend zijn in optimalisatie en digitalisering projecten binnen het haven bedrijf. minder gefocust op manuele handelingen en meer samen werken met (keten) partijen middels AI

(genereren van alternatieve manieren)

AI helpt bij het optimaliseren van grote logistieke systemen en hoe die interacteren met de fysieke omgeving om complexe doelen te bereiken. Waarom: AI kan met meer dingen rekening houden dan mensen.

Netto positieve (vanuit mens & milieu) transport en logistiek voorziening in de haven (= optimaal gebruik energie, planning, bemensing etc etc.)

AI als versneller inzetten om samenwerking tussen kennisinstellingen, overheid en bedrijven permanent en effectief te maken voor transport & logistiek

Ontkoppeling lading van logistiek netwerk, zodat ruimte ontstaat voor verregaande optimalisatie (met AI) van logistieke bewegingen. Op dit niveau speelveld kansen voor Transporter As A Service

EEN OPTIMALE AFWIKKELING VAN DE LOGISTIEKE PROCESSEN WAARBIJ ALLE STAKEHOLDERS OP EEN LIJN ZITTEN.
→ MOMENTEEL ZIJN DE BELANGEN VAN DE DIVERSE STAKEHOLDERS NIET GELIJK EN ZORGT VAN START AF DISRUPTIES

AUTOMATISCHE INFORMATIE STROOM DIE WAAR MOGELIJK ZELF BESLISSINGEN MAAKT EN WAAR DAT NIET KAN PERSONEN ONDERSTEUND DAT ZO EFFECTIEF MOGELIJK TE DOEN

We hebben op tijd en goede AI onderzoeksagenda opgesteld en hebben bijgedragen aan innovatie in de havens

Zelf lerend systeem dat schade of gebreken aan asset (kade's of steigers) analyseert en meld bij collega's en bedrijven zodat het (schade) voor komen kan worden en er altijd schepen afgemeerd kunnen worden

Bijdrage aan de verkleuring van AI o.b.v. systeemkennis op het gebied van binnenvaart logistiek en klimaat

Perfecte inzet van onze vloot, rekening houdend met klimaat, duurzaamheid en individuele eisen spelers in de keten.
→ Er is nu nog veel inefficientie en de eisen van bijv. de kade of de schipper is zijn vaak onzichtbaar. AI kan dit verbeteren

I. Decarbonized Port Cell Proces to meet the climate objectives
Must be connecting all actors & needed clean technology and let "AI" fill the optimal plan
II. Port 4.0: Human - AI collaboration in ports with AI as "good colleague"

Betere inschatting van toekomstig haven (grond) gebruik, zodat nu betere besluiten worden genomen over ontwikkeling
Omdat: ruimte schaars, energietransitie → keuzes nodig

Bergen van kennis en adviezen voor iedereen in de havens op het gebied van verduurzaming veiligheid en efficiency voor alle modaliteiten

AI als planning assistent kan automatisch vinden en plannen van matches
Planners hebben minder, meer efficiency

Gebruik van AI om kennis en ervaring vast te leggen en vervolgens beschikbaar te maken voor nieuwe generaties zodat deze niet verloren gaat met vergrijzing

(P) volledig autonoom opererende haven
in interactie met de mens
(P) duurzaam en met meer efficiënt gebruik van resources
(terminal, truck, waterweg operations optimaal afgestemd)
(P) veel spin-offs onderweg

Colofon

The AI Port Center is a research and innovation partnership between Delft University of Technology (TUD), Erasmus University Rotterdam (EUR), and Leiden University (LEI) focused on the use of AI technologies in the port environment. It collaborates closely with regional knowledge institutions, commercial partners, government, and civil society organizations. The goal for 2023 is to develop visions and research missions for the AI Port Center. The aim is that "activities at AI Port are guided by well-defined visions of the port of the future, and corresponding research missions that contribute to those visions" (Convergence AI Center: AI-Port; 2023). The topics include (among others): Net-zero port & Future human capital.

Contact

Tim Meijster
Innovation manager AI for Technology Industry and for Port & Maritime TU Delft
T.Meijster@tudelft.nl

Nicolette Stehouwer – Den Hollander
Senior Business Developer Erasmus University Rotterdam and Resilient Delta Initiative
stehouwer@eur.nl

Erasmus UPT, Centre for Urban, Port and Transport Economics is a research and education company founded by Erasmus University Rotterdam. Erasmus UPT provides government and industry with cutting-edge knowledge, international best practice advise and workable policy recommendations. The research serves as input for vision building, decision support and economic evaluation for clients in both the public and private sector, such as national and local governments, industry, consultants and NGO's. On each theme, Erasmus UPT's staff of experts has extensive international experience and a long tradition of 'making science work.' At the core of Erasmus UPT's business are three main themes: urban economics, ports and logistics and transport and mobility.

Contact

Dr. Dirk Koppenol
Senior Researcher Ports in Transition Erasmus UPT
koppenol@ese.eur.nl

Hannah Mosmans, MSc, LLM
Junior Researcher Port Economics and Maritime Law Erasmus UPT
mosmans@ese.eur.nl