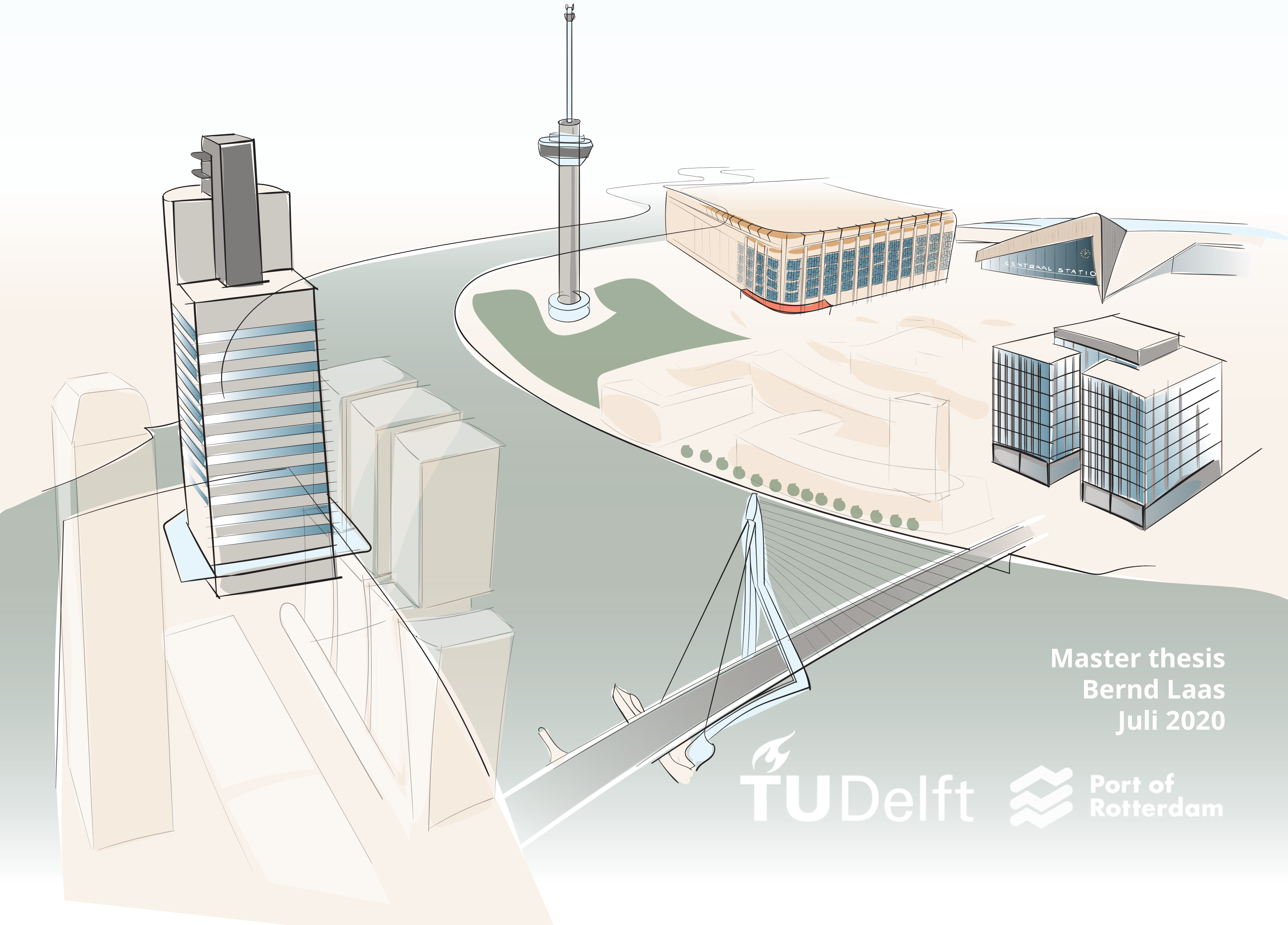
The new port infrastructure: strategic design of a container data platform for Port of Rotterdam



Master thesis
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The new port infrastructure: strategic design of a container data platform for Port of Rotterdam

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Acknowledgements

Besides my study I worked as information officer at Futureland, an information center of Port of Rotterdam (PoR) about the construction of Maaskvlakte 2. There I came to know a lot about the company PoR, its responsibilities and the companies located in the port area. To keep the information we use for presentations up-to-date, we got updated by the PoR about the most recent developments every once in a while. It was in one of these presentations that I got to know the Digital Business Solutions (DBS) department. The developments and challenges this department is engaged in are relatable to my assignments and courses I attended in the master Strategic Product Design. It aroused my interest whether strategic design could be of added value within this company and this department, for this reason I arranged my graduation project at DBS.

This thesis is the final project, after which I will finish my five years of studying at the faculty of Industrial Design Engineering. My graduation project has been the most challenging and most professional project I have done throughout my education. I would like to take the chance to thank everybody who has supported me during this project.

First, I would like to thank my company mentors Govert Geerlings and Wouter Buck for enabling and guiding this graduation project and giving me the freedom and trust to define my own graduation assignment. Your involvement and coaching throughout and besides the project was really valuable to me. I would like to thank all interviewees I spoke to during the project, who were willing to help me and give valuable input. And I would like to thank PoR and the DBS department for giving me the opportunity to work on this graduation assignment at their office and giving me access to many non-public resources that has been of value for the project. This also made me experience what is actually happening behind the scenes.

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Graduating during Corona

For the past half year have been working on my graduation assignment for DBS and PoR. In the first months I was offered the opportunity to work at the office of PoR in Rotterdam, which enabled me to get to know a lot of involved people in a short period of time. These made connections enabled me to do many interviews that were of value for defining the strategic problem statement, deriving more in depth information and later in validating my design online. Due to the COVID-19, the last months of the project I have worked from home. Although, the graduation project is an individual project and therefore can be done from home, I personally think that there should not be underestimated the impact this has on a project. I think there is essential value in telling people about your project, what you are currently doing and how you try to approach certain challenges of the project to people at the faculty of the university, work environment or in another context. By doing this, it can help to structure the project for yourself, learn from others how they tackled certain challenges and sometimes it can lead to accidental input and insights you can get from other people. For me this was especially difficult in the ideation phase of my design project. Working from home and not being able to be move to different environments and contexts, like going to a café with friend or colleagues, makes it difficult to be creative and set your mind of the project. Since, most good insights and new ideas do not happen from staring to a computer screen, but are the moments you are doing something else, by coincidence seeing something outside you can use in your own project context or talking to someone who has no knowledge about your project.

Online meeting technologies enable to stay in contact with another and can be used to update people where you are working on. However, it cannot replace all elements that are present in normal physical conversations and the daily working environment. Thinks that are important for designers and what I used to do, like going to people with a quick sketch of an idea and together iterating on this sketch by drawing on it, or involving a person who coincidently walks by during this quick validation, are not possible when working from home and also very difficult to achieve in online meetings.
In order to get value and input form others on your design that is needed for your project, in online meetings it is also somehow expected that the initiator, the graduation student, presents something where subsequently the invited attendees can give feedback on. Making these presentations and making unfished work presentable can be very time-consuming and these deliverables cannot always be re-used later in the thesis. I tried to overcome this in my ideation and validation phase by making drawings on paper and scanning these, so they could be shown online. The fact that they sometimes looked rapidly drawn and unfinished gave people the feeling that these deliverables were not the end result, therefore they adjusted their feedback from a more critical attitude to a more supporting way of giving feedback and were more drawn to think along.

Furthermore, in consolidation with PoR there was also decided to not approach potential future users of the design for my graduation project, since these parties in the logistic sector where significantly affected by the corona crisis and had something else on their mind. So, important feedback from the user side could not be gained. A way to simulate and replace this feedback was to use representatives of these user groups that where available, these people were found inside PoR, since PoR has many people who either previously worked at one of these companies or stay in close contact with these groups. In this way still some information and insights from the user side could be derived and assumptions validated.

Executive Summary

Sea ports are undergoing a digital transformation, which can offer benefits for many involved stakeholders in the logistic chain. In order to stay relevant, PoR should invest in developing new port infrastructure and digital connections that facilitate data exchange between logistic chain stakeholders.
For decades both the port of Rotterdam and PoR benefitted from two physical growth strategies: 1) expand the port area, and 2) attract more throughput. The first strategy is reaching its physical limits and the second strategy is increasingly under pressure, since competitors like the port of Antwerp and Mediterranean ports have grown relatively faster than Rotterdam over the past years.
Differences between ports are becoming smaller, which is likely to result in a competition on price and thereby lowering the ROI of PoR's physical activities and investments. In order to become more attractive than competitors, without competing on price, the port of Rotterdam should focus on parties who either split their cargo between ports or do not make use of the port of Rotterdam yet.
To execute this graduation project, an extensive exploration was done on the context and strategy of the port of Rotterdam, PoR and DBS. To obtain deeper information, both desk research and interviews were done. A strategic digital opportunity for PoR was found; a platform that has a focus on container data.
This thesis explores the design of a digital platform around container data for DBS, which contributes to the competitive position of the port of Rotterdam and the business model of PoR. This exploration resulted in Cadex, a data platform that facilitates cargo data exchange between data suppliers, e.g. terminals and data demanders, shippers.

During this graduation project, a gap in the PoR digital eco-system was found on cargo data. Interviews revealed that the data demand of shippers in the Rotterdam hinterland is currently not met. Especially international data about their cargo is either missing or has to be assembled by shippers themselves from a variety of platforms (a.o. via phonecalls). The designed platform, Cadex, matches cargo data demand and cargo data supply. Cadex offers shippers real-time data about their containers that enables shippers to act upon containers that deviate from the planned schedule. By making cargo data easy accessible it could save shippers significant costs that come with transport, the deprecation of their goods, the management of their logistics and their inventory. Especially in time sensitive trade, like fresh goods or factory parts this data is valuable. Moreover, it could also contribute to a lower carbon footprint of shipments.

The platform enables users to get data directly from the data owners (data supplies) like sea-port terminals and hinterland terminals and can therefore be labeled as reliable data. The data suppliers benefit from the revenue model the platform offers for their data and they are allowed to set their own asking price for this data, furthermore they benefit from the data they receive about their clients.

This thesis discusses the desirability, viability and feasibility of such a platform. Besides, an extensive brand analysis was done to explore the implementation difficulties that were found from interviews and research.
For implementation it is adviced that the platform first connects most inland terminals and terminals located in Rotterdam, then it should connect international short-sea terminals and in the last step connects international data suppliers that are active in the deep-sea, feeder and the transhipment segment.

PoR would directly benefit from the data exchange by charging a percentage of the price. In addition, PoR receives historical data about their clients, which improves their knowledge about the clients they serve and could be input for improvements in the port of Rotterdam. Furthermore, a better customer service is offered to shippers that make use of the port of Rotterdam.
The new port infrastructure Cadex offers, can contribute to the competitive position of the port of Rotterdam, which would lead to more throughput. Cadex could improve the score of the port Rotterdam on the port selection criteria and therefore, contribute to a better competitive position. Developing this new port infrastructure is a long-term investment since the connections hold value. Once built, the infrastructure can be reused by other parties or other digital purposes with some adjustments. This makes PoR a relevant party in the digital transition. Without this new port infrastructure, PoR is more likely to be bypassed by other competing players who will reap the benefits of the digital transformation in sea-ports.

Reading guide & Abbreviations

This thesis consist of five chapters, underneath the function of each chapter is described.

Chapter 1A Context
This chapter describes the first orientation of the port of Rotterdam, the company, other stakeholders and digital innovations at sea-ports. Quick readers can directly go to Chapter 1B.

Chapter 1B Problem statement
This chapter describes the design problem that this thesis aims to solve and it's context.

Chapter 2 Project Approach
This chapter describes what approach was used to tackle the design problem, the corresponding methods and tools used during the graduation project.

Chapter 3 The results
This chapter describes the results of the interviews and literature review.

Chapter 4 The design
This chapter describes the design and discusses it's the desirability, viability and feasibility

Chapter 5 Conclusions & Recommendations
This chapter describes the general conclusions of the thesis and the limitations and recommendations for further research.

Abbreviations

AIS	Automatic Identification System
API	Application Programming Interface
ATA	Actual time of arrival
B2G	Business to Government
DBS	Digital Business Solutions
ETA	Estimated time of arrival
ETD	Estimated time of departure
EU-MSW	European Maritime Single Window
FPOC	First port of call
Gate-in/out	When a container arrives or leaves the container terminal
JIT	Just in time
HIC	Harbour industrial complex
LPOC	Last port of call
Mainport	Dutch policy term of a hub that connects important international transport routes
NSP	Nautical Service Providers: Tugs, Boatmen, Pilots
OCR	Optical character recognition
PoR	Port of Rotterdam
PoA	Port of Amsterdam
PCS	Port Community System
PMS	Port Management System
TEU	Twenty-feet Equivalent Unit, the standard term for containers worldwide.
TOS	Terminal operating system

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Chapter 1A

For most people a seaport is a place, where some kind of magic happens when they first see it. They are amazed when huge ships, with the size of 400 meters long, come to bring goods that are unloaded by almost unmanned terminals, where robots drive around the containers and where these are then picked up by trucks trains or smaller ships like barges to bring these to their destinations. In some way all these different companies and people in know exactly what they are doing, where each container has to go to when they have to do their part in this complex logistic chain. It might sound futuristic, however it is just another day at the office for companies at Maasvlakte II. From the outside it is hard to grasp what goes on behind the scenes, and what complexity this must bring on the inside on a physical and on a digital level. Companies in the logistic chain know that not all shipments go according to plan, since one out of every fifteen containers faces problems during transport, resulting in avoidable costs. This graduation report will show you what is happing behind the scenes, how ports are likely to transform in the coming decades and how to innovate within this complex environment.

Welcome to Europe's largest seaport, welcome to the port of Rotterdam.

This chapter describes the first orientation of the port of Rotterdam, the company, other stakeholders and digital innovations at sea-ports. It introduces the company to the reader in terms of history, activities, business model and current products.

Context

1.1 The port of Rotterdam

History

Becoming the largest port of Europe and maybe even the most advanced port of the world did not happen from one day to the next. The origin of city of Rotterdam can be traced back around the year 1270 when the river the Rotte was dammed, in order to prevent the land from flooding. Soon Rotterdam developed itself as a village where goods were transferred from seagoing vessels to smaller river boats, the start of the port of Rotterdam. In the centuries that followed Rotterdam officially became a city, seagoing vessels became bigger, deeper canals and ports where constructed and local fisherman develop themselves as pilots for other seagoing vessels, a role which still exists today. Only when the New Waterway was dug out in 1872, Rotterdam became the mainport of Europe and start to grow rapidly due to the connection with the fast-growing industrial complex in Germany. In the century that followed the Port of Rotterdam expanded to the west, from the city center towards the North Sea. Important ports such as the Waalhaven, Botlek area, Europoort area and the first Maasvlakte were constructed. Rotterdam even conquered the position of world's largest port from 1962 till 2004, when this position was overtaken by the port of Shanghai. (Erfgoedhuis Zuid-Holland, 2018; Port of Rotterdam, 2016a, 2019b)

Infrastructure

Nowadays their harbour industrial complex (HIC) covers 127 square kilometres and the port of Rotterdam is the 10th largest port of the world and the largest port in Europe. Each year approximately 30000 sea-going vessels and more than 100,000 inland vessels visit the port. Rotterdam is also one of the deepest ports in the world, having a depth of almost 25 meters meaning that the largest sea going container, oil and ore vessels having a draught over 16 meters can access the port 24 hours a day. According to World Economic Forum (2018), the Netherlands including the Port of Rotterdam has the world's best quality infrastructure. With the construction of Maasvlakte II starting in 2008, the port obtained 2000 hectares of new port area. Thereby Port of Rotterdam (PoR) enlarged its port area with 20 percent in order to create extra capacity for future developments, like the fast growing container sector (Port of Rotterdam, 2019b, 2020c).

Economic and strategic value

Around 3000 companies are located in the port, providing 101.500 direct and 283.500 indirect jobs. The accumulated contribution of the port of Rotterdam to the GDP is 6.2 percent, 45 billion euros (Port of Rotterdam, 2020c). The port of Rotterdam has a strategic geographical location at the estuary of the Maas, this river is connected to the heart of Europe. Furthermore, the port is quickly accessible from sea as well. Next to Rotterdam's water connection, the port is connected by road and rail. These three modalities together enable cargo to reach its destination over a radius of 1600 km from Rotterdam, within 24 hours. When it comes to the delivery of goods to 500 million European customers, Rotterdam has a substantial role in this logistic chain (Port of Rotterdam, 2016a). The port also offers 196 short-sea connections from Iceland al he way to the Black Sea area (Port of Rotterdam, 2019a). Both important arguments for shipping companies to choose Rotterdam as first port of call and transhipment port. First port of call means that the port is the first stop of a shipping line , since large container ships visit multiple European ports, also called multi-porting (Notteboom, 2015), before they head back to another area, e.g. south-east Asia or the United States. Transhipment stands for cargo that is handled by seaports that is not directly sent to their hinterlands, but to other most time smaller ports, from a network point of view this has several advantages. Around 28% of the worldwide container throughput is so called sea-sea transhipment (Notteboom et al., 2018).

Container throughput: the future?

Last year 469 million tonnes where transhipped in the port of Rotterdam (Port of Rotterdam, 2020a). The port of Rotterdam owns almost half of its throughput to liquid bulk; all liquid products or raw materials like crude oil, petrol, fuel oil or vegetable oils like palm oil that are often transported by tankers or through a pipeline. The port is always has been and still is a big (fossil) fuel port. Furthermore, one third of the throughput is assigned to containers. The remaining part comes from dry bulk; products or raw materials that are not packaged separately, but transported in large quantities like grain, coal, iron ore, cement, sugar, salt or sand and also break bulk; products like paper, wood, cocoa, rolls of steel or parts of machines, that either can be transported in a container or are put on a vessel separately.

The international container trade has grown tremendously in the previous decades. Since the start of this millennium, the total throughput of containers in Rotterdam has more than tripled. In 2019 over 14.5 million TEU, twenty-feet equivalent unit, the standard term for twenty foot containers worldwide, was processed in the port (CBS, 2015; Port of Rotterdam, 2016b, 2019a). According to UNCTAD (2019), the United Nations conference on trade and development, international maritime trade is expected to expand at an average annual growth rate of 3.5 percent for the coming five years. This would mean that in the period the 2019–2024 a total growth of 18.7 percent is expected, there should be noted that this prediction was made before the Corona crisis. This growth is driven in particular by growth in containerized, dry bulk and gas cargoes.

Due to its effect on climate change, there is assumed that the use of fossil fuels will decrease in the coming decades and also might not be the leading commodity in the port of Rotterdam any more. Therefore this report will be focussed on the fast growing container transport sector.

Competitors

When speaking of competition for the port of Rotterdam, they consider their competitors to be located in the Hamburg-le Havre range. Within this range Antwerp and Hamburg are the biggest competitors. Looking at total throughput Rotterdam is bigger than both ports added up together, however looking at container throughput Antwerp is following Rotterdam closely and together with Hamburg they are a lot bigger (Port of Rotterdam, 2019a). A large competitive advantage that Rotterdam has compared to Antwerp and Hamburg is its strategic location. This offers two advantages: first its deepness and thereby unlimited access possibilities for vessels and second being fast accessible from sea, taking two hours from sea to berth. Both Antwerp as Hamburg have to be accessed by river, at low tide the depth of both Antwerp and Hamburg is around 13 meters, which is not sufficient for the world largest vessels to enter their port. Both ports solve this problem with special deepened out waiting areas for these vessels. Another solution they use is to not fully load the vessels. Next to limitations caused by depth, it takes around six hours to enter both ports from sea, meaning a retour (sea-port-sea) will take ten hours more compared to Rotterdam (Port of Rotterdam, 2020c). Furthermore, Mediterranean ports have become a serious competitor for Rotterdam in the last years, their relative growth has been higher than Rotterdam's, because of differences in pricing strategy or geographical location in relation to East-Asian trade routes (Port of Rotterdam, 2020a)

1.2 Stakeholders in the logistic chain

Around 3000 companies are located in the port of Rotterdam and even many more are involved in their corresponding supply chains. Not all these 3000 companies are involved in international container transport, but the ones that do, are identified in this paragraph. There is taken a look on which parties are involved when a container is shipped form A to B, as can be seen in figure 1.1.

Shippers

Shippers can be seen as the cargo owners, they are responsible for the import and export of goods in the ports, large shippers who make use of the port of Rotterdam include e.g. Ikea, Lidl, Action, Hema, Tesla, Heineken, Canon. Some of these large companies who do the logistic operations and management by themselves.

Forwarders

Freight forwarders, in short forwarders are the companies who take care of international container transport for other parties. Shippers that for example do not have an own large logistic department can decide to use a forwarder that arranges the logistic management of their shipments from A to B, including all documentations and certificates needed. Often the forwarders also arrange air freight. There are large international forwarders like DHL and small local forwarders located near the port area. Both shippers and forwarders are involved in the entire logistic chain of a container.

Modalities

Containers can be delivered of picked-up in the port of Rotterdam by three types of modalities: truck, train and barges. Not all ports are accessible for all types of modalities. All modalities have their benefits and downsides. Using trucks is the most flexible and often the fasted way of transporting a container, there is also no need to make use of a hinterland terminal, since the truck can drive directly from A to the port or the other way around. However, trucks are also the most expensive and most unsustainable way of transport also trucks are most influenced by traffic jams. Trains are often a faster option than barges, however are more expensive and less sustainable than too. Both trains and barges need a hinterland terminal to load or unload them.

Hinterland terminals

Hinterland terminals are located inland, they are used to load and unload different modalities. The port of Rotterdam is connected to over eighty hinterland terminals, these terminals are spread out over the Netherlands, neighbouring countries and countries in the centre of Europe.

1.2.5. Sea terminals

There are three different purposes a sea-terminal can have, short-sea, deep-sea and feeder. Short-sea entails the cargo that originates from and has a final destination within Europe. Feeder cargo originates outside Europe and is mostly transhipped in Rotterdam, often these the feeder and shortsea cargo shipments are combined. Deep-sea is cargo derived mostly from outer Europe by large container vessels that are destined for Europe or the other way around. The port of Rotterdam has a strong shortsea network, with over 200 destinations to various ports in Europe, like the United Kingdom, Ireland, Scandinavia, the Mediterranean, the Baltic States and Russia.

Carriers

Carriers, also known as shipping lines, are directly related to port calls. They are responsible for the over-sea transport of the container, there are different sizes of vessels depending on their purpose. In the last decade large individual shipping lines have formed strategic alliances, resulting in a domination the shipping world by the four biggest alliances.
In this way individual carriers taking advantage of economies of scale and greater geographic coverage. They decide whether a port will be the first port of call (FPOC) or just the last port of call (LPOC), which is essential for import and export. An imported container that is unloaded in a FPOC will be able to reach its final destination quicker than, if it would be unloaded in the second port.

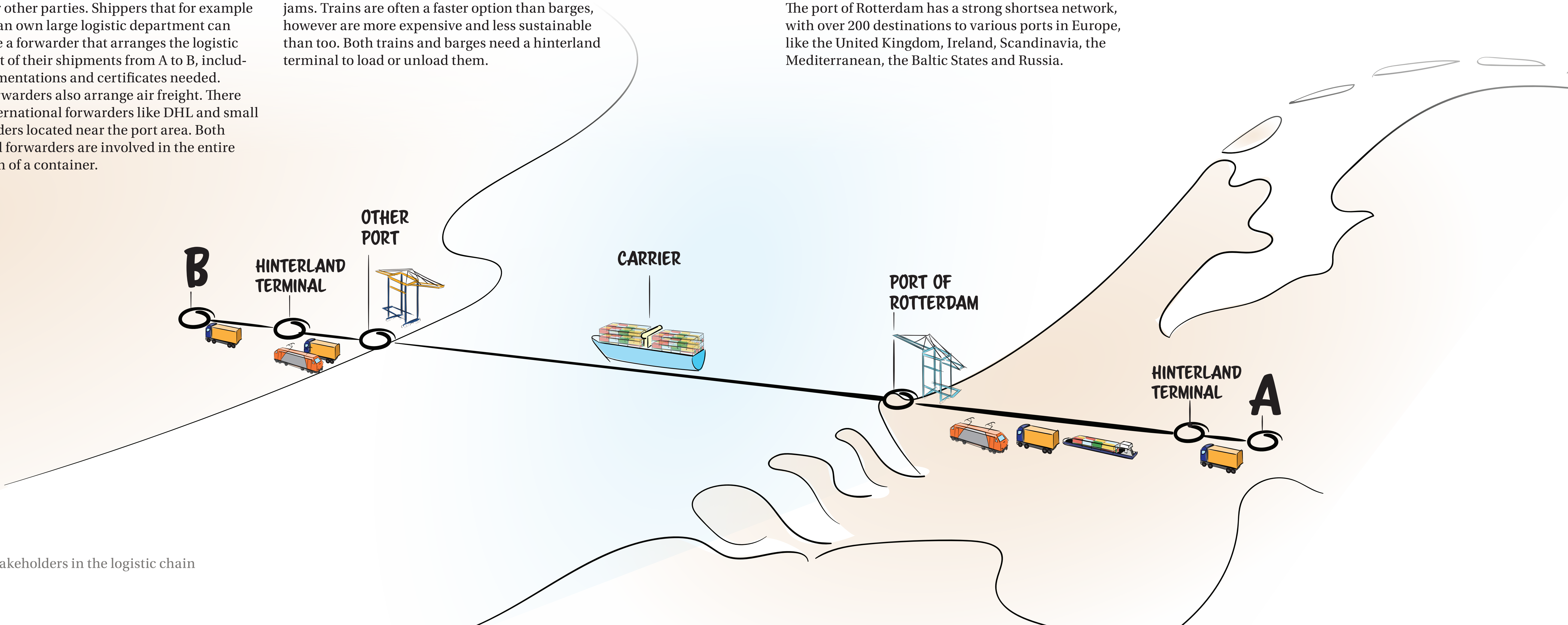


Figure 1.1 Stakeholders in the logistic chain

1.3 Port of Rotterdam

Port calls are complex logistic processes with multiple stakeholders, to make sure all the activities proceed safe and efficiently there is a port authority. The Port Authority of Rotterdam (PAoR) is responsible for the safe, smooth, clean and secure handling of shipping. The PAoR is part of the bigger company: Port of Rotterdam (PoR), that also develops and allocates port sites. In addition, PoR provides companies with everything they need for the safe and smooth transhipment and production of goods and raw materials (Port of Rotterdam, 2019a). Already in 1882, the development and allocation port sites became the responsibility of the municipality of Rotterdam and in 1932 the Port Authority of the Municipality of Rotterdam was officially established. In 2004, the Port Authority of the Municipality of Rotterdam was transformed into the independent unlisted public limited company Port of Rotterdam. First, with only the Municipality of Rotterdam as sole shareholder and since 2006 sharing this position with the Dutch State. Owning 70 and 30 percent respectively (Port of Rotterdam, 2019b, 2020c). Currently PoR is employing 1200 employees.

PoR role in the port

The role PoR has in the port of Rotterdam is quite unique. During interviews with the port of Scheveningen and Houston (Port Authority of Scheveningen, 2020; Port of Houston, 2020), there was found that almost all ports have some kind of central authority which takes responsibility for to safety and (vessel) traffic handling.

Facilitating innovation

However, the facilitating role of PoR, especially when it comes to infrastructure and new innovations is seen less often. They also have a strong relationship with their communities and know their clients very well. PoR is daring to invest heavily in new infrastructural projects like Maasvlakte II, a civil engineering masterpiece, where twenty square kilometre of new port area was built in what used to be the North Sea. Total costs, 2.9 billion euros, all invested by PoR itself not the state. PoR is involved in the initiation and decision making of these kind of project, though the engineering and construction are subsequently done by other companies. They also try to be ahead of certain developments in the industry, for example they have recently built a liquid gas (LNG) terminal where LNG can be loaded to bunker ships and small-scale LNG-tankers. LNG is a cleaner fuel alternative than fuel from oil, thereby PoR stimulates the transition towards LNG as new fuel for the shipping industry. Furthermore, they were the first port that included the requirement that the terminals had to be fully electric and powered by durable energy resources in their tender for new container terminals at Maasvlakte II. PoR is a driver for innovations in its port, and can partly be seen as responsible for the leading position the port of Rotterdam has being one of the most advanced ports in the world.

More evidence can support this leading position, because the port of Rotterdam is known for being frontrunner in innovations in container industry and port operations. Many foreign ministries, other port authorities and large companies visit the PoR visiting center, Futureland, to observe the latest innovations in real-life. A great example is that the port owns the world's first automated terminal, ECT, which opened already in 1993. Moreover, APM terminals, owning 74 port and terminal facilities in 40 countries all around the world opened their first most modern container terminal at Maasvlakte 2 in Rotterdam in 2015.

The terminal is largely automated, uses the highest container cranes in the world which are also remotely controlled, operates fully electrically and uses solely sustainable energy as a power source. According to Ben Vree, former CEO of APM Terminals, this terminal is the blueprint for future terminal operations (Port of Rotterdam, 2015).

PoR societal role

PoR also has a social responsibility in the Netherlands and Rotterdam metropolitan area. They work towards a port that is ready for the future and where economic growth goes hand-in-hand with improving the living environment. Their efforts are focused on both the port and own organization. Their responsibility can be divided into three key themes

• Safe & Healthy Environment

Safety is the highest priority in the port, under which nautical safety, social safety, external security, water safety, occupational safety and cyber security is considered. In addition PoR plays a prominent role in improving the living environment, by improving air quality, noise, the natural environment, biodiversity and water quality.

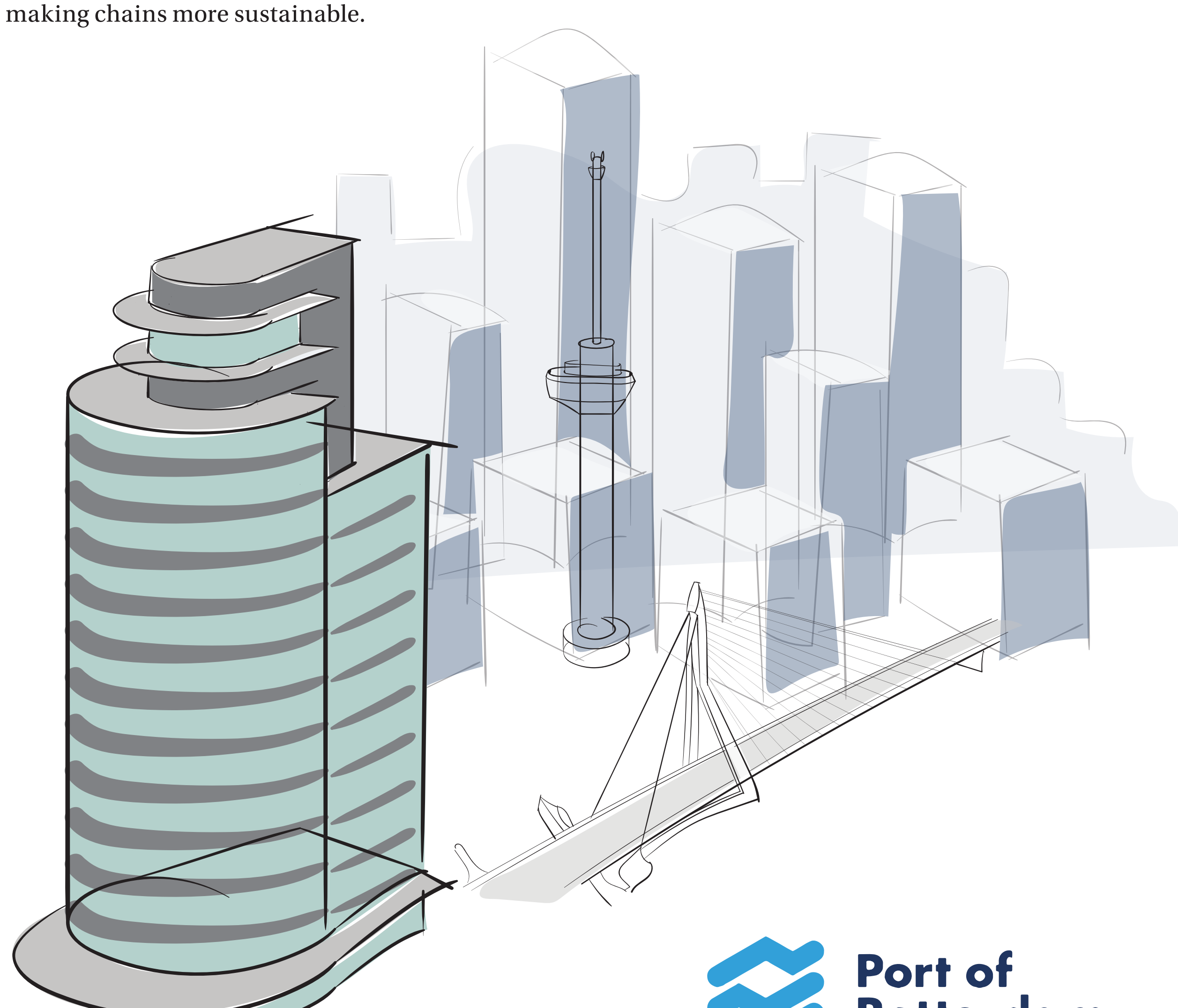
• Climate & Energy

PoR is actively involved in solutions against climate change, this includes, energy transition in energy usage at the port, they renew existing facilities and actively welcome new developments. They are also aiming for being the place in the Netherlands where the energy transition takes shape. Their focus is on the port and its own business and they also playing a role in making chains more sustainable.

• People & Work

Despite automation, like the use of robots and other technological developments, PoR aims for a port that offers direct and indirect employment to all population strata. (Port of Rotterdam, 2020b)

From this paragraph there can be seen that PoR plays an important role in the port of Rotterdam, however the company itself is not directly involved in container handling like the terminals or the construction of infrastructural projects like Boskalis or Van Oord, so how does PoR make a living?



Port of Rotterdam

Business model

In return for the activities of PoR, they receive rent from all companies located in the port and port dues from all visiting vessels. The total revenue of 2019 was 707 million euro. The allocation of port sites are mostly long lasting contacts with companies over a period of 25 years. In total PoR earned 373.8 mln euro in 2019 from this activity. Another 302.4 mln euro was earned with port dues. To give an example, an average large sea-going container vessel, carrying 14000 containers (TEU), which tranships half of its containers in Rotterdam will pay approximately 100.000 euro for a single port call in Rotterdam. PoR receives around 75.000 euro and takes several aspects in account to calculate the port due, under which the total weight of the vessel, weight of the transhipped cargo, amount of port calls of the shipping company and sustainability of the vessel. The remaining 25.000 euro goes to the linesmen, tugs and pilots which will assist the ship in its port call arrival and departure (Port of Rotterdam, 2020c). Although the stakeholders of PoR are state and local government, the company does not get any state aid. In 2019 the total profit of PoR was 181 million, 98.5 million of dividend was paid to the shareholders. An abstract representation of PoR business model can be seen in figure 1.2.

When looking at the current business model of PoR, their existence is actually largely dependent on the performance of other companies and their joint performance as well. Suppose the worst case scenario: the clients in the port area, like the terminals or pilots, would perform very poorly as well as their joint performance with other companies in the same logistic chain. This would result in that the port of Rotterdam is for example way slower or way more expensive than its competing ports. Companies that want to tranship their freight that had normally chosen to do this via Rotterdam will probably switch to another port due to this low performance, this would result in less throughput in this port and thereby less vessel visits. Also the companies responsible for this inferior performance will process less throughput and might not be able to afford the rent of their port sides. Since all individual actors also benefit from a high performance, it is not likely that the worst-case scenario would become reality. And in theory this would also work the other way around that a higher performance will attract more throughput.

It is important to keep in mind the amount throughput plays a big role in the business model of PoR and also in the entire port of Rotterdam. Maintaining the same amount is essential for PoR's revenue and preferably they want growth. Although, maritime trade has grown over the last decades and is still expected to grow in the coming years, PoR is not the only port who wants to attract more throughput and benefit from this growth. Therefore, they are constantly competing with their direct competitors, Antwerp and Hamburg, especially when it comes to containers.

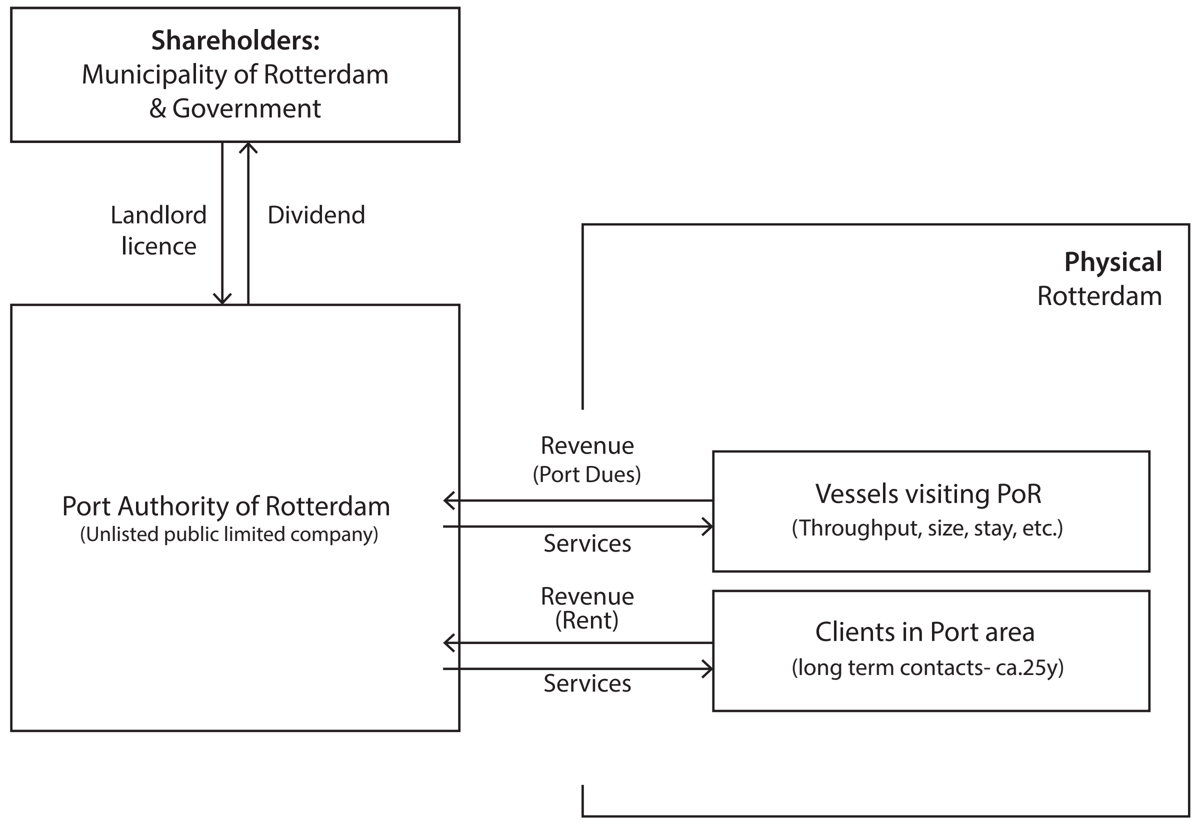


Figure 1.2 PoR Business model

1.4. Digital innovation in seaports

According to the United Nations conference on trade and development (UNCTAD, 2019), digitalization and automation are currently transforming the shipping sector. The maritime industry has not been idle in innovation, although there can be seen that their pace in innovation is not equal to the pace of innovation in consumer goods. This might be caused due to the international character and scale of the industry. New technologies provide opportunities to achieve greater sustainability, as well as enhanced performance and efficiency in shipping and ports. Existing business and partnership models are transformed by the forming of joint collaborative platforms and solutions, which are increasingly used. The newest innovations aim for more efficient and secure trade, working towards greater supply-chain visibility and the use of electronic documents. Another radical innovation is the development of autonomous ships that may soon become reality.

Heilig, Schwarze and Voß (2017), have done extensive research about the digital transformations in sea ports. In their paper they explain that there can be found three main generations of developments: first sea ports adopt paperless procedures, then they adopted automated procedures, and are now working towards smart procedures. More information about the first and second generation can be found in Appendix A.

Since 2010, seaports have started with developments for smart procedures, which Heilig, Schwarze and Voß (2017) call the third generation. New technologies, like machine learning and sensors connected to the internet (IoT), foster the improved gathering, storing, processing, and analysis of large and multiple source data. Currently central entities e.g. port authorities equip their port with these sensors in order to address inefficiencies and bottlenecks on both their infrastructure and traffic flows in the port. Furthermore, the increased availability and exploitation of real-time data improves responsiveness and decision making on events that deviate from their original schedules. Ports increasingly have an ongoing interaction with their involved actors, thereby they extend their traditional role as infrastructural facilitator or traffic controller by acting more as a port information integrator and provider. There can also be seen that there is a shift towards a more port-centric decision support, where the optimal planning is based on all available data for all actors and is send back to the individual
actors. This leads to a shift in process control, where individual actors used to be in control, towards requesting actors that partly give away their control and follow instructions. Just-in-time (JIT) sailing is a good example of a possible outcome of this transition. Nowadays, customers also demand more and more value-added information services, in order to get a better insight into their related processes. Also data sharing between different ports becomes increasingly important for establishing successful partnerships.

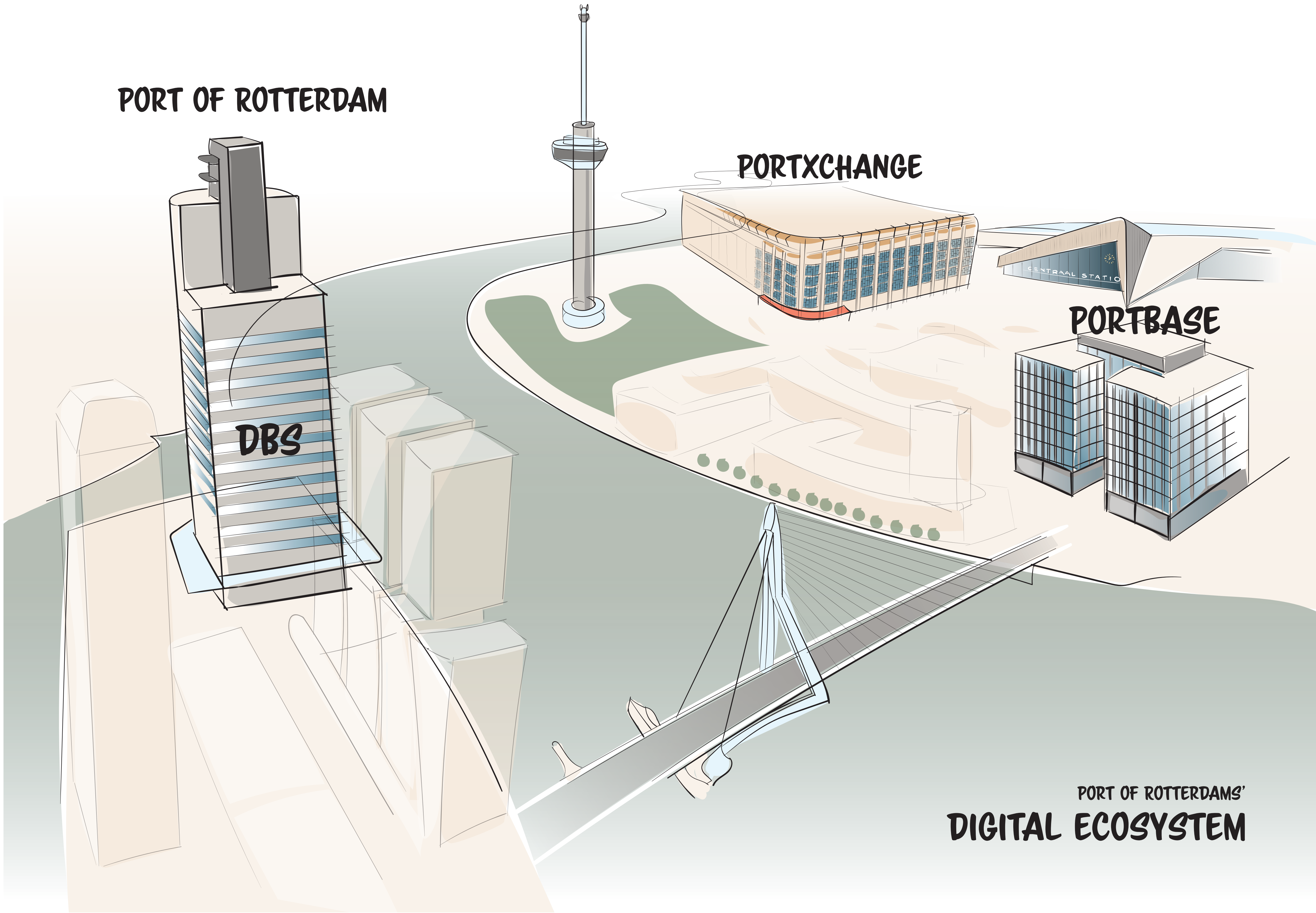
So who takes responsibility for this digital transformation in the port of Rotterdam?

1.5. The Digital Eco-system

PoR did not miss out on these digital transformations, and has become a port with a strong digital capability. Over the years they have developed multiple digital systems, services and products that are aimed at enhancing port operations. Some of these developments have grown into separate companies, others are used more internally. All these developments together are called the PoR's Digital ecosystem:

Portbase
Portbase is a non-profit organization that belongs to and serves the port community. It was founded by PoR and Port of Amsterdam in 2009 and has the broad support of almost all port community members. Their main function is to offer a Port Community System (PCS) to all port community members, this system facilitates data sharing between companies and information exchange with governments. Where communication was initially from company to company, like the notification of an arriving ship went via mail, these notifications are now uploaded to the port community system and instantly shared with all relevant members. The system centralizes communication and in this way enables companies to work faster, more efficiently and at lower costs. (Portbase, 2020a)

PortXchange
PortXchange started as the application Pronto, which was part of PoR, but it is recently launched as private limited company. Pronto is a shared digital platform for real-time information exchange about port calls. From all connected stakeholders Pronto receives information about a vessels departure of arrival. Pronto creates a single point of truth based upon this data. When a vessel deviates from expected schedule, for example when terminal operations take longer than expected or a vessel is delayed due to weather circumstances, Pronto send notifications and warnings to all relevant stakeholders about this deviation and new expected time of arrival or departure. In this way it tends to improve port call efficiency and works towards just in time sailing.



Digital Business Solutions

In 2018, the department Digital Business Solutions (DBS) was established, with currently 60 people working in this department consisting of developers, sales- and proposition managers. DBS works on a portfolio of products called PortForward for external customers (e.g. other ports, carriers, shippers and forwarders) and the port of Rotterdam. The products are aimed at improving port operations and processes in logistics chains (Port of Rotterdam, 2018, 2019d). Over the last two years DBS has developed many products which operate in different levels of the digital maturity model, this model can be found in Appendix B. A couple of products are briefly explained underneath:

Portinsider
A Port Community Systems (abbreviated to PCS). Information can be exchanged safely and efficiently via an independent platform. All community members can upload and extract operational data from platform. This lets shippers, freight forwarders and other organisations in the supply chain benefit from efficiency and cost. For ports, a solid digital infrastructure is a crucial for optimizing their port performance.

BoxInsider
Boxinsider supplies container Track & Trace information for shippers and forwarders. It provides an overview of the container status, and an overview of the planning of vessels that ship containers to Rotterdam. Users are pro-actively informed about events and exceptions.

Streamline
Streamline is a marketplace for container transport between the five deep sea container terminals in Rotterdam. Streamline brings together: requests for transport of containers from one terminal to the other, and suppliers of transport: barge, rail and truck.

Portmaster
Portmaster is a port management system (PMS) that supports port authorities in processing vessel declarations, and in safe planning and handling of vessel calls. It provides insight in the operational status of the port via a map, and it monitors planned and actual operational events. Also, harbour dues can be calculated.

Navigate
Navigate supplies possible routes to transport a container from A to B, using sea, rail, barge and truck transport. Alternative routes can be compared on speed, earliest arrival, price and carbon footprint. Also in future, a selected option may be booked via Navigate.

OnTrack
OnTrack aims to improve efficiency of the rail transport product. It supplies overviews of the status of trains and terminals, for use by terminals, carriers and rail infra suppliers. OnTrack adds to the reliability and predictability of rail transport.

LAB
The Port forward lab a collective term for new not completely developed products aimed at port efficiency and optimization. Services which are under development and beta APIs are made already available here.

1.6. PoR a hybrid organisation

With DBS, PoR has made a decent investment in expanding their digital capability as a port authority. PoR's strategy for DBS was to create a new revenue stream with digital products, use this revenue to reinvest in new digital product development for its own port and future products to sell. More information on the strategy can be found in appendix C. Developing products for clients outside the port area of Rotterdam is new for PoR. DBS can be seen as a kind of market organisation, a term described by Brandsen and Karré (2008), who did research into different types of organisations. According to their research market organisations are independent, have various customers, are free to determine their own output and who to address it to. Besides, their funding is generated at the market and generated by the organisation itself. Whereas, PoR shows more characteristics of a task organisation, given its authoritarian role in the port of Rotterdam and its close link to the government. A typical task organisation is totally dependent on a principal, like the government, for its task, funding, strategy, the organisations output and to who it is addressed.

Although, PoR is a private company and has freedom to make its own decisions and strategy, it cannot be seen as market organisation, since it owns it landlord licence and thereby an important part of their existence to the government.
With DBS, PoR transformed from being a task organisation into a company which is also a market organisation. Brandsen and Karré (2008) call this a hybrid organisation. This situation is illustrated in the figure 1.3. based on Mouwen (2000). This can be seen as a challenge since hybrid companies sometimes encounter internal friction between the two types of organisations within (Brandsen et al., 2009).
Yet, the digital activities are a very small part of PoR and the revenue stream DBS taps into yields below expectations. Therefore, recently a pivot was made in PoR's strategy: products developed by DBS have to contribute to the Rotterdam digital eco-system, which could be something different than solely revenue. Where PoR initially invested in DBS to create an independent new large revenue stream, and DBS acted like a so called market organisation, PoR now invests in DBS as an innovation department, transforming DBS back into a task organisation.

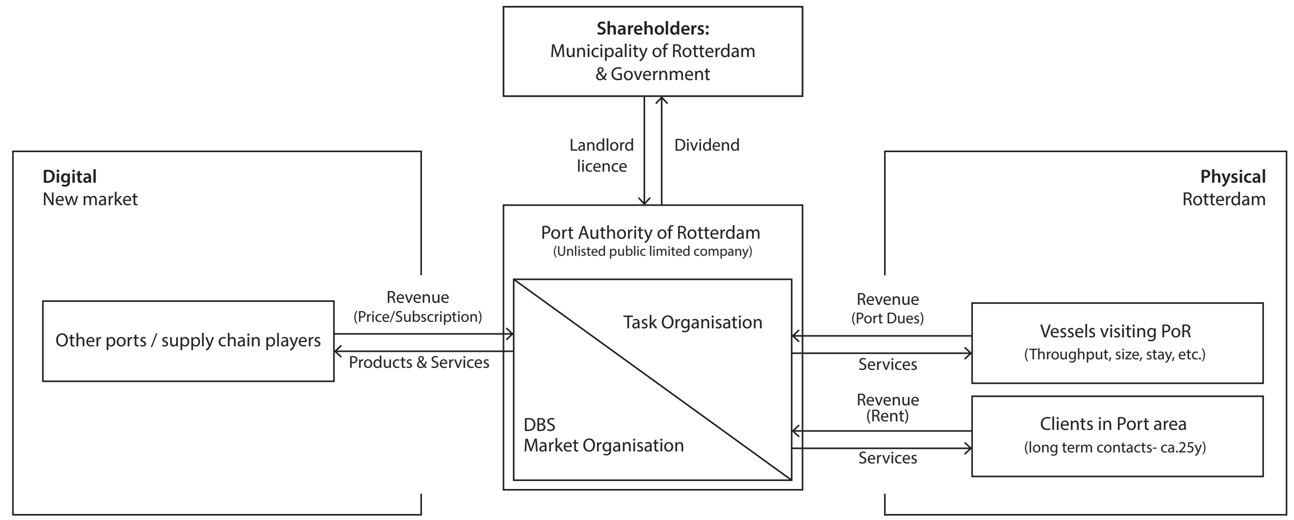


Figure 1.3 Business model of the hybrid company

Chapter 1B

Problem Statement

This chapter describes the design problem that this thesis aims to solve and its context.

The Problem statement

According to the United Nations conference on trade and development (UNCTAD, 2019), sea ports will be subject to a sustainable and digital transformation in the coming years, among which the port of Rotterdam. These important developments affect the Port of Rotterdam Authority (PoR), whose core tasks are to develop, manage and exploit the port area. PoR also has a societal role for both the Rotterdam metropolitan area and the Netherlands. Within these transformations, PoR has to find new ways to maintain its relevance next to its current activities as facilitator of physical logistic streams. PoR has the goal to be the smartest and most sustainable port of the world and to become the best connected hub of Europe (Port of Rotterdam, 2019a; Port of Rotterdam et al., 2019). The company deployed two growth strategies to maintain a leading position in Europe: 1) expand the port area, and 2) attract more throughput. These strategies directly contribute to the physical side of business model of PoR, illustrated in figure 1.4, where this growth is translated to revenue. With the recent construction of Maasvlakte 2, the port area has reached its physical limits and thereby PoR's growth by means of port expansion. The second option, to attract more container throughput, is depending on the growth of import and export of trade companies, manufacturers and the consumer market size in its hinterland. The growth of container throughput of competitors like the port of Antwerp and Mediterranean ports, in the last years, has been higher than Rotterdam's, because of differences in pricing strategy or geographical location in relation to East-Asian trade routes (Port of Rotterdam, 2020a, 2020c). In order to attract more throughput and catch-up with the competitors' growth rate, the port of Rotterdam should be more attractive to parties who split their cargo between ports or do not make use of the port of Rotterdam yet. So PoR has to find new ways to maintain their relevance and become more attractive.

A step in the digital direction was taken in 2018, when PoR launched Digital Business Solutions (DBS), a department that develops and sells digital products to supply chain players and other port authorities, represented at the digital side of PoR business model in figure 1.1. With DBS, PoR has made a decent investment in expanding their digital capability as a port authority. PoR's strategy for DBS was to create a new revenue stream with digital products, use this revenue to reinvest in new digital product development for its own port and future products to sell. More information on the strategy can be found in appendix C. Yet, the digital activities are a very small part of PoR and the revenue stream DBS taps into yields below expectations. Therefore, recently a pivot was made in PoR's strategy: products developed by DBS have to contribute to the Rotterdam digital eco-system, which could be something different than solely revenue. Where PoR initially invested in DBS to create an independent new large revenue stream, and DBS acted like a so called market organisation (Brandsen and Karré ,2008), PoR now invests in DBS as an innovation department, transforming DBS back into a task organisation. This can be seen as a challenge, since hybrid companies, containing both types of organisations, sometimes encounter internal friction between these two types (Brandsen et al., 2009).

For supply chain players, knowledge about their container's condition and whereabouts is becoming more important. A strategic opportunity for PoR could be to be involved in data streams around containers, which are present in the port and related supply chains. According to Zuidwijk (2015) companies in the port of Rotterdam are sitting on a gold mine of data, since the port deals with thousands of supply chains and over 14 million containers every year. This turns the port into one of the most potentially information-rich transport hubs on the world. There is still a lot to gain from sharing and using data, since one out of every fifteen containers faces problems during transport, resulting in avoidable costs*. Timely available data could to improve container transport performance and efficiency across the entire supply chain, and thereby contributes to the competitive position of the port of Rotterdam.
DBS could use its capabilities to contribute to the port and the digital eco-system by building a digital platform that facilitates data exchange between supply chain players, as shown in figure 1.1. The only element missing in the strategy opportunity is how it would contribute to PoR's business model.

Therefore, this thesis is focused on strategically designing a digital platform around container data for DBS, which contributes to the competitive position of the port of Rotterdam and the business model of PoR.

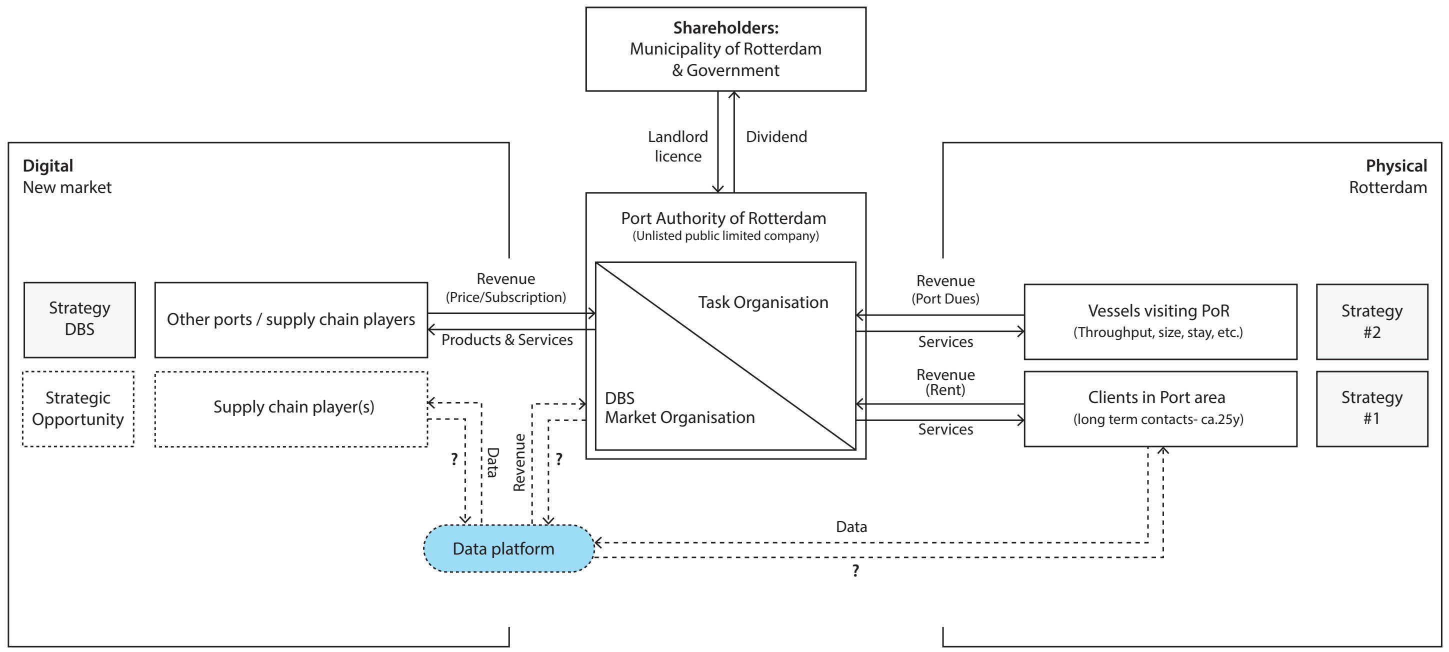


Figure 1.3. Abstract representation of PoR's Business model, strategies and strategic opportunity

Current situation
New situation
New digital product

*This number was derived from an interview (Port of Rotterdam, 2020j) and is a rough estimate based on industry experience. This number could thus vary between supply chain players

Chapter 2

Project Approach

This chapter describes what approach was used to tackle the design problem, the corresponding methods and tools used during the graduation project.

2. Project approach

As can be seen in the first chapter, this project takes place within a complex environment. The thesis aims to explore the strategic design of a digital platform around container data for DBS, which contributes to the competitive position of the port of Rotterdam and the business model of PoR.
For this graduation project there is chosen to use the steps of the Delft innovation model as a guideline for the project (Buijs, 2012). The model describes the steps faced during an innovation process, showed in figure 2.1. It is a circular model where product use is the end the of the innovation process, but at the same time it forms the starting point of a new product innovation process.

Buijs, divides the entire process in four-stages:
- The fuzzy front end (FFE), where previous product(s) are evaluated that are the starting point of new innovation, by using internal and external analyses interesting search areas and new product ideas and strategies are generated.
- New product development (NPE), where new product ideas are turned from design brief into real products.
- Market introduction, where the new product is launched to the market.
- Product use, the stage where products are bought and used by consumers.

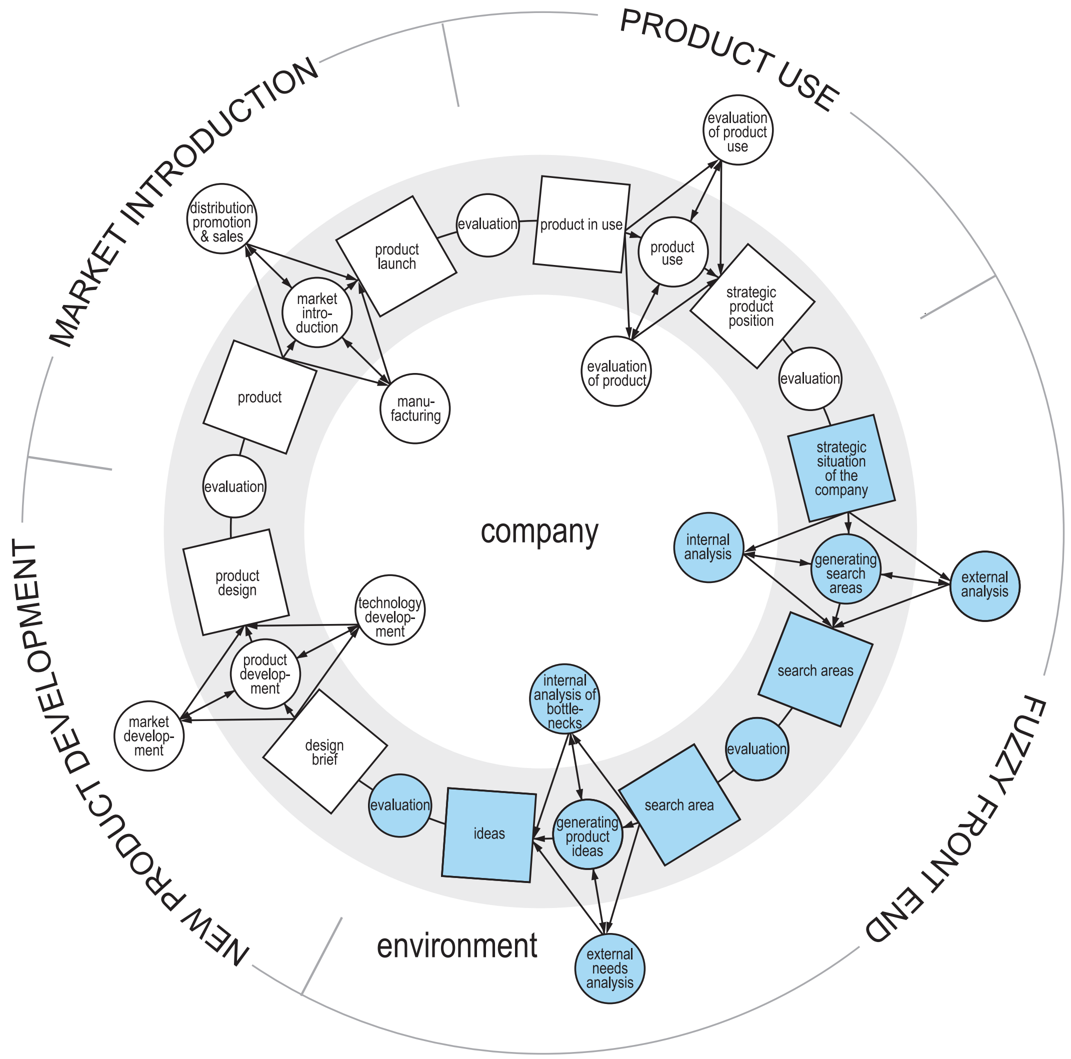


Figure 2.1. Project focus within the DIM model

Strategic design

Due to of the strategic character of this graduation project the focus is mainly on the Fuzzy frond end phase described in the DIM model. Since the aim of the project is on translating the strategic opportunity into a feasible, desirable and viable design of a platform. Besides the fuzzy front end (which incorporates strategy, search areas and ideas), a brief exploration is done into a possible and successful implementation strategy of the product.
The emphasis of this project matches the idea of Calabretta & Gemser (2017) about Strategic Designers: 'A designers' role becomes even more strategic if he or she is involved not only in the innovation strategy, but also in a broader range of strategic decisions like the company's overarching vision, corporate strategy and organizational culture, when it comes to strategic design.'

Strategic situation and defining search areas

In order to get a better understanding of the strategic situation of PoR and DBS, internal and external research is needed, the following sub-questions are formulated and researched.

Internal analysis:
1. What opportunity for DBS is present in the digital vision of PoR?
2. What differences do exist between DBS and PoR, which might explain encountered friction between both parties?

External analysis:
3. What are the activities and strategy of other digital eco-system players?
4. What data is interesting for logistic chain players and what needs do they have?
5. What criteria do logistic chain parties use to determine their port selection and can data influence the competitive position of a port?
6. Which difficulties can be found in data exchange?

The sub-questions are researched using literature research and multiple open interviews obtain deeper understanding of the topic in a short period of time. Given the confidentiality of the topics treated in interviews the interviews were not recorded to comfort the interviewees so they would speak more freely. During and directly after interviews interesting findings are written down. In table 2.1, an overview can be found of the interviews. The participants are not mentioned by name but only their departments are listed.

Table 2.1. Overview of the interviews

Number of interviews	Participants	Topic	Phase	Tools
2	Corporate strategy and DBS management	Direction for this project	First evaluation of the project	Scenarios
8	DBS, Pronto, Portbase	Digital vision and connected ports	Strategic situation	Visual communication
2	Shippers and forwarders	Problem and opportunities	Search areas	

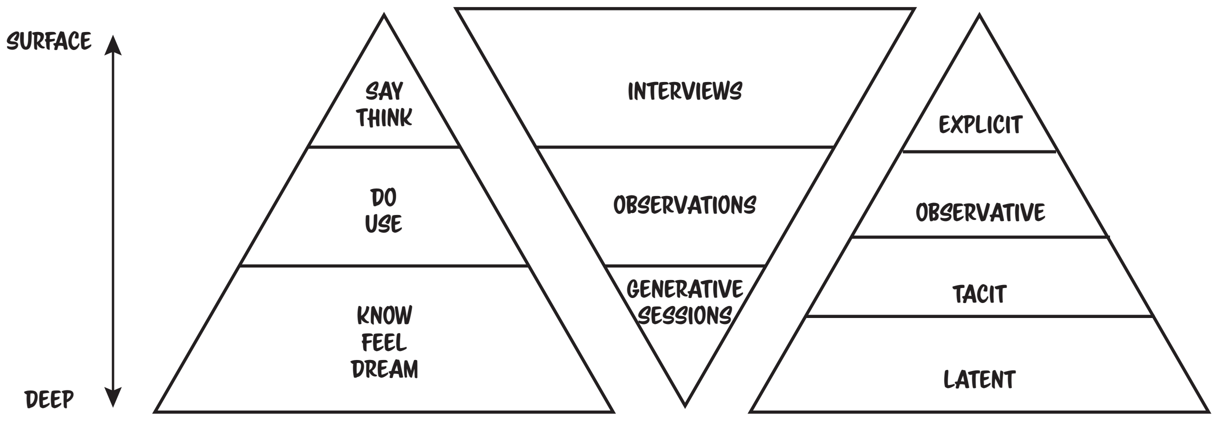


Figure 2.2. Do, Say and Make model

Figure 2.2 shows the Do, Say and Make model from the convivial toolbox
(Sanders & Stappers, 2012), this model shows that with normal interviews often only surface information will be derived. In order to reach deeper level of information, often more valuable level of information, designers can develop tools that can be used during interviews or generative sessions. For the interviews in the graduation project, scenarios and other visual tools are used to obtain more tacit and latent knowledge from the interviewees.

Scenarios
For the strategic analysis an open interview guide and three different future scenarios presented as an infographic are prepared. Those scenarios are used because, according to Mullins & Walker (2015), many researchers question the ability of interviewees to articulate the deeper meaning of what they say. These scenarios can be found in Appendix D and are used to get on a deeper level of information retrieval in the short period of time and to see if a certain direction would trigger the interviewees.

Visual communication
Visual communication is used to deal with complexity, throughout the whole project infographics were used. These visualisations are used to discuss the digital vision and connected ports and to ideate and validate the ideas. Thereby, participants are enabled to iterate on the existing research and ideas. The visualised communication- and graphic tools can be found in Appendix E and Appendix F.
Why chose for visual communication? Illustrations, graphics, icons, charts, and other visual assets often are more engaging for a reader than presenting the same information in the form of text. Not only it is more interesting, it is faster to understand, it is intractable e.g. when using it in interviews an allowing people to draw on a printed version and it's memorable for the reader. Furthermore, it also strengthens the overall design. In design projects text should be used to complement the design, rather than acting as the focal point. However, there can be argued that making more complex infographics, that could visualize or schematize complex topics e.g. innovation or a company's culture, strongly depends on the makers skill level and therefore is not a suitable method for everyone.

Internal differences
In order to research the sub-question; 'What differences do exist between DBS and PoR, which might explain encountered friction between both parties?' DBS and PoR are viewed from a branding perspective.

Due to the establishment of DBS, PoR became a hybrid company and currently is moving back to a task organisation. It is important to know which differences are existent within this hybrid company in order to find out what might cause internal frictions between the two types of organisations. Currently there is limited research done in the field of hybrid companies. And the internal discussions cannot fully be explained by the available literature. According to Brandsen, Philip, Karré and Helderman (2009), the combination of two types of organizations within hybrid organizations could lead to risks when tensions arise due to the combination of conflicting characteristics within one organization. However, their theory does not cover an in-depth analysis about these conflicting characters. Additional literature is used to frame the characteristics of organizations and might explain why certain conflicts arise. Mark and Pearson view organizations through the lens of cultural archetypes and use those archetypes to frame brands, consumer markets, and individuals. Their theory is built upon Carl Jung's understanding of psychological archetypes.

What are brand archetypes?
Next to differentiation on price, quality, and service, companies can differentiate themselves from competitors on brand personality. Brand personality can be defined as the set of human characteristics that are associated with a brand (Aaker, 1997, p. 347). A comprehensive way to put brand personalities in a framework is the use of archetypes. Mark and Pearson (2001) were the first to apply the idea of archetypes to brands. An understanding of a company's brand archetype is not only valuable for its customers but can function as a guideline and inspiration for a company's own employees. It could enhance its values and propositions, helps to provide a clear direction for their vision and strategy, unifies teams and ensures that everyone is working together towards a shared goal.

Mark and Pearson (2001) identified twelve different archetypes, see figure 2.3 describing its primary function in people's lives, and gives one example of a leading brand or brand icon owning that identity. The fact that Mark and Pearson (2001) mention twelve archetypes, does not include that that all archetypes are equally different. They argue that in everyday human life there are four major human drivers, which are positioned along two axes and are each other's opposites. Four main clusters containing three archetypes can be formed. For every human driver, there are three archetypes that have the most similarities with this driver. Figure 2.4 there can be seen when the drivers are positioned along two axes and the corresponding archetypes are placed within this system.

In this project DBS and PoR are considered both as separate organisations, so there can be researched what archetype(s) belong to both organisations, if they share common archetype(s) and if these results can further explain conflicts mentioned by Brandsen, Philip, Karré and Helderman (2009).

Archetypes and Their Primary Functions in People's Lives

Archetype	Helps people	Brand example
Creator	Craft something new	Williams-Sonoma
Caregiver	Care for others	AT&T (Ma Bell)
Ruler	Exert control	American Express
Jester	Have a good time	Miller Lite
Regular Guy/Gal	Be OK just as they are	Wendy's
Lover	Find and give love	Hallmark
Hero	Act courageously	Nike
Outlaw	Break the rules	Harley-Davidson
Magician	Affect transformation	Calgon
Innocent	Retain or renew faith	Ivory
Explorer	Maintain independence	Levi's
Sage	Understand their world	Oprah's Book Club

Figure 2.3 Archetypes (Mark & Pearson, 2001, p.13)

Figure 2.4 Positioned archetypes (Mark & Pearson, 2001)

Search areas and ideas

The outcomes of the strategic analysis, desk-research and interviews are as input for the search areas and ideation. The creation of ideas is an iterative process, meaning that the concept can develop over time with the use of input from stakeholders. For this development, many stakeholders are included in this pro-cess by making use of interviews, which are shown in table 2.2. Eventually, the concept is tested and iter-ated on three pillars of strategic design; desirability, viability and visibility. Desirability answers the ques-tion: do people want it? Feasibility answers: can we make it? And viability: should we do this? Those ques-tions have led to the finally proposed platform in Chapter four. To ensure a good implementation strategy, the chapter ends with a proposal for implementation of the product.

Table 2.1. Overview of the interviews

Number of interviews	Participants	Topic	Phase	Tools
8	DBS, Shippers and forwarders, Corporate strategy, Portbase	Ideation and validation	Search area and ideas	Visual communication

Chapter 3

The results

This chapter describes the results of the interviews and literature review. Under which: the opportunity that is present in PoR's and digital eco-system's vision for DBS, the data that interesting for logistic chain players and where this data is derived from, what difficulties are faced in data exchange, how the platform could contribute to the competiveness of the port and the differences that exist between DBS and PoR.

3.1 The digital vision

PoR's Vision

Together with covenant partners; the Dutch government, the province of South Holland, the municipality of Rotterdam and Deltalinqs, PoR developed the Port Vision (Port of Rotterdam et al., 2019). This document describes the future prospects for the port and industrial complex for 2030. The Port Vision functions like a compass or guideline instead of being strict rules.
In the report is stated that: The port of Rotterdam will be Europe's most important port and industrial complex in 2030. The port will function as a global hub and is the best connected port in Europe. Furthermore it's a leader in efficiency and sustainability, part of global logistics chains and international data exchange in 2030. Manufacturers, shippers and carriers are seamlessly connected to other parties through digital products like planning tools, platforms and e-marketplaces. These parties can obtain international real-time information about shipping routes, planning deviations is which is shared with hinterland parties as well. This facilitates integrated international digital door-to-door logistics. The coordination and exchange of data in the port is efficient and easy via a PCS and works with the highest technological and safe standards. For this international data exchange global standards must be developed.
This Port vision is largely integrated in the corporate strategy of PoR. The Port Vision also states that PoR is committed to further develop technologies and greater transparency to promote data exchange. PoR aims to be the smartest port of the world (Port of Rotterdam, 2019a), with the development and roll-out of digital products and services they want increase their level of service and competitiveness. In this digital transformation they want to have a facilitating role.

> ***"Our right to exist is based on customer satisfaction."***
> \- Port of Rotterdam, Annual report (2018), p.44

On the one hand, PoR wants to define their role in the digital transition clearly, on the other hand they do not want to compete with their own customers (Port of Rotterdam, 2020d).

> ***"Our ambition is a fully digital and transparent supply chain, where every party involved in the chain has access to data about the status, location and expected arrival times of their cargo."***
> \- Port of Rotterdam, Annual report (2018), p.44

In order to reach the above stated goals, PoR is currently performing multiple digital activities under the collective term PoR digital eco-system. The companies and department in this ecosystem all have their own roles and different strategies within the larger vision. However, what this overall vision exactly includes is not clear, at least not clearer that the above stated sentences.

Why is the vision not yet a strong future vision?

From interviews with many interviewees from DBS and Corporate strategy (Port of Rotterdam,2020d, 2020e, 2020g, 2020h, 2020i, 2020j) it became apparent that there is no clear future digital vision. Most tangible overall vision found during research, is the digital maturity model developed by DBS, which can be found in Appendix B. This vision describes the development of a worldwide network of smart ports and is mainly aimed at port authorities. These ports can exchange structured and digital information with each other and other logistics players. In this model PoR also translates the meaning of smart ports to connected ports. A connected port is part of a digital network of both other ports and hinterland parties, which would enable just in time sailing and door-to-door logistics chain transparency.
Although the benefits of connected ports seem very promising, this is not yet a strong (future) vision.
A strong future vision contains four distinguished properties: clarity, value drivers, artefact and magnetism (Simonse, 2018). Without these properties a vision could be seen as incomprehensible and it leaves room for free interpretation. During the graduation project it became clear that eco-system parties have a dif-ferent opinion and interpretations about the vision of connected ports. Also visually attractive and under-standable artefacts related to connected ports are not present in the company. Moreover, there is no clear overview of what data connections should be established, how this data connections could be made in the coming years. Although, the value drivers of the vision are present, the vision of connected ports lacks clarity, artefacts and has magnetism in some departments however not the whole organisation. So it can be stated that the connected ports vision is not a strong future vision yet, as defined by Simonse (2018). Without a strong future vision or desired future shared by all parties involved in the ecosystem, it is hard to align their digital activities and dived roles and responsibilities, so they would contribute to one strategy aiming for becoming the smartest port in the world.

Getting rid of the haziness

In order to start making the vision more clear and get a better understanding of the roles and strategy of other eco-system parties, both literature research and interviews were used. Connected port is all about making digital connections with other ports and other parties that can supply relevant data, so involved parties in the logistic chain can access this data and on their turn optimize their systems based on input of others, which would lead to port call optimization and door-to-door logistics. From interviews it became apparent that most of the data that can be exchanged related to the marine and logistics sector can be categorised in 4 categories: Vessel related data, Cargo related data Community data and Port data.

According to Menger (2016) and Minderhoud (2018), data who have written their theses about the use of data in seaports, data can be subdivided into four levels:

- Fixed information. Fixed information, as the name suggest, does not change over time. E.g. of the IMO number of vessels, Container identification number, number of berths in a port.

- Historical information. Historical information holding events that happened in the past. E.g. last visited ports of a vessel and terminal handling time of a container.

- Status information. Status information represents the current condition. E.g. the current location of a vessel or a containers position on the terminal.

- Predicted information. This information contains predictions about future events. E.g. the expected time of arrival of a ship (ETA), the predicted depth of a sea port taking in account the tides.

In appendix G, a table of all data categories, data levels and corresponding data types can be found, this table was created with the help of interviewees of DBS (Port of Rotterdam, 2020g, 2020h, 2020i, 2020j). Knowing a bit more about what data could be exchanged it is also worth knowing what could be the benefit for parties of make this exchange, appendix H gives an example of this benefits by describing a scenario about exchanging ISPS data between ports.

Future roles in the digital eco-system

Now we are coming back to the roles and strategies of the eco-system parties. To answer the question if eco-system parties are already involved or aiming for international data exchange, interviews were held with PortXchange and Portbase (Portbase, 2020b; PortXchange, 2020).

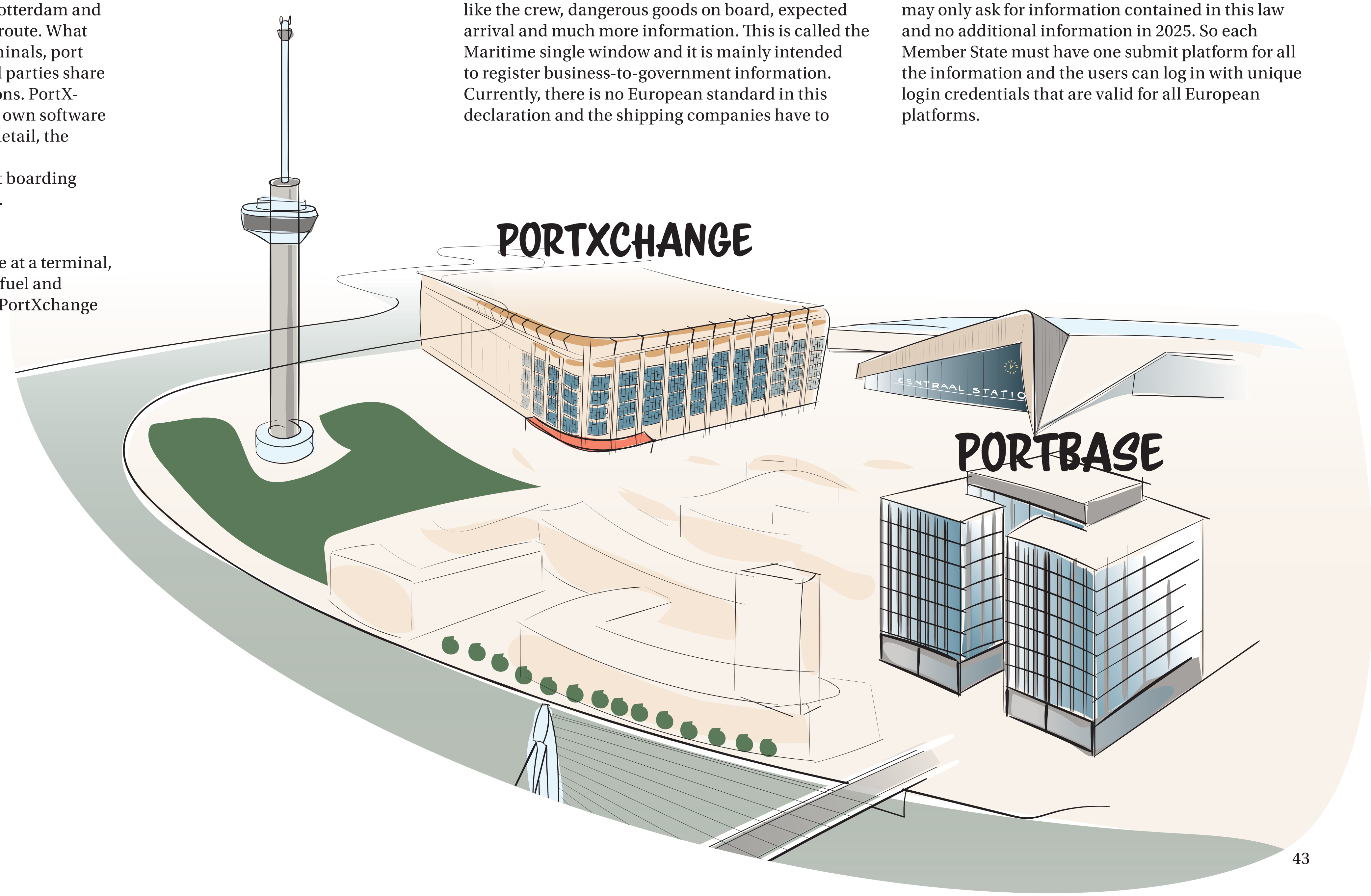
PortXchange

PortXchange was established to improve JIT sailing, which is very beneficial for the container segment. Currently, 75% of carriers participate with PortXchange, moreover all terminals in the port of Rotterdam are connected. Next to Rotterdam, PortXchange is working for the port of Houston and the port Felix-towe. Since Maersk, the largest carrier worldwide, and one of the partners of the application would like to optimize their shipping route between Rotterdam and Felixstowe. So what data is exchanged in order to optimize such a route. What is needed is an estimation of all involved port call parties, e.g. terminals, port authorities, linesmen, pilots, agents and carriers. In Rotterdam, all parties share their estimated comple-tion and estimate starting time of operations. PortXchange combines all data derived from different sources and their own software and shares the most accurate ETA to all relevant parties. In more detail, the application is build up out of multiple information layers:
- Port master data (shipping lanes, terminal locations, berths, pilot boarding place), this data is derived from their software that can map a port.
- Port events (ETAs, etc), derived from all parties connected.
- Port restrictions, for e.g. depth or weather conditions.

When a delay is recognized for example when a berth is not yet free at a terminal, carriers are notified that the ship can slow down it's speed, saving fuel and which can count up to thousands of euros per call. The strategy of PortXchange is to expand to other ports and also expand to other types of carriers, such as liq-uid bulk (oil, chemicals). Currently they are only focused on container ships, where JIT sailing is very benefi-cial. However, in other segments this is quite different, for example crude oil tankers only call at or from a certain oil price, and otherwise it would wait outside the ports for a better price.

Portbase

Portbase's aim is to create value for their direct customers, which are carriers, port community parties like terminals, the government, shippers and forwarders. Portbase is a platform where all these parties can upload or derive information about port calls and is the link to the Dutch government, e.g. documents needed for customs and clearances can be exchanged. So what is the strategy and vision of Portbase for the coming years? In 2025, the European Maritime Single Window (EU-MSW) will be intro-duced. Whenever a vessel calls at a port, shipping companies must provide information about this visit, like the crew, dangerous goods on board, expected arrival and much more information. This is called the Maritime single window and it is mainly intended to register business-to-government information. Currently, there is no European standard in this declaration and the shipping companies have to provide the information, often in different formats, the government demands of the concerned country. To do this, shipping companies often have a local agent in each country who actually enters this data on behalf of the shipping company. This creates extra costs and the shipping companies are already under considerable pressure when it comes to their margins. That is why they started lobbying at the European Commission to change this situation. After a long time, since 2010, a new law was adopted: Each European member state must have one user interface for the registration of business-to-government (B2G) information, a technical interface to linking to the national maritime single window and member states may only ask for information contained in this law and no additional information in 2025. So each Member State must have one submit platform for all the information and the users can log in with unique login credentials that are valid for all European platforms.

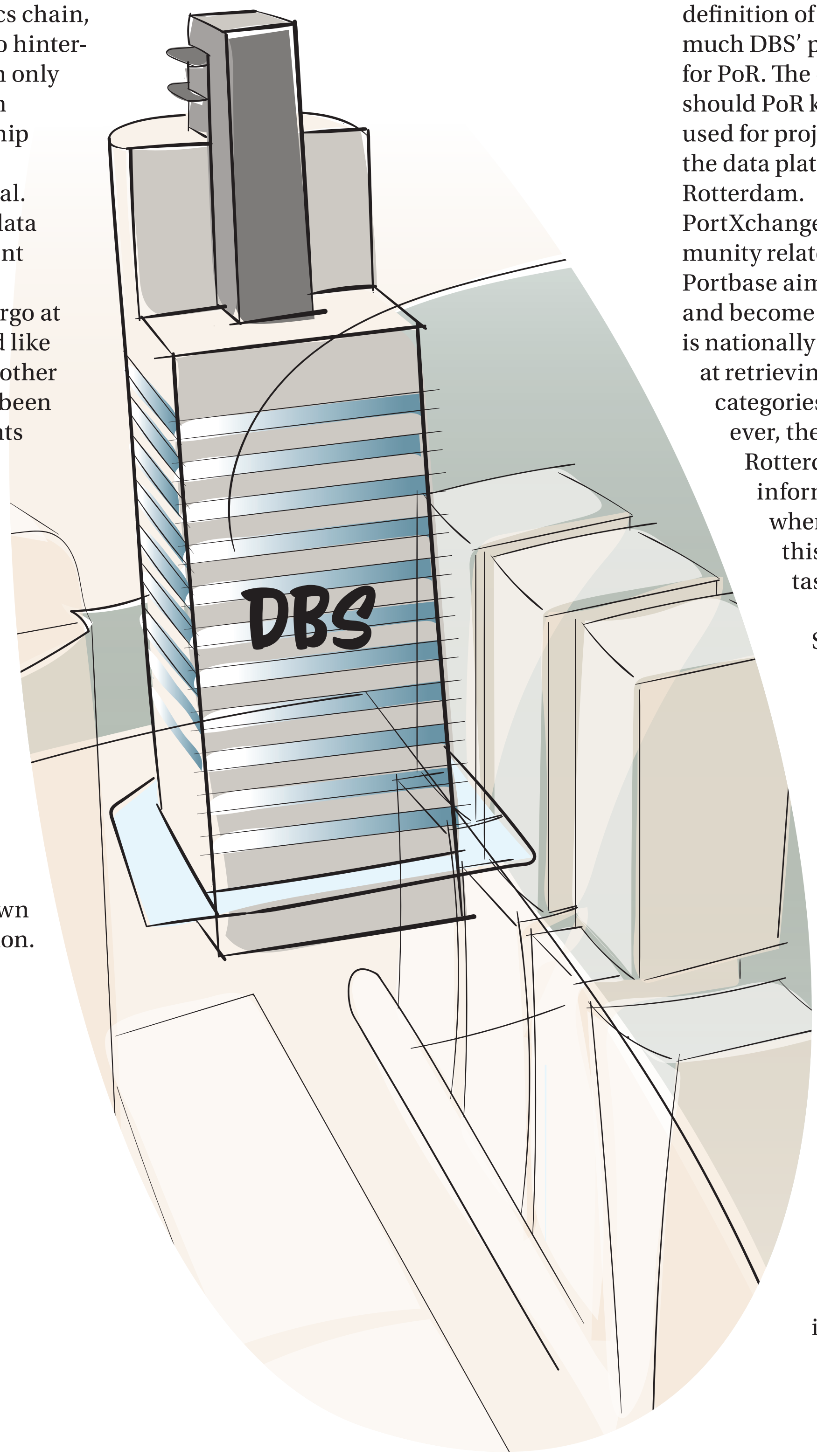


Portbase's strategy

Instead of sending this information to all governments separately, Portbase wants to become the single digital entry point or submit platform for the shipping companies for whole Europe. This role suits Portbase well, since they already have this role in the Netherlands and they want to expand this role internationally. For Portbase, it is important to either maintain their current position or capture the new European role. Moreover, when another party would take this European position, it would probably mean that most of the notifications of the shipping companies would no longer ended up in the PCS of Portbase. This would make the PCS less valuable because an important part of the information is missing. Portbase is also working on the concept that forwarders located in the hinterland of Rotterdam can send their declaration to Portbase and that Portbase will forward this information to the PCS of the port in question, this would also work the other way around if a forwarder e.g. in Germany wants to send cargo to Rotterdam, it could send the needed information to the PCS which is used in Germany, which will send it to Portbase. This concept is called a network of trusted networks.
For Portbase it is important to be as connected as possible to all initiatives and platforms in the future, so the PCS will maintain and expand its value for their users. Furthermore, Portbase's focus will shift more from connecting local parties to contracting shipping companies. So, if it is possible to connect create a network of trusted networks, it could also be possible for shipping companies to report all their information to a central party, this party ensures the correct distribution of the information. To take the role of this central party, it is important that Portbase could actually interest shipping companies to do all their declarations via Portbase in the future. It might be obvious that there is considerable competition to capture this central role by other PCS parties, like NextPort form Antwerp.

Additional services

Although, Portbase will focus on becoming the central party in the network of trusted networks, according to the interview the most valuable information might be the data related to cargo. Portbase has a certain role in logistics chain, and already offers various services to hinterland parties. Currently, Portbase can only provide information within a certain range: from a few hours before the ship enters the port of Rotterdam until a container leaves the gate of a terminal. Outside this range Portbase has no data and insight in the cargo. An important identified need of forwarders and shippers is status updates of their cargo at other ports. For example, they would like to see if their cargo has arrived at another port and for import or cargo if it has been sent from the other port. Also, insights in deviations are extremely valuable to them, e.g. knowing whether a ship with their cargo is too late or whether a number of containers have not arrived. For additional value creation for the customers within the port community and hinterland, it could be very interesting to establish a data exchange connection with ports where a lot of cargo goes to or from relative to the port of Rotterdam. The numbers on cargo flows to and from Rotterdam are known by Portbase. What is unknown is which parties own the cargo, which is private information.



Opportunity for DBS

According to a recent pivot in PoR strategy, DBS' products now have to contribute to the Rotterdam eco-system, and that can now be something other than a revenue solely. However what this contribution means is not clear, it is hard to contribute to PoR's goal of becoming the smartest port in the world, when their definition of a smart port is not yet known. So it is very difficult to determine how much DBS' prod-ucts are worth for the port of Rotterdam and what do they yield for PoR. The quantification of the benefits is something which is lacking. So why should PoR keep investing in projects of DBS if these investments could also be used for projects of other departments of PoR. Could the strategic opportunity of the data platform focus on a certain category of data that adds value to the port of Rotterdam.
PortXchange's activities are mainly aimed at exchanging vessel related and community related data be-tween parties and uses port data for better predictions. Portbase aims to exchange business to govern-ment (B2G) data internationally and become an important party in the network of trusted networks, more-over it is nationally involved in cargo data but their international activities are not aim at retrieving interna-tional cargo data for their customers and is more on the categories vessel related data and being able to forward information. However, the shipment of cargo of Shippers and Forwarders does only include Rotterdam, they are involved globally. For them it is very valuable to have information not only of their cargo in Rotterdam but also in other ports where their cargo is exported to or imported from. Currently, obtain-ing this information from other ports is a complicated and labor intensive task.

So, none of the eco-system parties is currently involved in or focusing on exchanging international data around containers, cargo data, which could be very relevant for shippers and forwarders and achieving transparency in the logistic chain and door-to-door logistics.

DBS is already involved with exchanging national cargo data, in 2019 they launched Boxinsider. The track-ing and tracing app provides shippers and forwarders with real-time status information on containers they import via the port of Rotterdam. The application anticipated on a need from shippers. In the past, they were used to collect information from various platforms and parties, in order to track their import con-tainers and create schedules. Constantly monitoring terminals' and carriers websites is time-consuming and not covenant. Therefore, DBS developed one platform that contains the status information of import containers and send push messages when container's deviate from schedule. Furthermore, Boxinsider of-fers an overview of the containers expected, including ETA, ETD, discharge and gate-out data. This data already is a huge help for shippers when it comes to formulating schedules. Forwarders can use this data for their clients to keep them informed and take targeted actions. Only how is this cargo data generated and where is this cargo data derived from?

3.2 Data generators

In this millennium many new technologies were introduced in the maritime sector, e.g. RFID tags are used to identify objects such as trucks. Furthermore, the automatic identification system (AIS) was introduced, which is a signal vessels emit that includes their location and speed. Currently, AIS is one of the most used technologies for tracking a vessels position. Container terminals are also equipped with optical character recognition (OCR) systems (PEMA, 2013). These systems are able to capture and recognize machine-readable codes, like a container-specific serial number, present on all sides of a container (Heilig & Voß, 2017). This code can be seen as the container identity and a lot of information is connected to this identity, like the owner's credentials, the container's weight, its destiny, bill of lading, it's content, previous journeys and more. Some not all information about the container is also known by the terminals. In this way a container terminal can identify a container automatically and knows where this specific container has to go to or who is assigned to pick it up. These scanners are present at many places on the terminal like the gates and cranes. The container identity number and OCR systems are the worldwide standard how containers are tracked and traced. One can determine a container's location and at which party in the logistic chain the container is, by knowing which scanner has last scanned the specific container number. The data related to containers in this thesis is called cargo related data. To make this more specific only the data which is needed for tracking and tracing is considered, this includes for example fixed information like the owner and container identity number, real-time status updates like container is loaded on the ship, container terminal gate-in or out. Additionally, it includes predictive data like estimated time of arrival (ETA) and historical data like actual time of arrival (ATA) in a container's transport journey. In figure 3.1 an example is shown about data types that are present on a terminal, which is one of the logistic chain parties. Print board lines are used to illustrate the digital layer beyond the physical processes on a container terminal. Other cargo related data, like insurance and declaration documents needed by parties like customs are not taken into account. DBS has made an extensive overview about all relevant data points for track and tracing within a container journey, this overview can be found in appendix I.

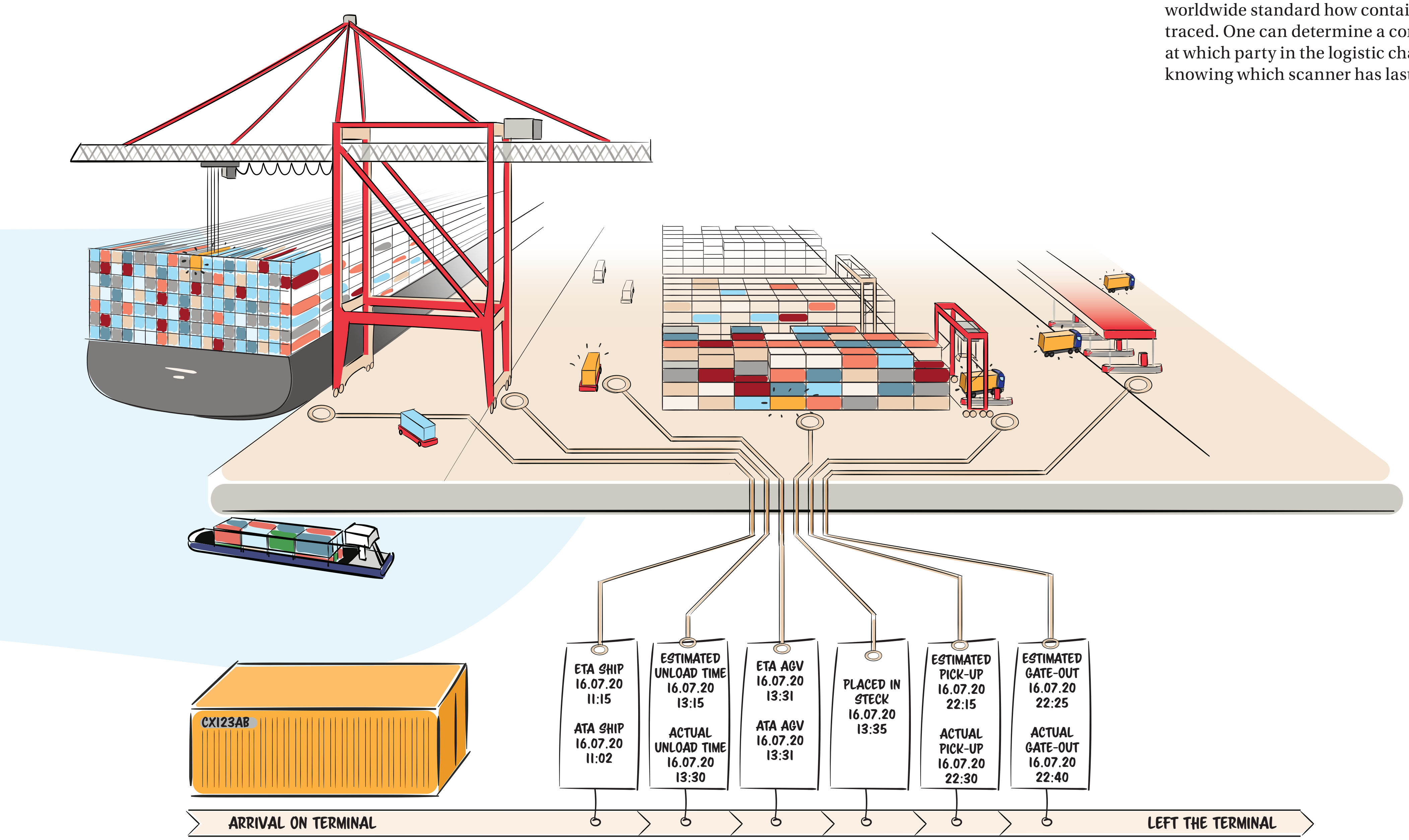


Figure 3.1 Data types present on a terminal

3.3 Implications found in data sharing

From interviews (Port of Rotterdam, 2019e, 2020j; Portbase, 2020b; PortXchange, 2020) and literature research, there was found that there are many implications involved in data exchange, which makes innovation in this field very complex and difficult. In the paper written by Heilig, Schwarze and Voß (2017), it is stated that the implications and challenges that come along with 'third generation' of innovations in seaports. Their findings are complemented with findings derived from the interviews and other literature. The found implications are presented below.

Large differences between stakeholders

Among actors in ports the degree of digitalization varies a lot. Large companies in a port show a high degree of digitalization, however the smaller companies (e.g., empty container depots), have fewer resources in terms of finance and IT expertise, and therefore are often lagging behind. This was also found by DBS, they call this the difference in digital maturity, and has therefore build several digital products so ports could grow to a higher level of digital maturity (Port of Rotterdam, 2019e). This makes it difficult to develop one-size fits all, where different parties can make use of (Portbase, 2020b). Both DBS and Portbase also encounter a lack of standards in the industry, this causes difficulties in building connections between different systems and optimalisations.

Different interest prevent cooperation's

Ports, community parties and shipping companies are subjected to strong global competition, therefore innovations and digital transformations at ports are often driven often the goal to gain more competitive advantage. This rivalry is among ports as well as on a local port level. The strong rivalry hinders the achievement of global competitive advantages since parties are concerned whether their cooperation would lead to advantages of their direct competitors and thereby creates an unwillingness to participate. This is also the case according to the interview with PortXchange, since JIT sailing currently offers the most benefit to shipping companies, they save fuel and have fewer delays. However, the terminals benefit much less, since JIT sailing has few financial benefits for them, but they are also asked to cooperate. According to a report of the Erasmus University Rotterdam et al (2015), the need for co-operation in logistic chains in order to realize total transparency is lacking. Although, the physical processes in container chains are highly developed. What is lacking is the data-handling, the real need for transparency and the willingness for co-operation in the chain to realize total transparency.

Data ownership and trust

According to the interview with Portbase, as a rule of thumb every port that has handles over a million TEU has a PCS, where information about port calls and cargo is exchanged. To create a well working PCS, where parties are willing to cooperate, two aspects are important:
1. Who owns the information?
2. How reliable is the data

Locally, these two aspects are usually well regulated and agreed on contractually. But the moment you start sharing data internationally or from PCS to PCS, this becomes more way more complex. The parties do not know exactly where their data goes to anymore, and thereby do not know what they are consenting to in the international construction of data exchange. Also there is a difference in parties that only operate locally or that already operate internationally, such as shipping companies. Preferably companies do not want to share sensitive information like status updates of their operation, since this data might end up at their competitors in some way. So the cooperation also has to deal with the trust position of the party that is going to collect and distribute the data. Furthermore, data owners are willing to share data of parties involved in the same port call, however they prefer not to share data if they are not involved in a common call (PortXchange, 2020). According to an interview with DBS management (Port of Rotterdam, 2020e), parties also do not want to cooperate if they have the feeling that a third party is making profit on their data.

Shift of independency

The digital transformation brings along a shift of power and tends to increase the influence of central control entities, like port authorities. Although, this central role is needed to improve port operations on the overall level, it also leads to concerns about the autonomy and individual interests of parties. This was also seen by PortXchange, besides that the terminals benefit less financially cooperating also involves less individual operational freedom and flexibility (PortXchange, 2020).

Hard to estimate the monetary value

It is not unimportant to estimate the return on investment (ROI) of digital strategies. However, due to the growing complexity and additional network effects, it is difficult to estimate value of smart port initiatives in monetary terms, something DBS knows all about. Also it is hard to determine the price or value of data.
Need for (new) expertise
Developing new digital products in ports require a high degree of IT/IS knowledge, something which is not common to be present in most ports. To be able to make full use of the benefits the solutions could bring real-time information must be exploited in order to improve and speed-up decision making. Thereby ports need experts like computer scientists, mathematicians, and data scientists having an experience in modelling, analytics, statistics, and software engineering. To make these experts work on products which steer digital transformation into the right direction, their expertise must be combined with a detailed knowledge of port operations.

Conclusion

The implications can be seen as obstacles that prevent a new international data exchange platform to make it into a successful implementation. During the product development phase it is essential to take these implications into account and to develop solutions that can overcome these obstacles. Making it more likely that possible partners and future clients are willing to participate.

3.4 The platform and port competiveness

Although there is value in exchanging cargo data, would a platform be able to contribute to the competiveness of the port of Rotterdam, and which parties determine via which port throughput is shipped?A lot of research has been executed in the field of port competiveness and decision makers. Martínez Moya and Feo Valero (2017) did an extensive literature review on the available literature in these fields. They argue that it is hard to determine the real decision-maker and that next to that it also varies between countries and industries. Also in literature seems to be no consensus on who should be considered the decision-maker, the carriers, the shipper or the freight forwarder and that it can be seen from two perspectives; the sea-side and land-side perspective. For this project there is focused on shippers, since cargo data is more relevant for them than for carriers and their future role is more certain than the role of forwarders. Furthermore, shippers can be seen as the most important decision maker, since they are the cargo generators. A more elaborated view on the decision makers and target group selection is discussed in appendix J.

The selection criteria of Shippers according to literature

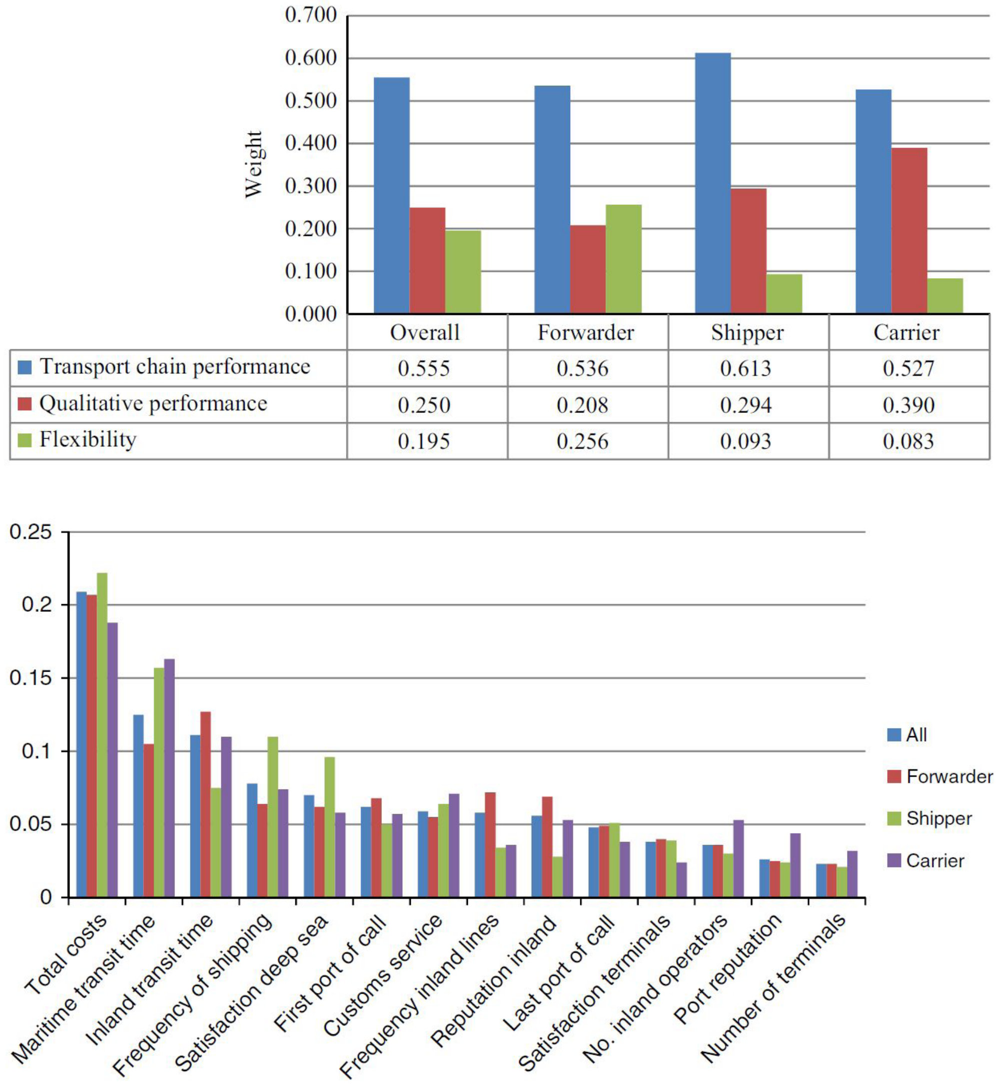
Nevertheless is it only performance, like speed and quality, or also price which make these parties choose for a specific port for their freight transport and are there also other aspects they take in account? Since there is no clear and single answer on the question who is the decision maker, it is important for port authorities to know what criteria these parties take in account when making their decision.
These criteria are called the port selection criteria, and they describe the many elements these parties consider in their decision making, which goes further than earlier mentioned price and overall performance alone. It is a long list containing at least but not limited to: Port location, port charges, customs and government, regulations, hinterland connections, available modalities, terminal operators, port facilities, shipping services, port information systems, empty container management, cargo volume handling, port efficiency, port reputation, cargo safety and insurance, and more.

Martínez Moya and Feo Valero (2017), divide these criteria in two groups, the first group of criteria can be influenced or controlled by port authorities like efficiency or port charges, which can be improved through e.g. the design of competitive strategies and investments in infrastructure in order to in improve competitiveness. The second group of criteria that cannot be influenced, such as the port location, which can be seen from two perspectives as well; from the land-site the location in respect of production and consumption centers and from the sea-side in respect to main navigation routes. They state that the geographical location is pointed out by many studies as the key determinant or even the solely determent of port choice. However, this is contradicted by other studies saying that also other criteria affect the attractiveness of ports, since the imbalance of cargo traffic between ports cannot solely be assigned to the correlation between distance and cost.

'One of the most debated issues in this area of research is still whether the factors under control of port authorities prevail in the port choice process over those beyond their control.'

- Martínez Moya and Feo Valero (2017) p.308

They argue that port efficiency and port effectiveness are both important criteria. Especially for inland decision-makers port efficiency is a key determinant. Port effectiveness, is measured by the achievement of port objectives, customers' satisfaction and the quality of service provided. A variable that is considered to affect both port efficiency and effectiveness is ICT development. However, the empirical evidence on the role of ICT as decision criteria is still scarce, Acosta, Coronado, and Mar Cerban (2007) state that this item is among the five most important factors in port choice. Furthermore, port connectivity and port charges are mentioned by Martínez Moya and Feo Valero (2017), to be important criteria under the control of port authorities.
Besides, a more recent study was carried out by the Technical University of Delft and PoR. Rezaei et al. (2019) researched how port performance and port choice are related in the Hamburg-le Havre range, so port authorities could anticipate on future changes in port choice by shippers, freight forwarders and carriers. Their main conclusions can be seen in figure 3.2 and can summarized as follows, transport costs and times are the dominant factors for port competitiveness. This is in line with other scientific literature they reviewed. According to their study, these account for over half of the weight of all criteria. However, they also found out that the other half is represented by the qualitative (satisfaction and reputational) criteria, and flexibility that can be offered in terms of the number of choices available for handling and shipping. This is perhaps even more interesting, since this is better under control of port authorities.



	Overall	Forwarder	Shipper	Carrier
Transport chain performance	0.555	0.536	0.613	0.527
Qualitative performance	0.250	0.208	0.294	0.390
Flexibility	0.195	0.256	0.093	0.083

Figure 3.2 Weights of the main and sub-criteria (Rezaei et al., 2019)

The selection criteria of Shippers according to PoR

During the project an interview with the commercial department, shippers and forwarders, was done (Port of Rotterdam, 2020f). This department is a relatively new department of PoR, and acts as a neutral party that supports to improve the entire logistics chain for shippers and freight forwarders*. They reach out to other parties involved in a certain logistic chain and find out where this chain can become more reliable and efficient. This is done by connecting parties, actively sharing their knowledge and by driving innova-tion. Since this department is aimed at shippers and forwarders, they build up knowledge about shippers' and forwarders' needs, desires and bottlenecks they face in their work.

According to the interview, the most important criteria for port selection is reliability. This can be meas-ured or seen as the standard deviation on lead times and total duration, whereby large outliers determine the performance. Simpler said, most containers are shipped or transported according to their expected schedule, these containers are not that interesting or critical. Shippers and forwarders are most interested in the so called 'outliers', containers that are (much) too early or too late, because these influence their own processes significantly. An example from practice is Tesla, the electric car manufacturer, for them it's very important to rely on the reliability of a seaport when it comes to their containers. Since their factory planning is based upon the expected arrival of containers loaded with parts and components for further assembly. When a container arrives too early or too late their own process could be affected. So for ship-pers and forwarders it is very valuable to be able to plan on the expected arrival or departure of their car-go. It's not necessarily bad if shipping containers via Rotterdam would take a day longer than via its competing port, it's about not getting a container ten days earlier or later compared to the rest of shipments.

Therefore, these parties are interested in data about their containers, so they can better anticipate on un-expected deviations. When having timely information about these containers they could decide to last minute change the inland trans-port mode for example. For instance, if a container is much too late, a differ-ent modality can be chosen, e.g. make use of a truck instead of a barge for further inland transport. So, flexibility in (last minute) mode choice is also an important criterion. Normally when containers are on schedule shippers and forwarders generally opt for the most sustainable modality.

In addition, the quality of services in a port is important. This includes if cooled containers, often loaded with fruit or other cooled goods, are always connected to a reefer. This the connection to power net in order to supply the container with power to keep the temperature constant. This is done at vessels, terminals and sometimes even trucks. Another service mentioned is the safety of containers, so how well are the containers physically secured against burglary and how are they secured digitally and is the paperwork right.

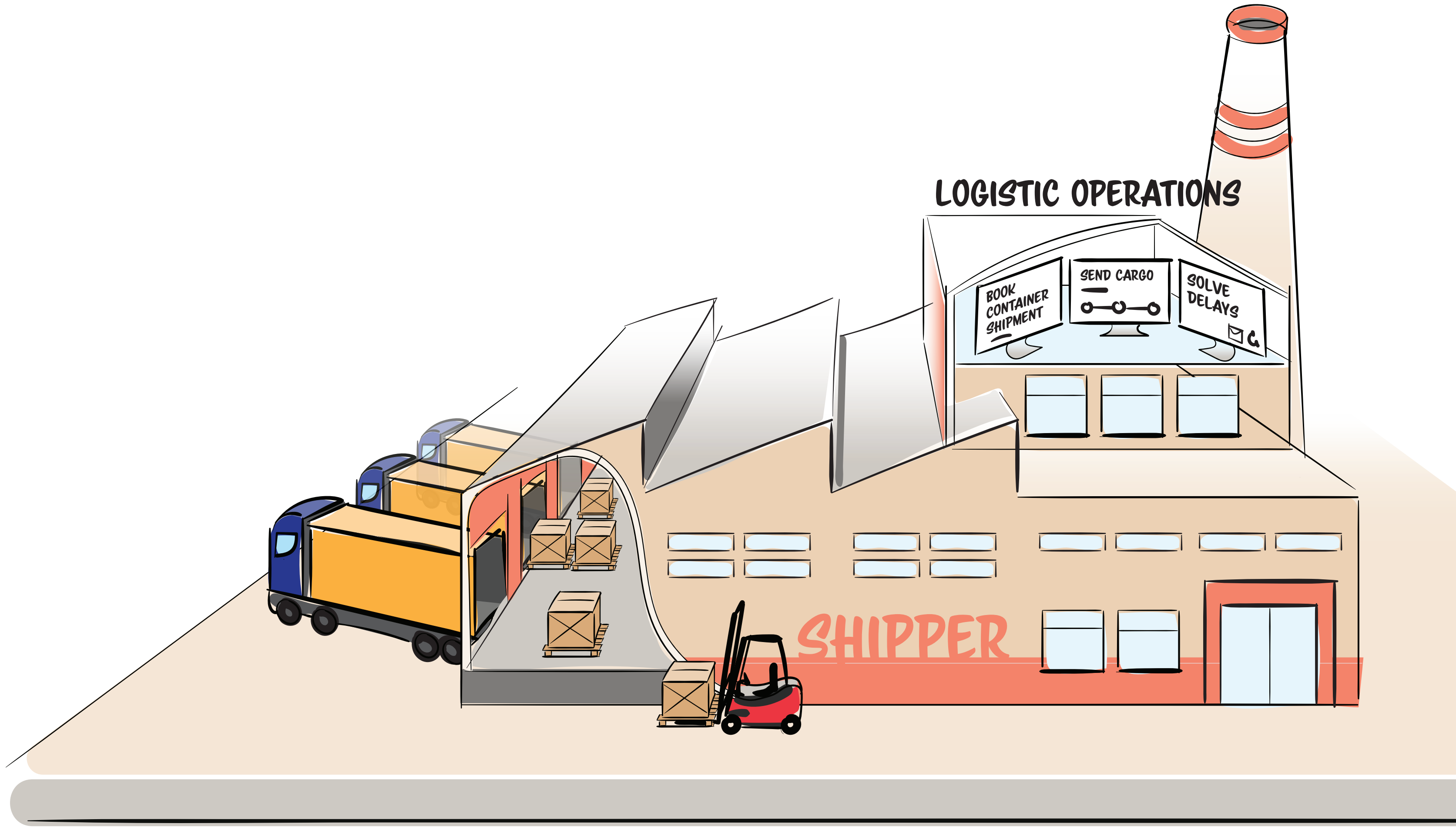
"DBS could maybe develop new products from a shipper centric approach" - Shippers & Forwarders (Port of Rotterdam ,2020f)

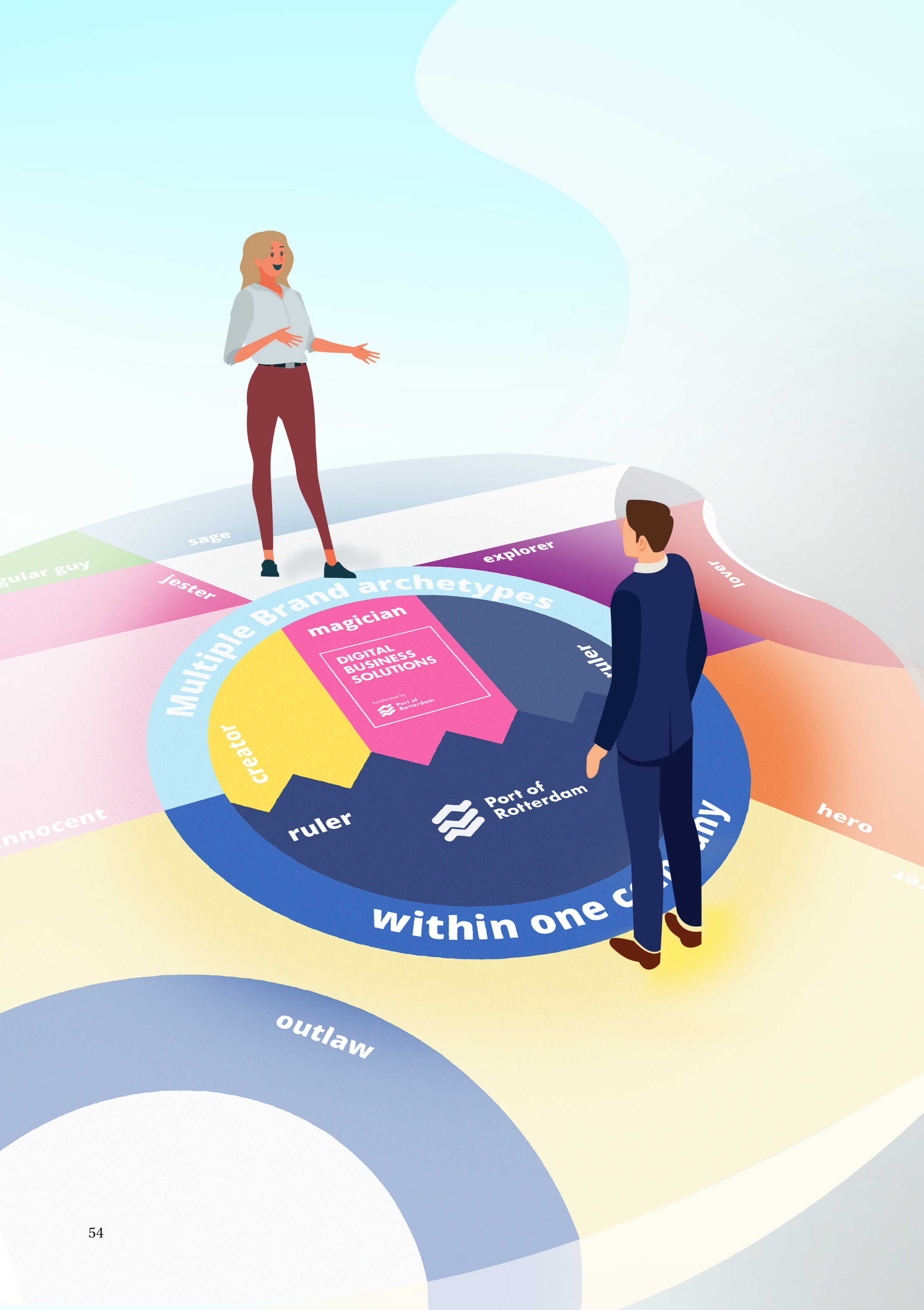
The commercial department was closely involved in the development and scale up of Boxinsider, so containers can be track and traced in the port of Rotterdam. Recommended was that DBS could innovate from a user centric approach in order to create direct value for clients.

*Shippers become relevant to PoR when they ship at least 1000 TEU or more via the port of Rotter-dam annually. Given port of Rotterdam's throughput of 14.8 mln TEU in 2019, the smallest relevant shippers are responsible for a tenth of a pro mille of this throughput (Port of Rotterdam, 2020f).

Conclusion

In a broad sense, the results found in literature and in the interview correspond. Where in literature there is argued that transport chain performance is the most important factor the interview confirms this, however calls this reliability. Also the focus of the interview has not been on the criteria price or costs, which is found in literature to be still the most dominant criteria. The emphasis of the interview was more on the satisfaction, reputation and flexibility of the port and associated services, the importance of these factors are also recognised by Rezaei et al. (2019), stating that this is perhaps even more interesting than the transport chain performance. That shippers and forwarders have a need for more data about their containers in line with Heilig, Schwarze and Voß (2017), that stated that customers nowadays also increasingly demand value-added informa-tion services, in order to get a better insight into their related processes. What is not present in literature is the attitude of shippers and forwarders towards sus-tainability, and that this might also become an increasingly important criterion. From interviews it became even more apparent that shippers and forwarders have large information need, which at this moment is not met. What is missing is international data about their cargo, e.g. that they want to know if their exported cargo is arrived in another port after it was shipped from Rotterdam. For the platform there is focussed on shippers. Shippers are also one of the decision maker in port selection, creating added value for this logistic chain player could also influence the competitive position of the port of Rotterdam and thereby contribute to the second growth strategy of PoR, attracting more troughput.





3.5 Two different brand archetypes within one company

DBS is part of PoR, however many differences between DBS and PoR exist. These differences sometimes lead to disagreements about strategy, vision and the contribution DBS' product have to PoR. In order for the platform to make it to the implementation phase, it is important that these differences are further ex-plored.

What archetype shows most similarities with PoR?

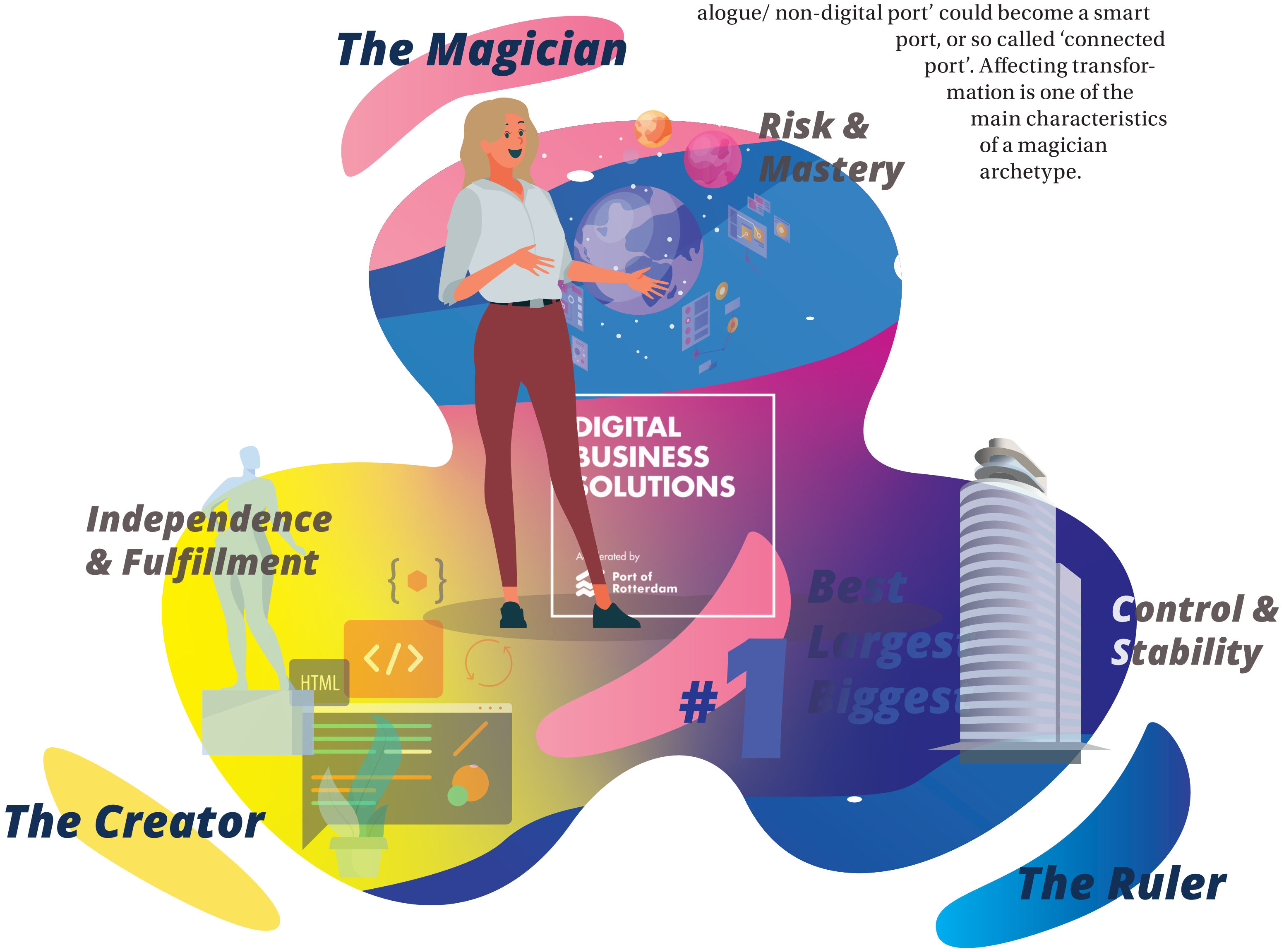
PoR is responsible for the safe, smooth, clean and secure handling of shipping and allocation of port sides for the port community, this fits an archetype which is at the control and stability pole of Mark and Pear-son's system. Most if not all characteristics of the Ruler archetype can be found at PoR, more information about the ruler archetype and corresponding characteristics can be found in Appendix K.
When looking from this branding theory perspective PoR, there can be seen that PoR shows similarities with a Ruler's call; provide resources, create order and harmony. There can even be stated that PoR is a level three ruler; being the leader in multiple port related communities. Over the years PoR has built exten-sive expertise in infrastructural projects and port management, and is among world's leading companies within this field. The compa-ny facilitates resources like physical infrastructure and its maintenance, pro-vides order e.g. controlling vessel traffic and determining policies and governance for the port and creates harmony between players is the port community by, for example, letting them communicate efficiently and save via a port community system. Because PoR has this role within its communities they can be seen as level three Ruler archetype.

Furthermore, PoR's performance for a large part is dependent on the performance of its clients who to-gether also form a community. When these clients do not cooperate well, this could lead to slower cargo handling or extra costs, and a decrease of the whole port's competitive position. So, for PoR is beneficial when these clients can function optimal. Therefore they have strong relations with their clients, know their client current needs and anticipate on future needs, a good example of this is the construction of Maasvlakte II. Also PoR's clients show loyalty and sign long them contracts with the company. Moreover, the company is known for being stable, orderly, and is associated with power, since it used to lead be the number one port of the world and currently the largest port of Europe, a position that PoR at all costs wants to maintain and enlarge.

Another characteristic is their impressive head-quarters that is located at a prominent location in Rotterdam, next to the Erasmus Bridge.
From internal observations there can be stated that PoR is a hierarchal organisation where most employ-ees dress formal. Also politics play an important role within and outside the company and aiming for con-sensus between departments and community and other players.

What archetypes shows most similarities with DBS?

DBS was observed in a simular way as PoR. Whereas PoR really fits the Ruler archetype, DBS does not embody such a clear one. However, also DBS owns a couple of characteristics that indicate a different archetype than PoR has. DBS was founded to develop new software, many companies in the software developing sector embody the creator archetype.
In addition, DBS developed its current products according to their own vision about how ports will grow digital. Their vision, the digital maturity model, comprehends a large transformation; how an 'analogue/ non-digital port' could become a smart port, or so called 'connected port'. Affecting transformation is one of the main characteristics of a magician archetype.



DBS the Creator

The creator is known for being the artist, writer, innovator, or entrepreneur that tries to tap into the human imagination. The innovator turns away from business as usual, using its unique ability to imagine a different way. Ultimately, they desire to create products so special that it will endure. This is something what is definitely one of the main drivers of DBS. During internal interviews there was explicitly stated that:

"PoR looks more at business as usual, whereas DBS tries to look at business as unusual in order to create new products to provide a new sustainable revenue streams here to stay for the coming decades"

– DBS (Port of Rotterdam, 2020i)

According to Mark and Pearson (2001), when looking at research and development, a Creator provides the impetus to develop new products and services. The employees of DBS show many similarities with the creator characteristics, many have a huge intrinsic drive to innovate and create new products which add value to their customers. They have an out-of-the-box mind-set and are given the freedom to develop new products in their own way as long the product quality is excellent.

DBS the Magician

According to Mark and Pearson (2001) Magicians can be known as the visionary, catalyst, innovator, charismatic leader or mediator. A Magician wants to find out the fundamentals of how things work and to apply these principles to getting things done. They want to discover ways to create and maintain prosperity and are looking for win-win outcomes. They invent products that make things happen. The Magician archetype can be found in companies who for example are involved in corporate change strategies and other transformative services or products. The DBS Lab, which DBS owns can been seen as a kind scientist laboratory where they experiment with new promising technologies like block-chain and machine learning.
DBS shows similarities with a Magician organisation, since an important aspect of DBS is that they tend to inspire and try to activate other parties so they will join the digital transformation. They do this by for example publishing whitepapers about future thoughts and how new promising technologies could change the current world. Because DBS believes this digital transformation cannot be done solely.

"A connected port is needed because of the network effect, digitising you do together, alone you can't make the difference and make it happen"

- DBS (Port of Rotterdam, 2020e)

DBS also promotes a kind of magical future state. They promote that every ports can become a smart ports, or connected port. And if they are a smart ports they will be part of transparent door-to-door logistics and can make use of port call optimisation like just in time sailing.

DBS the Ruler

Still there can be seen that DBS incorporates characteristics of the Ruler archetype. This might not be a surprising discovery, since they were founded only two years ago, originating from a typical Ruler company, PoR. Some of their developed products help individuals to become wealthy, more powerful, and better established in their fields and communities, like the Ruler archetype. To make this more explicit, for some products DBS also offers a series of workshops and consultancies in order to help other ports to become digital. In this workshop their current workflow is mapped and a new digital purposed workflow is which would fit with DBS's products. The customers, most of the time much smaller ports, are very eager to learn from the 'great' Port of Rotterdam. Thinking by themselves: "If this is the way it works in Rotterdam, it will definitely work in our port." So, there is a large sense of authority, which makes it easier for others to follow. Hereby, DBS is maybe even unconsciously a role model of proper behaviour and are enforcers of the status quo. With DBS's products and corresponding workshops is, it is involved in setting standards and direct how things are done. For DBS the Ruler archetype might be hard to separate from since DBS always operates under the PoR brand since for the outside world they are seen as one.

DBS; the creator, the magician and the ruler.

DBS embodies characteristics of several different archetypes; the Creator, the Magician and the Ruler. This makes them different from PoR, since PoR is mainly perceived as a Ruler archetype. A more elaborated analysis can also be found in Appendix J.

So why is it be important to know to the archetypes of PoR and DBS? As earlier described the founding of DBS lead to a hybrid organisation, however due to the pivot in strategy DBS is brought back to the task organisation. According to Brandsen et al. (2009), the combination within hybrid organisations can create opportunities due to synergetic effects, however could also lead to risks when tensions would arise due to the combination of conflicting characteristics within one organisation. This is supported by Mark and Pearson (2001), that frictions could arise from a collision of archetypal values. They illustrate this friction with an example in the medical field where the insurance companies govern managed care and embody the Ruler archetype. Whereas most medical service providers tend to be Sages, Magicians, or Caregivers. Therefore, they have different values than the insurance companies. The resulting friction comes from a collision of archetypal values.

To make this more applicable to PoR and DBS another example is given the political character of a Ruler archetype and its search for consensus, is very appropriate in situations where neither a fast response nor high-level innovation is required. But the downside of this is that they are very slow to act. In software development the pace of innovation is much higher than in other sectors. This includes making fast decisions in order to be efficient in your development and be one time when new opportunities rise. Therefore, there will probably arise friction between the entities about the pace of decision making. When looking from an archetypical perspective to the original strategy of DBS, PoR and DBS could maybe have known beforehand that frictions would arise between the two entities. The full review of the original strategy for DBS can be found in appendix L.

By knowing each other's archetype, PoR clearly embodying the Ruler and DBS embodying a mixture of the Creator, Magician and Ruler, one could anticipate on expected behaviour and decisions of both entities. For example, one might evaluate if a purposed new product idea would lead to encouragement or resistance from the other entity. So, the in the design of the platform both entities archetype(s) must be taken into account and it should have a fit with their main values in order to avoid future frictions internally.

Chapter 4

The design the data platfrom

This chapter describes the designed platform for the company and discusses the desirability, viability and feasibility of such a platform. Furthermore, it describes how the design can be implemented and fits the company.

4.1 The design scope

When DBS would like to innovate in the area of international cargo data exchange, the solution has to overcome the implications concerned with this innovation area. So, is there an approach or a way DBS could use to include the parties who are responsible for the data supply and make it more likely that they would join and accept this innovation? And how will this innovation eventually contribute to more container throughput in the port of Rotterdam.

Data suppliers: logistic chain stakeholders

As earlier described PoR does not own or generate cargo data themselves. Therefore, data suppliers need to be connected to the platform. These are the parties which are also part of the physical container flow, like the container terminals located in the port of Rotterdam. Given the tremendous amount of ports and hinterland terminals the port of Rotterdam is connected to, the platform proposed in this thesis is only focused on a specific part of the logistic chain: between the hinterland terminals in the hinterland of Rotterdam and the short- and deep-sea terminals outside of Rotterdam, as illustrated in figure 4.1. The essential data supplier needed to track and trace a container in this part of the logistic chain are hinterland in the hinterland of Rotterdam, terminals located in the port of Rotterdam and deep- or short-sea terminals outside the port of Rotterdam. Normally, carriers are also involved in this part of the physical container flow, however it is not needed to connect carriers to the platform, since the track and tracing of a vessel can be executed by an application build by DBS, the AIS engine. This application is based upon real-time AIS data, which is bought by DBS from other parties, and is used to determine a vessels location and predict on what time a vessel will arrive.

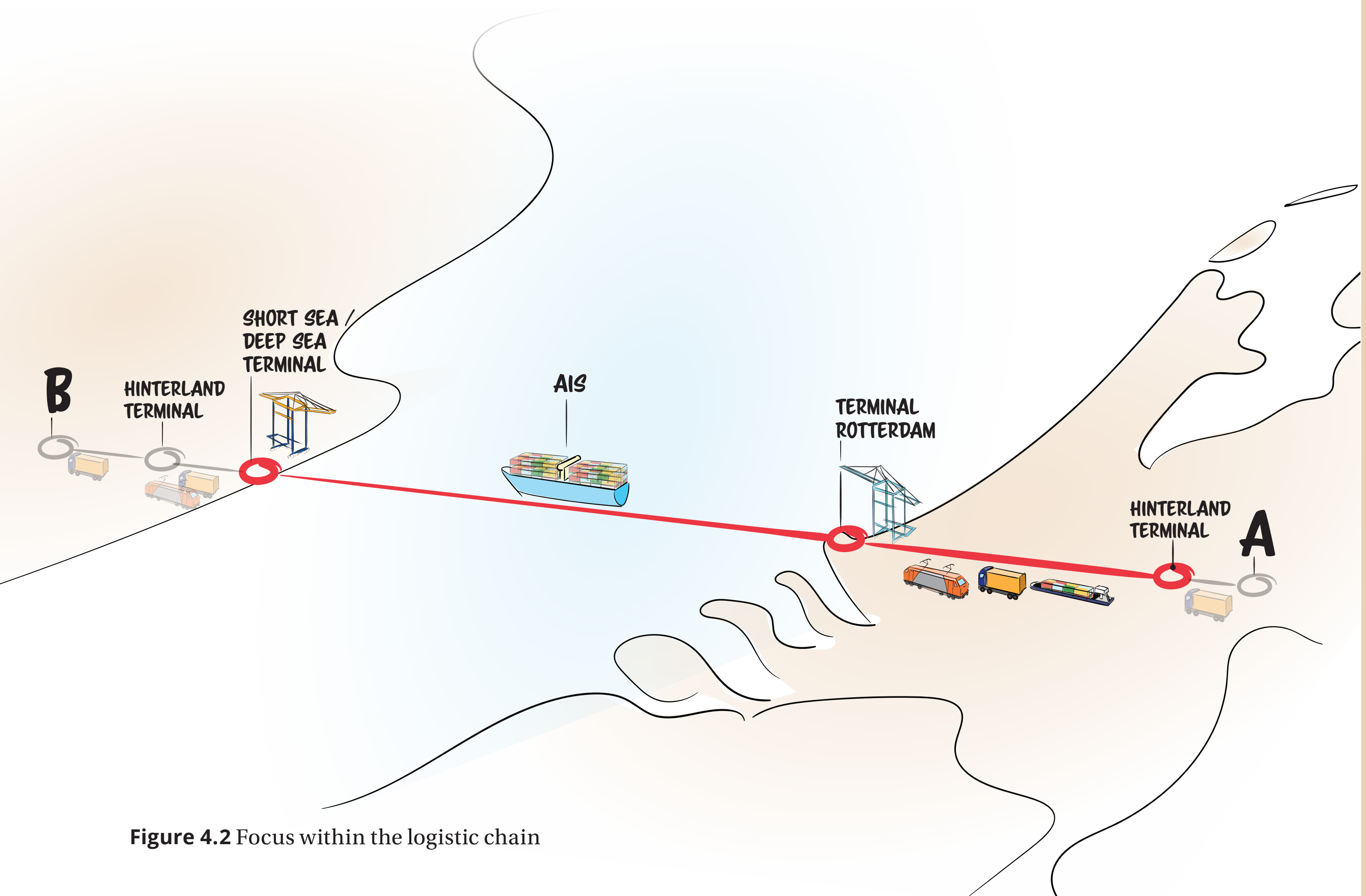


Figure 4.2 Focus within the logistic chain

Earn a data supplier's trust

Without the trust of the data owners the platform has no chance of becoming successful. Most of the implications that come with international data exchange mentioned in chapter 3, originate from the companies that own the data, the data suppliers. Moreover, these implications mainly boil down to a lack of trust in either the technology, business model or company behind the platform. Therefore, there has been a strong emphasis on designing for trust in the design phase of the platform. Yet, how does one design for trust? From literature there was found that trust is affected by three trust factors and four credibility dimensions. These factors and dimensions were derived from a model about online trust of Corritore, Kracher, and Wiedenbeck (2003), that has been extensively applied to web design in e-government, e-commerce and e-banking. They identified three trust factors: users' perception of technology's credibility, ease of use, and risk. The four dimensions of credibility include: 1) honesty, meaning well intentions, truthfulness and unbiased actions, 2) expertise, defined by knowledge, experience and competence, 3) predictability, the expectation that a product or technology will act consistently based on past experience and 4) reputation, based on recognized past performance.

The trust factors and credibility dimensions can be transformed into design requirements in such a way that these add to the trust and credibility position the platform.

The platform:

- Makes use of a credible technology
- Offers ease of use
- No or low risk should be considered with the use of the platform
- Is honest or considered fair
- Is of good or high quality, in order to reveal the company's expertise
- Functions stable and is reliable
- Uses the reputation of other products as past performance

Tactical direction

One of the most important implication to overcome is that no different interests are present between parties who are involved in the platform. So how could PoR convince data suppliers to join the platform? And how will this platform eventually contribute to more container throughput in the port of Rotterdam?
From literature and interviews there was found that the data demand of shippers in the Rotterdam hinterland is currently not met. Especially international data about their cargo is entirely missing or fragmented information can be found at different online platforms or derived by calling individual parties, so there is a demand for international cargo data that is available on one platform. Furthermore, data suppliers, are willing to share data to parties that are involved in the same port call, however they prefer not to share data if they are not involved in a common call (PortXchange, 2020). Therefore, a platform could be developed that facilitates data exchange between data suppliers and data demanders, shippers. PoR and the data supplier both have the same goal to serve their shippers in the best way they can, so these shippers will make use of the port and services for their shipments. What PoR and data suppliers have in common is that they share some of the same shippers, so called 'common shippers', shippers that make shipments via the port of Rotterdam and the data supplier. For example, a large international beer brand ships over 100.000 containers a year via the port of Rotterdam, almost half of those containers are destined for the port of Houston, United States.
This shipper is a common shipper of both PoR and the data supplier, a container terminal in Houston, so there is no different interest between PoR, the data suppliers and the common shippers.

A platform can be developed by DBS that facilitates the cargo data exchange between data demander and data supplier. Digital connections between data suppliers and the platform can be developed around the needs of common shippers. This way a part of the supply chain of these shippers can be made transparent, which improves customer satisfaction.

"Our right to exist is based on customer satisfaction." - Port of Rotterdam, Annual report (2018), p.44

"Our ambition is a fully digital and transparent supply chain, where every party involved in the chain has access to data about the status, location and expected arrival times of their cargo ."

- Port of Rotterdam, Annual report (2018), p.44

Figure 4.2 illustrates how the three parties interact. According to the interview with S&F (Port of Rotterdam, 2020e), shippers become relevant to PoR when they ship at least 1000 TEU or more via the port of Rotterdam annually. Given port of Rotterdam's throughput of 14.8 mln TEU in 2019, the smallest relevant shippers are responsible for a tenth of a pro mille of this throughput. Therefore, it is assumed that shippers relevant to other ports contribute to at least tenth of a pro mille of the ports total throughput. W

"DBS could develop products from a user centric approach"

- Shippers & Forwarders department- (Port of Rotterdam, 2020f)

The main function of the platform is to facilitate data exchange between the data supplier, in this case the other port's terminals, and the shipper who owns the container and is interested in the information about the container. One of the implications found in chapter 3 is that there is a large difference in digital capability and maturity between parties, so it is not likely these parties could set-up this connection on their own. Moreover, there is dealt with sensitive real-time data, so it is important that the connection between parties is stable and secure. It is hard to cover stability of the connection, when both parties would only buy the product once, and thereafter carry the responsibility for this themselves. So, if in this case a default in the connection would occur it is hard to say which party is responsible and who has to fix the problem and in what time frame it should be fixed. Therefore, it is more logical to develop a platform, where aspects like maintenance, connection set-up, use of servers, connection security and stability and more is are arranged by PoR and DBS, the service provider.

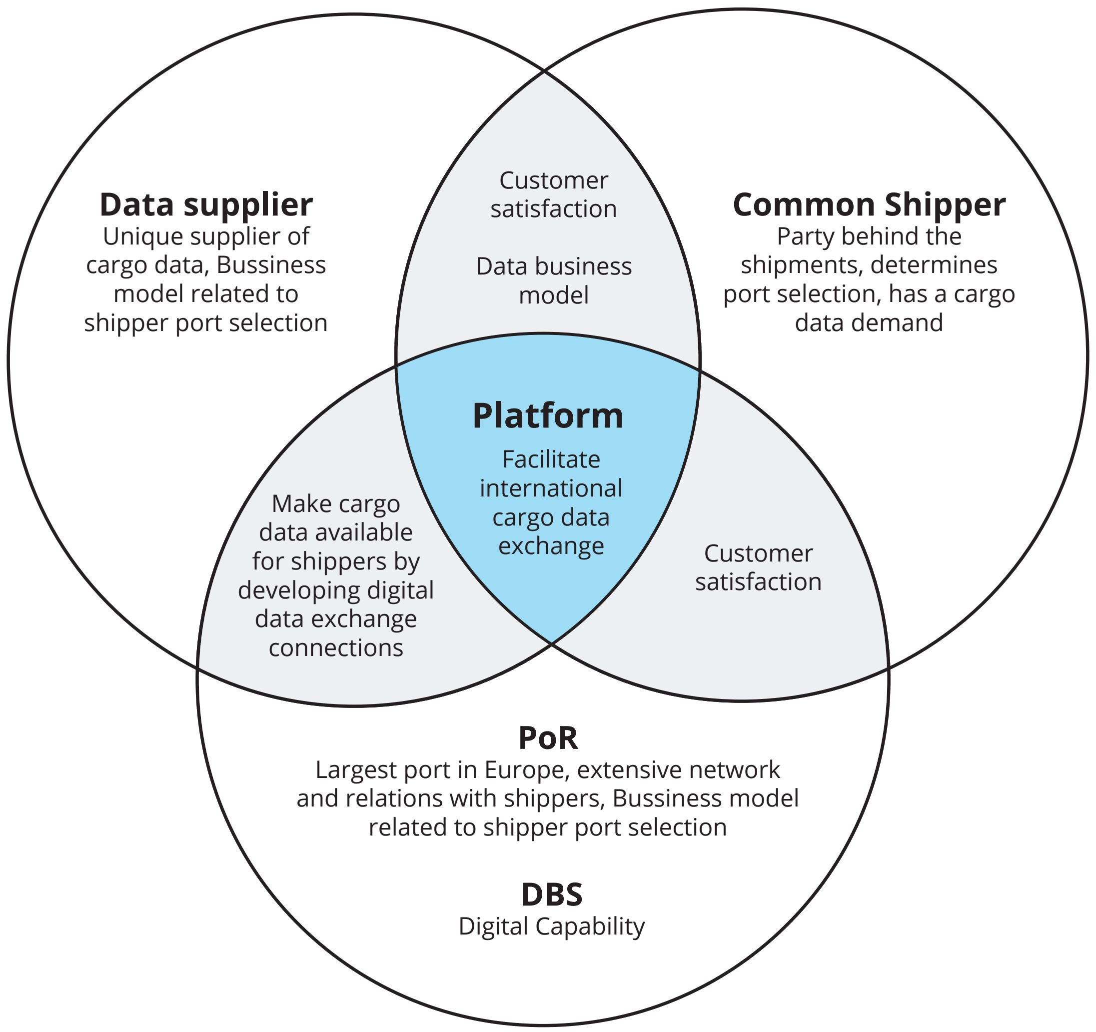


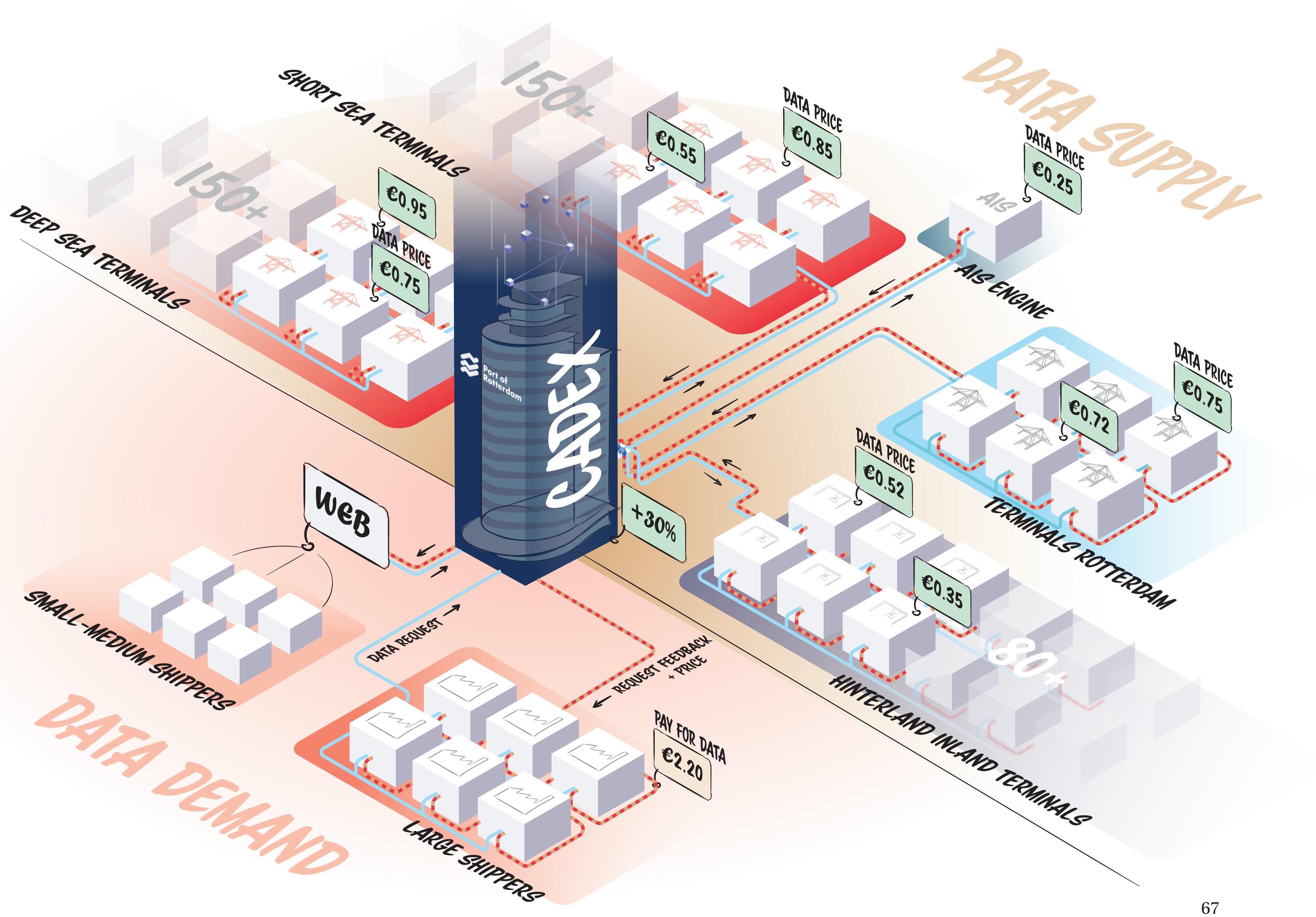
Figure 4.2 Interaction between involved parties

4.2 Proposed design

Cadex (Cargo Data Exchange)

The design of a cargo data platform was ideated and validated in an iterative way, using input from interviewees (Port of Rotterdam, 2020k, 2020l, 2020m, 2020n, 2020o, 2020p; Portbase, 2020c), the used visual communication object can be found in appendix F .

Cadex is a platform that matches the cargo data demand from shippers with data from data suppliers, that generate this data when a container comes past their terminal. The parties at the data demand side, shippers, pay for the data and usage of the platform. The parties at the data supply side get paid for the data they provide. All parties connected to Cadex have a verified account. Shippers can obtain historical, real-time and predictive data about their containers, e.g. terminal gate-in time, real-time location and status and predicted time of arrival of the vessel a container is loaded on. The data is accessible for shippers through two different solutions, an application programming interface (API) and web version of Cadex. The data is derived from the parties who generate this data, the data suppliers of the platform. These parties and technologies essential to track and trace a container from hinterland terminal to deep- or short-sea, or the other way around, are connected to the platform on the data supply side. All parties are able to ask a self-determined price for their data. The prices are also visible to the shippers, so they know what a specific request will cost beforehand. Shippers pay per request and data suppliers receive a payment for each data feedback they provided. Figure 4.3, gives an overview on how Cadex matches data demand with supply, what connections are made and what is exchanged. To elaborate more on figure 4.3, a scenario has been used to show the different steps within the data exchange process. This scenario has been split up in different steps.



Scenario

Before the physical flow of a container is executed, it is necessary to know when and which parties are involved until the container reaches its destination, this also includes what vessel it will be loaded on. This information is needed, so the platform can make data requests to the right data suppliers. Shippers who make a booking for a shipment of a container derive this information beforehand. So, by sharing this information with Cadex, there can be determined where to request data and what vessel must be tracked. This brings us to the first step.

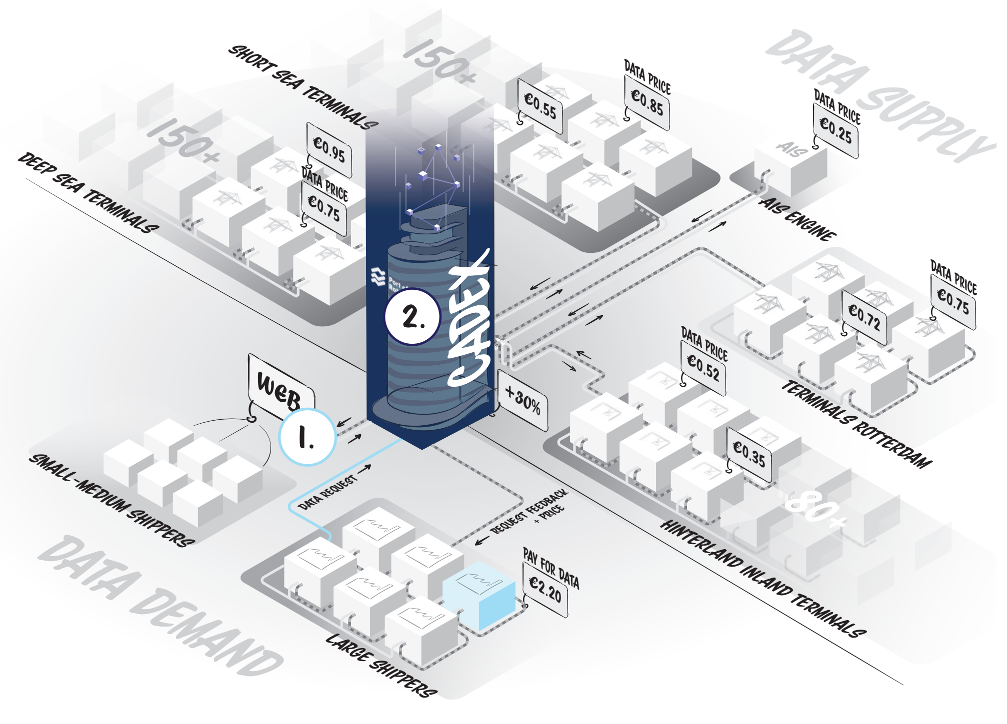


Figure 4.4 Data Request is send to Cadex

Step 1: The shipper sends a request to Cadex

The request consists out of two aspects, the technically required specifications and the desired feedback specifications. The technically required specifications are e.g. the container number, vessel id, etc. needed to track and trace the container. In the desired feedback specifications, there is specified what data will be requested to the suppliers. Shippers are free to choose which kind of data feedback they desire from the suppliers. The request can be send by filling in certain fields on the web version. For large shippers that sometimes ship hundreds of containers a day, Cadex offers an API where requests can be send automatically from out their own systems.

Step 2: The request is handled by the Cadex.

The platform registers the shipper's request as an object upon which data can be stored and added to, so the feedback of the suppliers can be registered on the related container. Furthermore, the request is translated into a data supply request.

Step 3: Cadex sends the request to the right suppliers.

The data supply request is send to the right data suppliers. For example, in case of a container that is exported via the port of Rotterdam to a short-sea port, the data supply request is send to the involved hinterland terminal, the terminal located in Rotterdam, the AIS engine to track the vessel and short-sea port. This process is illustrated in figure 4.5.

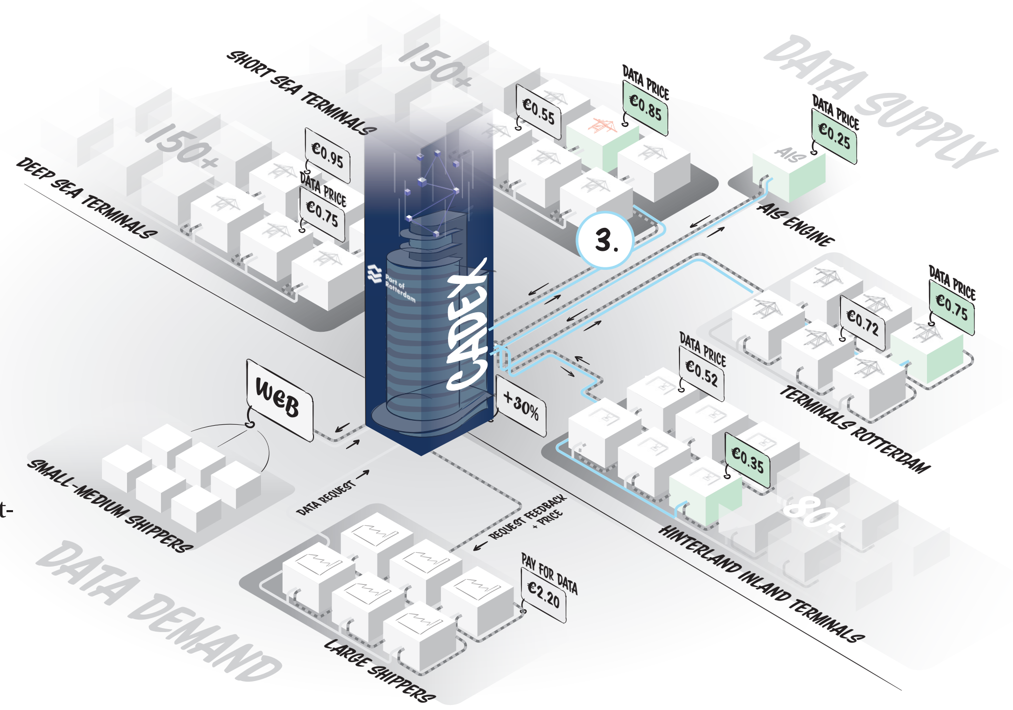


Figure 4.5 Data request is sended to data suppliers

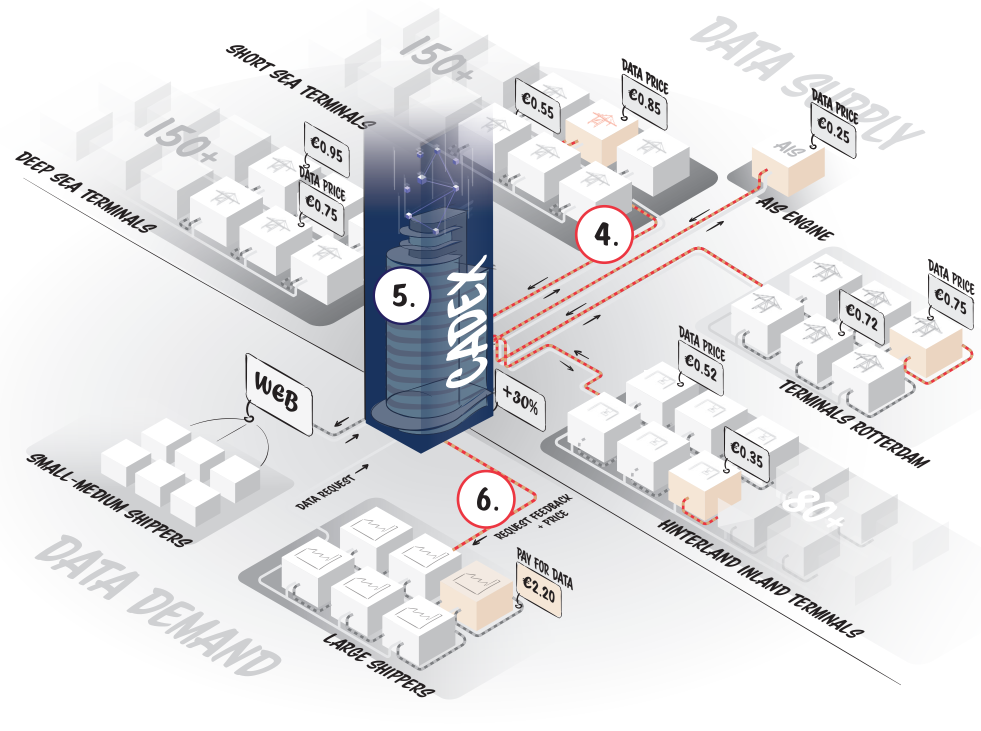


Figure 4.6 Data request feedback is send to Cadex

Step 4: The supplier provides the data feedback.

The data supplier retrieves the data supply request and returns the feedback data to the platform. Cadex offers an API for the data suppliers where data supply requests and data feedback can be send and exchanged automatically. More information about this step is described later on. The feedback data can be historical, real-time and predictive data about the corresponding container. See figure 4.6.

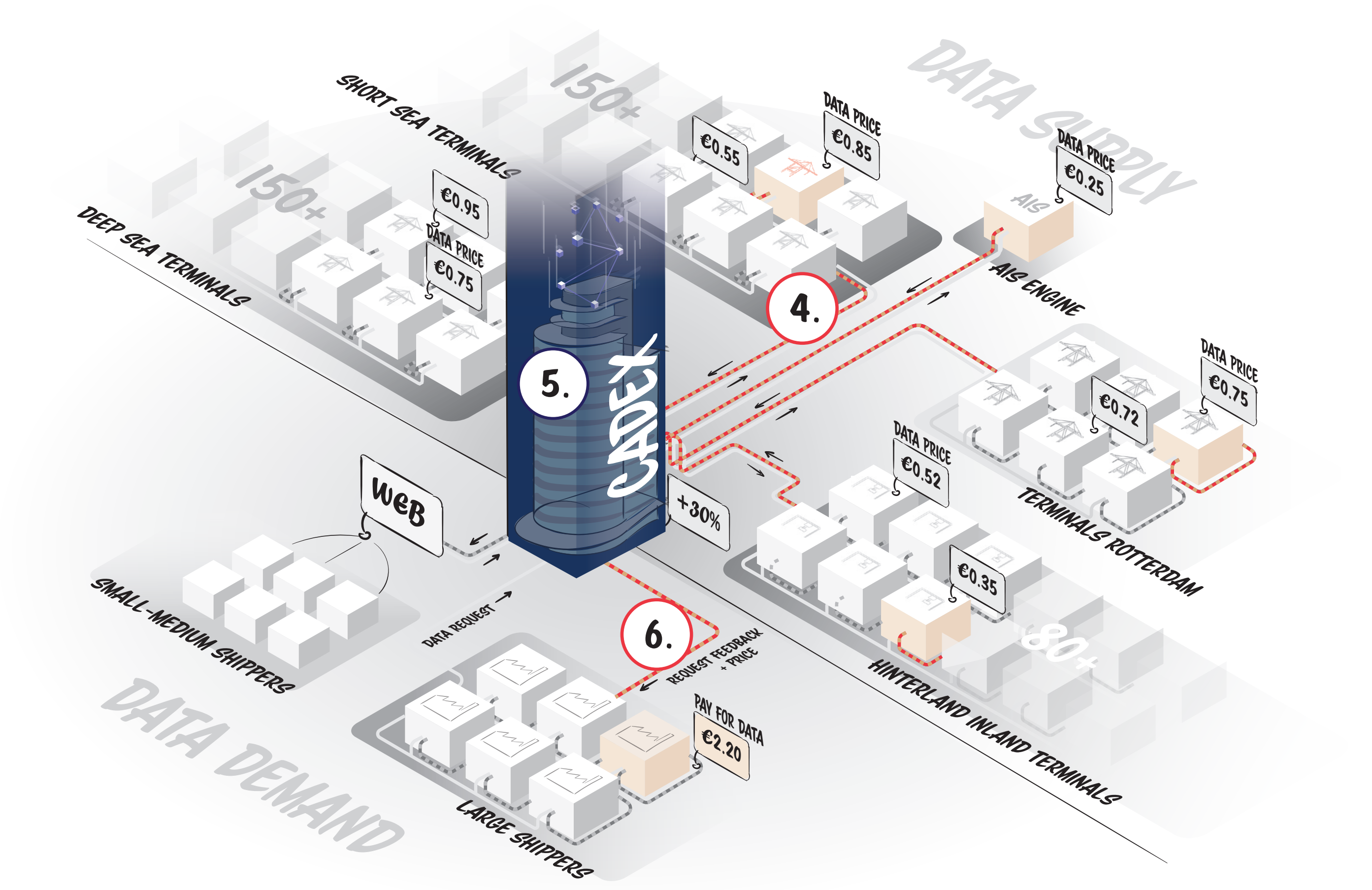


Figure 4.6 Data request feedback is send shipper

Step 5: The data feedback is handled by Cadex.

The data platform receives the data feedback from the suppliers and collects and stores this data on the related registered request of the shipper. Furthermore, the price of the data is calculated by adding up data prices of the suppliers. During this process, an extra amount of 30 percent is charged upon the price of the data suppliers, for the use of Cadex.

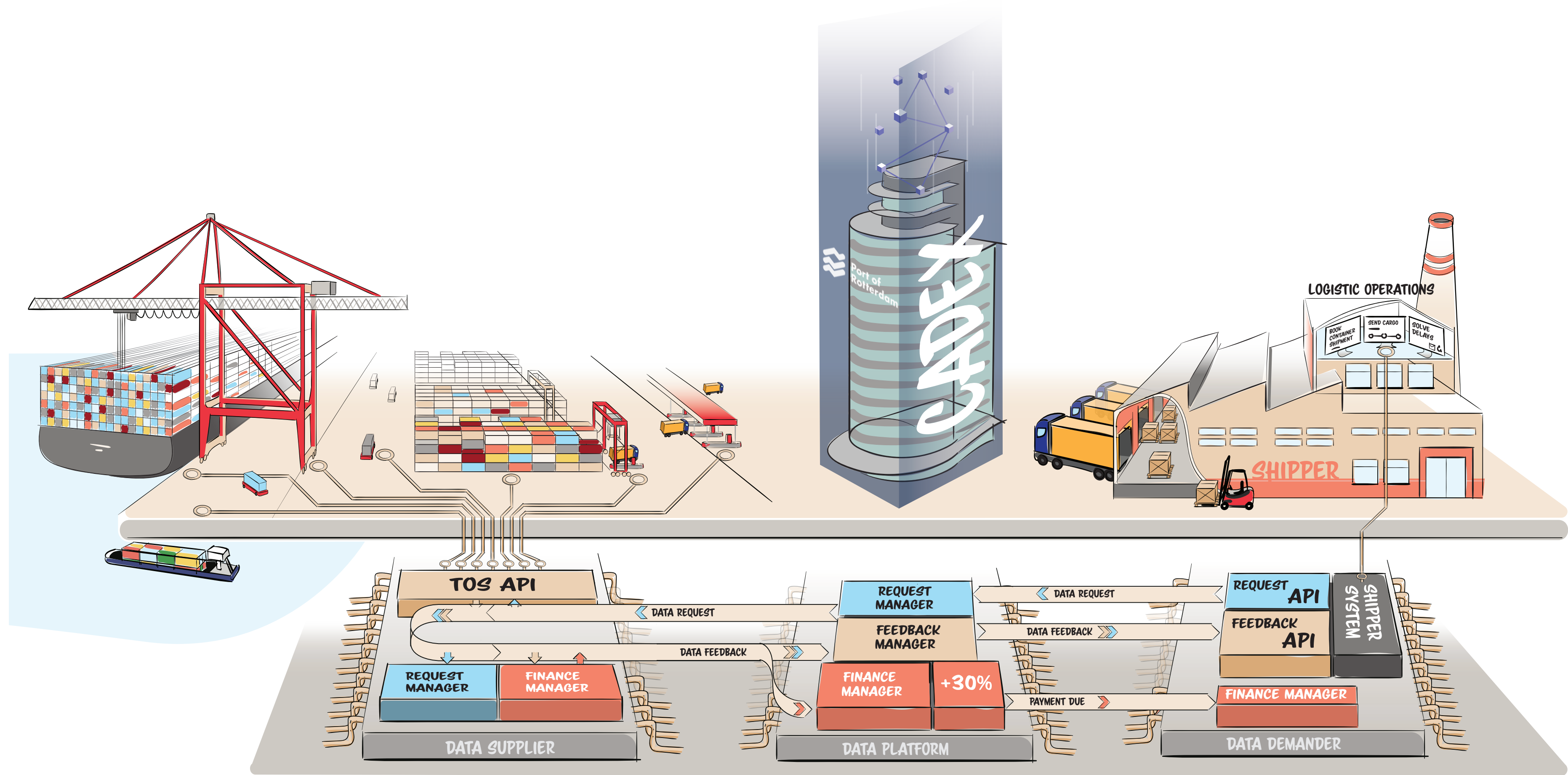
Step 6: The feedback data and payment due is send to the shipper.

The platform sends the feedback data together with the costs to the shipper. For shippers that make use of the web version of the platform the feedback data is displayed in a graphical overview, the related payment due can be viewed in another tap. Large shippers receive the feedback data and related payment due via the API. This 'raw data' they receive is used as input for their own systems.

(Step 7. Payments arrangements)

Once a month an invoice will be send by PoR to the shipper in order to receive the payment due(s) for the requested data. The money is subsequently distributed to the data suppliers who provided the feedback data.

In the following paragraphs Cadex is described in more detail from three different perspectives, the data demand side, PoR side and data supply side. Furthermore, the platform's architecture and necessary connections are described in the feasibility paragraph (page 76). More information about the benefits for the shippers, data suppliers and PoR are explained in the desirability paragraph (page 78). The viability paragraph elaborates on the business model, costs, expected revenue and company fit (page 80). After this paragraph there is described how Cadex solves the trust requirements, mentioned earlier.



4.3 The data demand side of Cadex

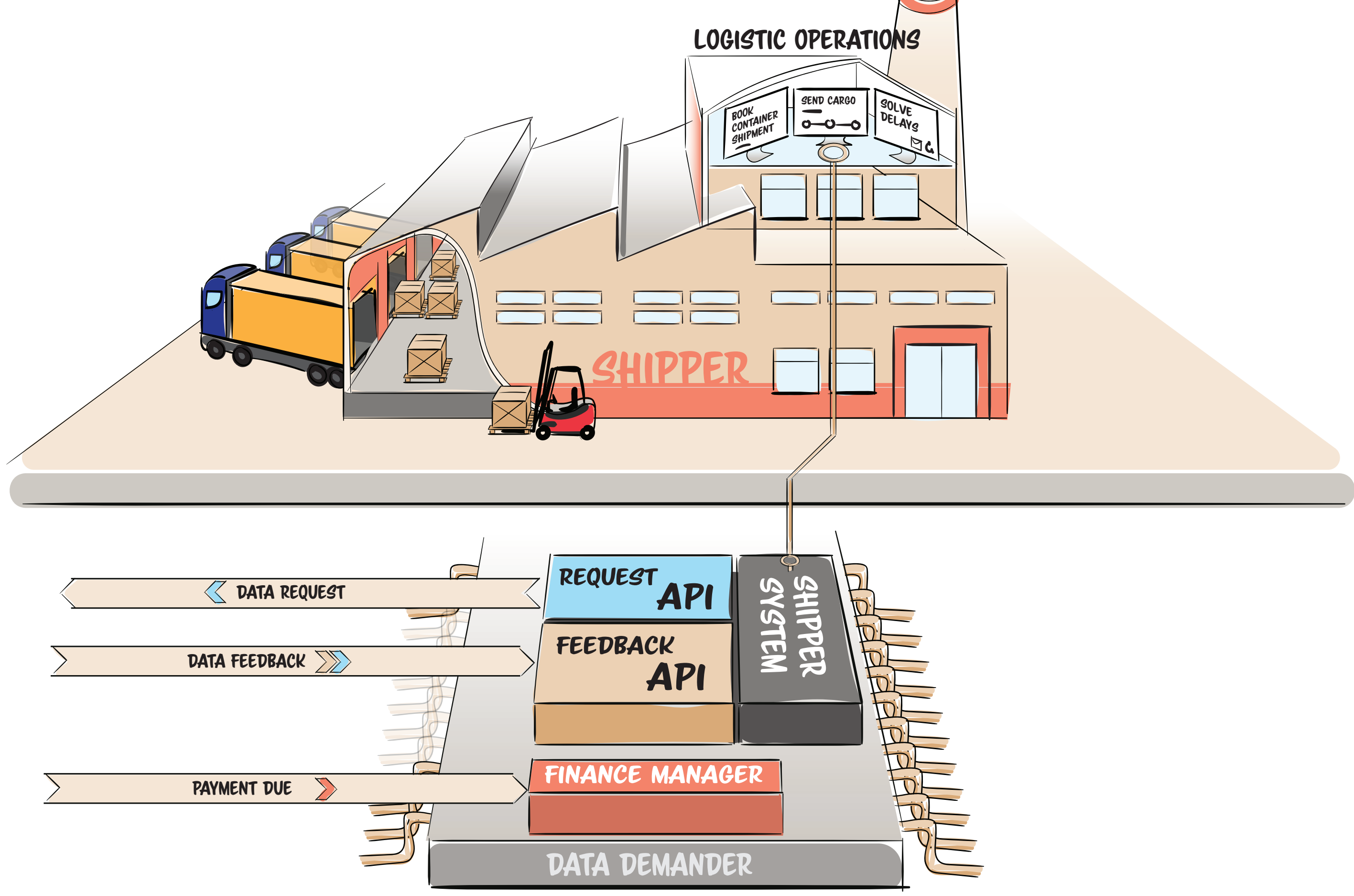
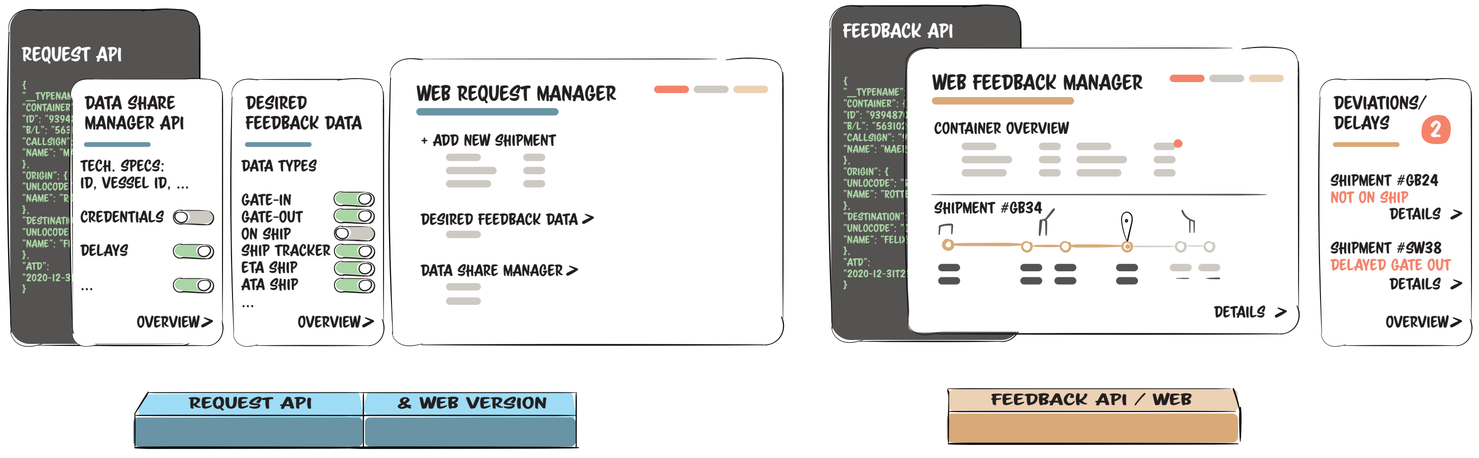


Figure 4.7 Data demander connection to Cadex

As earlier described; shippers who book a shipment, derive related information about this shipment beforehand, this data is present in the shipper's system. Figure 4.7 gives an impression about how the physical processes of a shipment and what digital processes and modules are related. Part of this booking information is essential for the platform in order to track and trace the container. So, these essential technical specifications must always be shared with Cadex. Other data that can be shared could be additional information about the shipments like credentials of company, the deviations and delays of shipments and more. This additional information is interesting for parties like PoR and the data suppliers to receive. One can compare this information with the well- known cookies a customer accepts when visiting a website. The website owner can use this data to get a better insight about its customers and their preferences. Just like the cookies for a website owner, the additional information could give PoR and data suppliers a better insight about their clients and might also use the information to improve the processes for this client. To make sure the additional information does not cause any liability issues, no real-time information is included only historical data will be considered.

Nevertheless, it is not sure whether all shippers are willing to share this additional information. Therefore, a data share manager (DSM) is used, that enables shippers to set the data that is being shared to the platform. DSM's are already in use in port of Rotterdam's PCS. PortBase enables users to filter the data they share with Cadex and can decide which party is



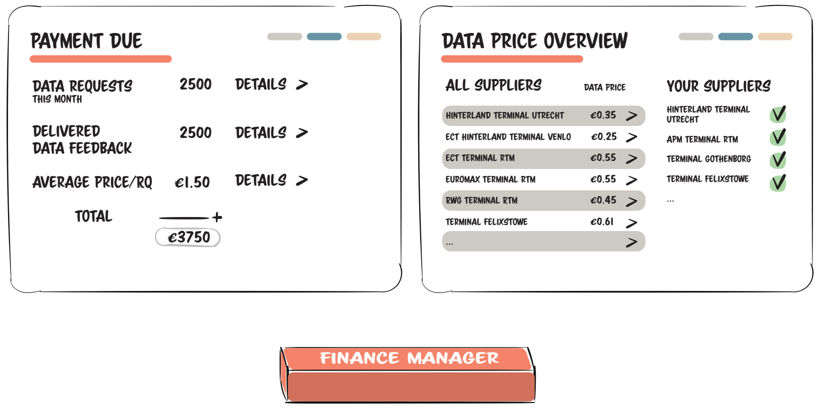


Figure 4.8 Data demander dashboards

allowed to access what data (Portbase, 2020c). Furthermore, shippers can set the desired feedback specifications, where they specify what data will be requested to the suppliers. Cadex works according a no use, no pay principle, so shippers only pay for data they want to receive. Shippers are free to choose which kind of data feedback they desire from the suppliers, since not all shippers are interested in the same data types. During the start-up phase of Cadex it is likely that basic status updates e.g. the gate-in or out are available. Most shippers are interested in all these basic updates, so why should this desired feedback tool be integrated into the platform? The tool comes in handy, whenever more specific data types also will be made available e.g. container temperature of cool-containers, this data type is only interesting for a small part of shippers. The settings of both the DSM and Desired Feedback tool can be changed at all times, the saved preferences are automatically applied to all request, however can also be applied on individual requests, an impression of both tools can be seen in figure 4.8. The required technical specifications, additional information and desired feedback are send as a request to the platform. Small shippers can send these requests by filling in certain fields on the web version of the platform. For large shippers, that some times ship hundreds of containers a day, Cadex offers an Request API where requests are send automatically from out their own systems.

Whenever data feedback is received from the data suppliers, it is made available to the shippers. For shippers that make use of the web version of the platform, the feedback data is displayed in a graphical overview. There all shipments are listed, details about shipments can be viewed and deviations and delays are automatically recognized and translated into notifications, so shippers can act fast upon this information updates. Large shippers receive the feedback data via the Feedback API. This 'raw data' they receive is used as input for their own systems.

The payment dues that are related to the feedback data can be viewed in the finance manager. Payments are not done directly after receiving a data type, in order to prevent high transaction costs and to keep it organized. Therefore, an invoice will be send once a month to the shipper to pay the amount due. The platform ensures that the payment will go to the right suppliers. Shippers know the asked prices of the data of suppliers beforehand, and no misunderstandings will arise afterwards. In the data price overview, all data suppliers can be found and what they ask for their data, specified per data type. In the 'your suppliers' tab shippers can view suppliers that are related to their requests and accept their conditions. If a shipper does not accept a data supplier's conditions, this data will not be requested and paid for. Again, these settings are applied to all shipments. When a supplier changes their asked price(s), this change is not immediately applied to the platform. First a notification will be send, so all data demanders that had already accepted the previous conditions are notified and have a fair chance to view and accept new conditions. After a reasonable time, ca. a week, the change is applied to the platform.

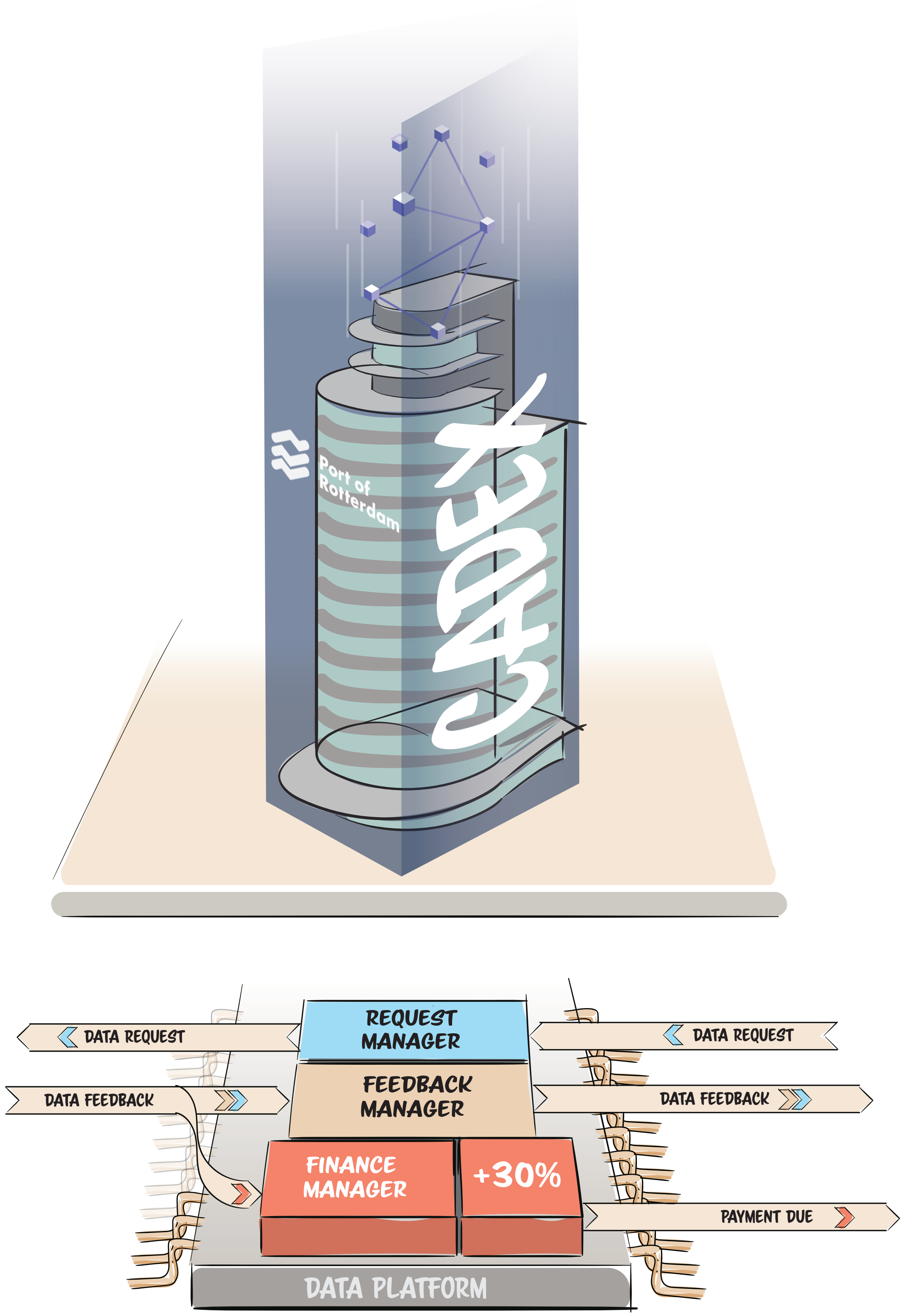


Figure 4.9 Modules inside Cadex

4.4 Cadex for PoR

Figure 4.9 gives an impression of the digital processes and modules are included in the platform. As earlier described in the shippers scenario, the platform has to register a data request as an object upon which data can be stored and added to, so the feedback of the suppliers can be registered on the related container, this is done in the request manager module. Furthermore, this module translates the technical information, additional information and desired data feedback preferences of a request this into a data supply request that can be send to the right data suppliers that are involved in the physical flow of a shipment.
The data feedback module receives, collects and stores the data feedback of the suppliers on the related registered request of the shipper. It also compares if the feedback data deviates from the original schedule of a shipment and if so makes it into a notification. Subsequently, this module makes this data available for the shippers on either the web version or the data feedback API.
The finance manager module matches the delivered feedback data with the by the supplier set asking price of the data types. Next, it adds together all the individual prices into a subtotal amount for the request. Upon this subtotal amount an extra thirty percent is added, which is further explained in the viability paragraph. This total amount is send as payment due to the shipper.

In order to manage all the connected parties, Cadex offers a couple of dashboards where all parties can be viewed, accounts can be managed e.g. accounts can be verified, added or deleted, changes made by parties can be accepted and payments can be arranged. These dashboards are shown in figure 4.10.

In another dashboard the additional information shared with PoR can be viewed. This historical data could be very valuable and exported to be analyzed in order to gain more knowledge about PoR clients, the connections they use and problems they phase during shipments. The information could be input for improvements in the port of Rotterdam. When for example a certain sea-side connection is often delayed, PoR could decide to research this problem and improve the connection.

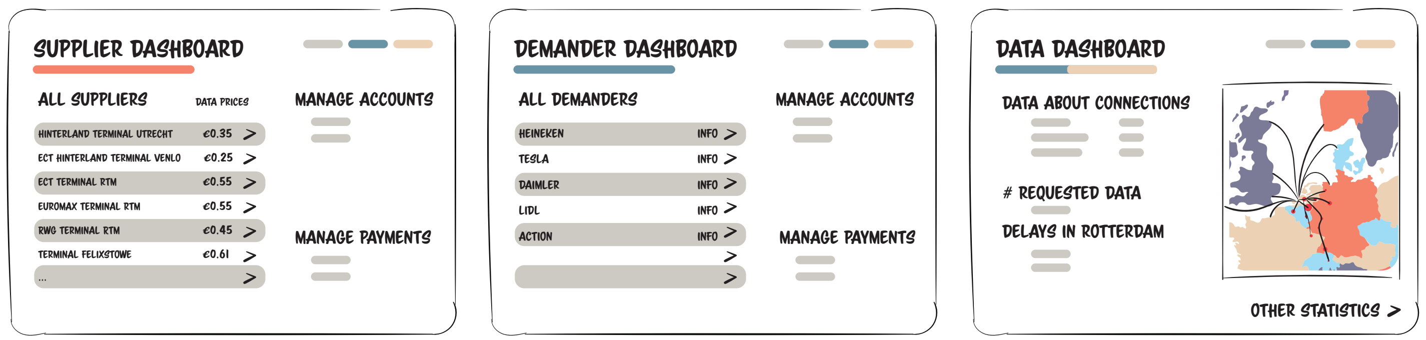


Figure 4.10 PoR's dashboards

4.5 Data supplier side of Cadex

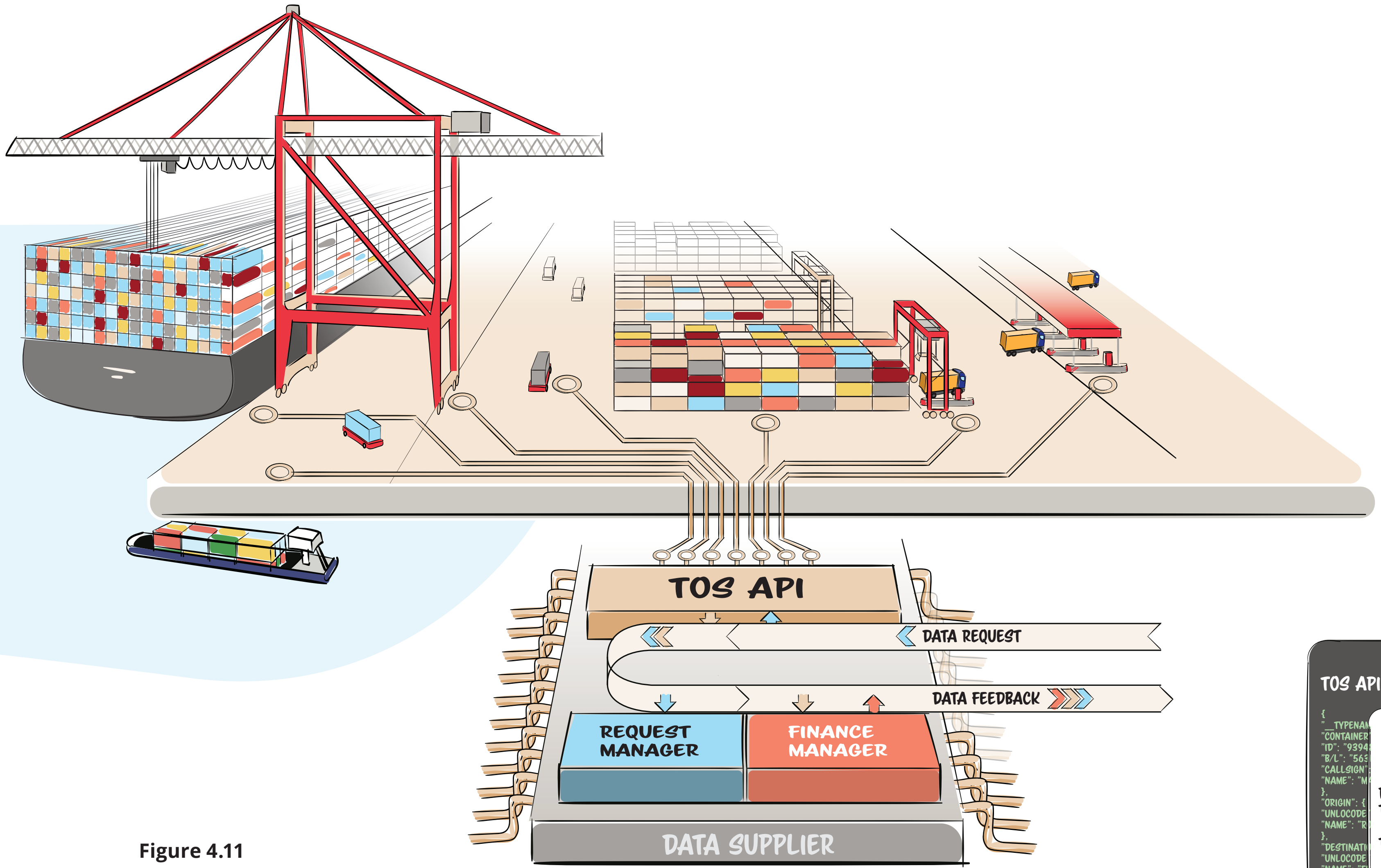


Figure 4.11
Data supplier connection to Cadex

Figure 4.11 gives an impression about the digital processes and modules that are included in the data supply side of the platform. The cargo data that is generated on the terminals is saved in their terminal operating systems (TOS). This data, together with other data they receive from external parties, terminals know exactly where each container has to go to, where it should be placed, what ship or truck it is planned for, etc. Most of this data is very sensitive and terminals are often not willing to share all of it. Therefore, the TOS API module also includes a DSM that enables the terminals to filter the data that is allowed to be shared to the platform. When the data supply request is received, there is checked whether this information is present in the TOS system, if so the allowed data types about the corresponding container are send back as feedback data.

Just like PoR has, data suppliers are also offered a request overview. In this overview additional data is present that is relevant to the specific supplier, they cannot access data of other suppliers or data demanders. This data enables the terminals to gain insights into their clients and the statistics and analytics of the data that they have shared, as shown in figure 4.12 .

The finance manager consists of two parts. One part is an overview for the terminals to gain insight into the requested data feedback streams and the amount of money that they will receive from the platform. The second part is the price manager. This enables the terminals to set a price for their data. This price could be set per data type or one price per requests. This price is also visible for the data demand side. When a supplier changes their asking price(s), this change is not immediately applied to the platform. First a notification will be send, so all data demanders that had already accepted the previous conditions are notified and have a fair chance to view and accept new conditions. After a reasonable time the change is applied to the platform.

Payments are not done directly after receiving a data type, in order to prevent high transaction costs and keep it organized, therefore once a month an invoice is send to the shipper to pay the amount due. Cadex ensures that the payment will go to the right suppliers.

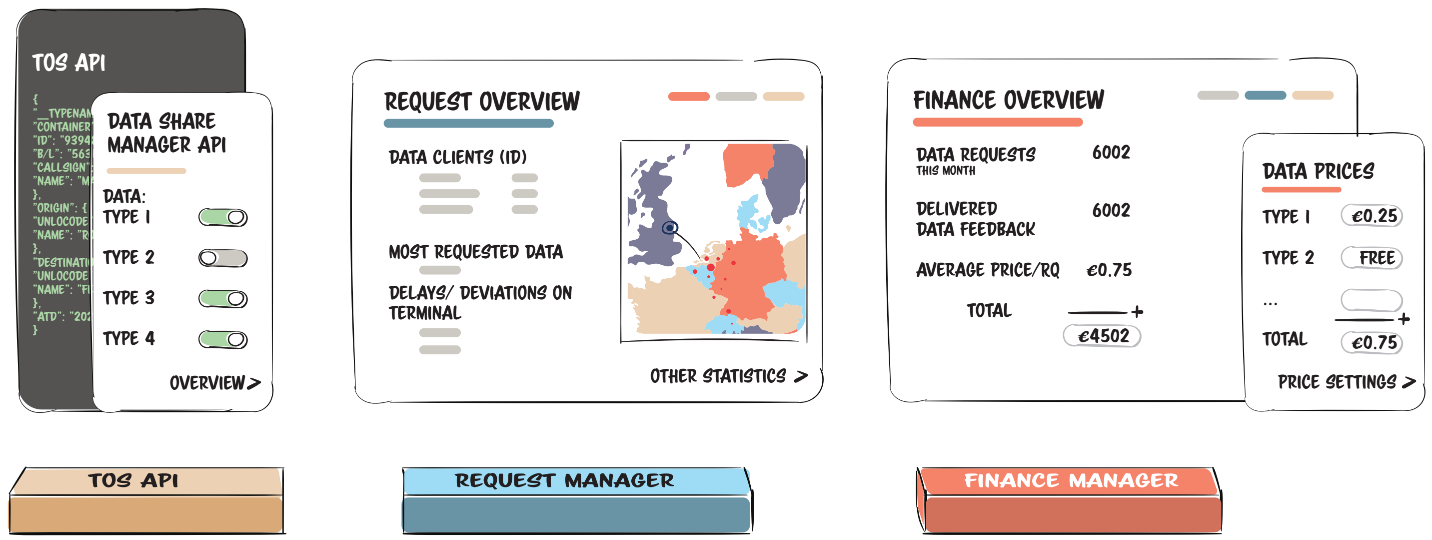


Figure 4.12
Data supplier dashboards

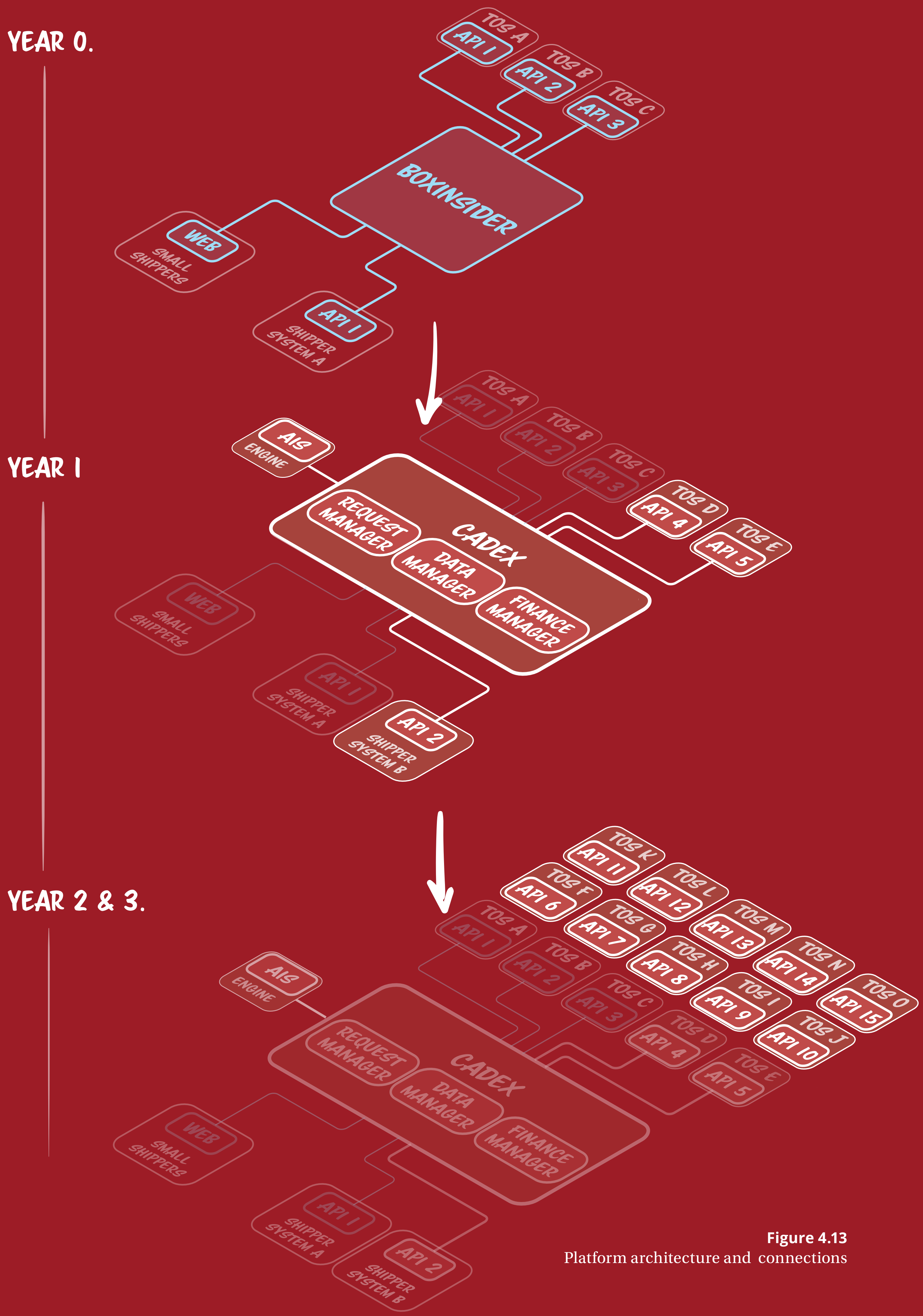


Figure 4.13
Platform architecture and connections

4.6 Feasibility

From the previous paragraphs there can be seen that many modules are present within Cadex and many connections with data demanders and suppliers are made. So, do the digital capabilities of DBS match these technical challenges? DBS has already gained relevant experience when Boxinsider was developed. Since BoxInsider already contains many functionalities that are essential for the platform it can be seen as a strong proof of concept that DBS is able to build the required modules and connections. Moreover, the architecture of Boxinsider can even be used as a basis for further development of the platform. As shown in figure 4.13, the architecture and developed connections of BoxInsider can be used in the first phase of the platform development. According to an interview with a developer of BoxInsider, they currently offer a web version where cargo data about the port of Rotterdam can be viewed, a single API* for large clients to request and receive cargo data and a couple of different TOS API's that manage the data requests and feedbacks with the data suppliers (Port of Rotterdam, 2020q) .

Upon these existing basis multiple modules can be build, like the request manager, which includes the DSM and Desired Data Feedback tool, data feedback manager and the finance manager. Also, the dashboards that correspond with these modules must be developed for the data suppliers, data demanders and PoR itself. Furthermore, the AIS engine, which was built by DBS to track and trace vessels can be connected to the platform. To increase the connectivity of Cadex for the data demanders, there can be thought of developing more, or at least a second API using a different programming language. With two versions of the Shipper API it could be easier for shippers to connect their system to the platform.

Also on the data supply side the platform's connectivity can be increased, in figure 4.14, it can be seen that there are multiple different TOS's used by terminals worldwide. When DBS develops more TOS API's, more data suppliers that work with different TOS's can be connected to Cadex. Most large terminals work with the TOS of Navis, so by developing an API for this specific TOS, a lot of potential data suppliers can be connected. Small terminals more often have custom build TOS's, before developing a matching API, there should be considered if the connection outweigh the API development costs.
Given their gain experience with BoxInsider, all of the above mentioned developments are considered to be feasible for DBS.

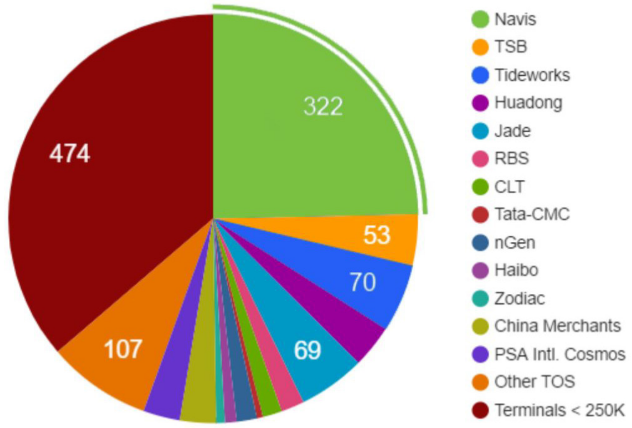


Figure 4.14
Terminal operating system market (Navis, 2017)

* An API defines the kinds of calls or requests that can be made, how to make them, the data formats that should be used, the conventions to follow.

4.7 Desirability

The desirability of Cadex can be viewed from three perspectives: for the shipper, for PoR and for the data suppliers.

Desirability for shippers

First of all, Cadex could save shipper valuable time, currently international cargo data is entirely missing or fragmented information can be found at different online platforms or can only derived by calling individual parties. The platform brings together all these fragmented pieces of data in one place.
Cadex makes this data easily accessible via either the web version or the API, shippers can act quickly upon deviations in their shipments schedules and can for example book a truck last minute to get the container in on time. This increased insight, enables more accurate and faster actions, and thereby schedule reliability. Shippers can save significant costs that come with the management of their logistics, transport delays, the deprecation of goods that arrive too late, and unnecessary stock levels. Especially in time sensitive trade, like fresh goods or factory parts the cargo data is very valuable.

Saving money is one element that is desirable for shippers the other is increased sustainability of transport, both are two important reasons for shippers to get involved in the concept (Port of Rotterdam, 2020n). Containers that arrive earlier can for example be planned on a barge or train instead of a truck, which significantly decreases the footprint of the transport of a container.

Furthermore, shippers have a certain say in the platform, since they are free to choose what kind of data feedback they desire from the suppliers and what additional data they allow to be shared to the platform. In this way Cadex is also desirable for shippers who do not need all data. Also, the risks are low since there is paid per request and prices can be viewed and accepted beforehand.

Example of cost savings on inventory

(Vernimmen et al., 2007), did a study on the impact, schedule reliability has on shipper's stock levels. They present a case of shipper, a multinational manufacturer that imports parts needed for its factory, in order prevent a run out of stock and thereby factory shut down, the shipper has a safety stock level. Large and sometimes unknown deviations in the import lead times causes a large stock levels that are necessary to compensate for deviations and delays. With better information, shippers could significantly influence schedule reliability and lower deviations, since they can act quickly. The research shows that for this case a 20 percent decreasing in necessary stock levels could be reached by this shipper. The annual holding costs of a stocked container can count up to 30 percent of the value it carries, these costs include interest, depreciation, insurance and warehousing costs. In this case the shipper could save between a couple of hundreds of thousands of euro's up to two million euro's annually by not needing this extra 20 percent of safety stock.

Desirability for data suppliers

The data suppliers benefit directly from the revenue model Cadex offers for their data. They also receive historical data about their clients, which improves their knowledge about the clients they serve. This is something that is currently often not known by the terminals. Furthermore, they can offer a better customer service, which could result in a higher client satisfaction. Connected data suppliers might also benefit from the indirect effect that the improved visibility for the shipper could make shippers decide to ship more throughput via this party instead of via other parties

Desirability for PoR

Just like the data suppliers, PoR benefits directly from the data exchange by charging a percentage of the price. PoR also receive historical data about their clients, which improves their knowledge about the clients they serve and could be input for improvements in the port of Rotterdam. Furthermore, a better customer service is offered to shippers that make use of the port of Rotterdam. This could result in a higher client satisfaction, which can cause an indirect effect that the improved visibility for the shippers could make shippers decide to ship more throughput via the port of Rotterdam instead of via other parties.

Conclusion

Cadex can be seen as a win-win situation, for both the shipper and data supplier. The platfrom makes cargo data available to shippers. Shippers in their turn could improve their container transport chain performance, the most important port selection criteria for them. The added value the Cadex brings could also contribute to a higher customer satisfaction and therefore improves also the qualitative (satisfaction and reputational) selection criteria of the port of Rotterdam.

4.8 Viability

Business model

Cadex offers PoR a new revenue stream on the digital side of PoR revenue model, showed in figure 4.15. The revenue is a percentage of the price paid by the shipper for the requested data. This revenue is used to cover costs like investments needed for the development of the platform and connections, the maintenance and hosting and the remaining part can be seen as profit margin. To make the business model seem fair to all parties, this platform percentage is set on thirty percent, so the majority of the price goes to the rightful owners, the data suppliers.
Moreover, PoR also retrieves historical additional data about its customers and their shipments that could be used to start new innovation projects to improve physical processes in the port of Rotterdam.

The aim of Cadex should not only be generating revenue with data exchange between supplier and buyer, it's about being the port which provides digital infrastructure for its shippers by creating a network of data suppliers, which could be utilized by cargo owners.

The platfrom could also contribute to additional throughput since increased client satisfaction can influence the port selection of shippers. However not many shippers split their cargo between sea-ports, instead they split between different modalities or different container vessels. So to gain more through-put a new shippers who do not make use of Rotterdam could be approached. (Port of Rotterdam, 2020k)

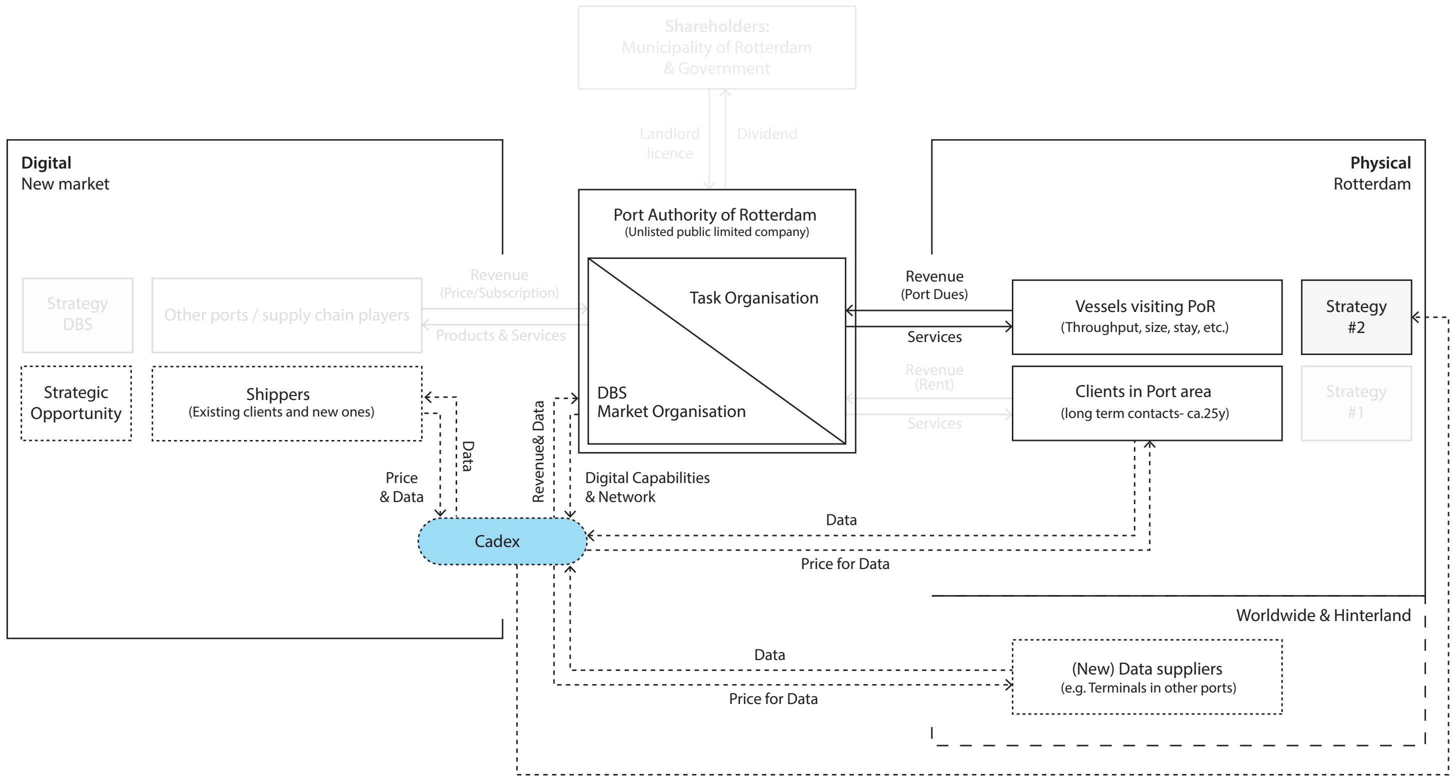


Figure 4.15 Business model of Cadex for PoR

Costs estimate

In the feasibility paragraph there was explained how Cadex could grow in steps into a platform that is able to connect with many systems and TOS's. A rough estimation of corresponding costs of these developments, based on earlier developments for BoxInsider, is presented in figure 4.16. Building a TOS API will cost around 10.000 euro per API. Next to the development costs of the platform it also has maintenance a hosting cost for PoR, which are estimated about 1000 euro per month. Figure 4.17, shows an overview of the investment and cost that are related to the platform.

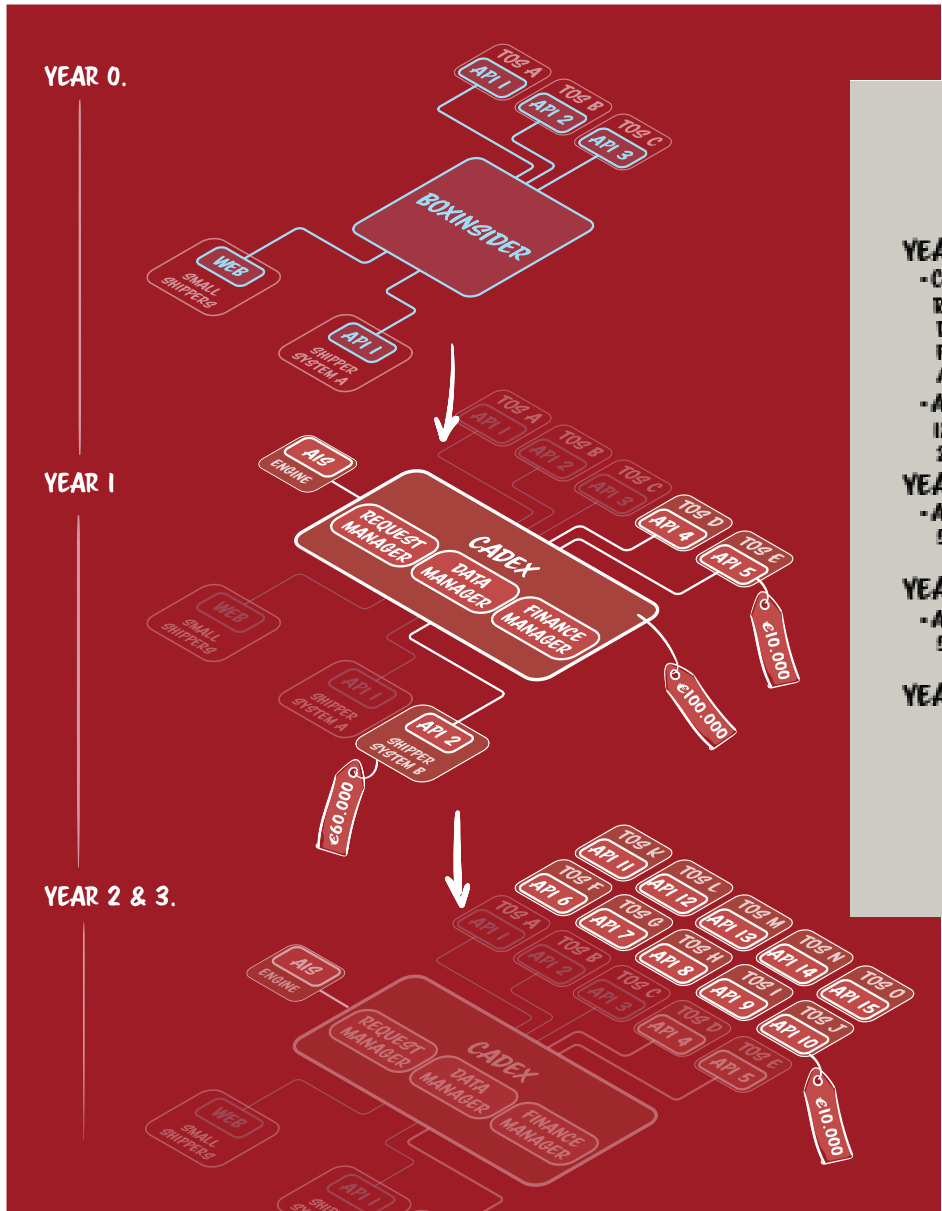


Figure 4.16 Platform architecture and connections cost estimate

	DEVELOPMENT COSTS	HOSTING/ MAINTENANCE
YEAR 1.		€12.000
- CADEX: REQUEST MANAGER, DATA MANAGER, FINANCE MANAGER, AIS IMPLEMENTATION	€100.000	
- API: 1X SHIPPER SYSTEM B, 2X TOS	€80.000	
YEAR 2.		€12.000
- API: 5X TOS	€50.000	
YEAR 3.		€12.000
- API: 5X TOS	€50.000	
YEAR 4.	€ -	€12.000
	€280.000	€48.000
TOTAL	€328.000	

Figure 4.17 Overview of the investments and cost Cadex

Revenue estimate

In order to make a revenue forecast, there is assumed that the average total price paid per request is 1.50 euro, this includes the margin of the platform. There is assumed that the asking price of the data of data suppliers will vary between minimum of 10 cents and a maximum of 1 euro. The total price depends on the number of suppliers involved in a request and their asking prices. For example a extensive request uses the following data suppliers: hinterland terminal, terminal rotterdam, AIS ship tracker and terminal of desitination . If all data suppliers ask 50 cents for their data, and the AIS ship tracker will cost 25 cents, the subtotal will be 1.75EU. After the added margin the total price for the shipper will be 2.28EU. When a shipper requers less data, the price will be lower. Prices is based on current prices paid for BoxInsider. Furthermore there is assumed that every year the amount of request will grow with 100.000 request, so in four years one million request will be handled by the platform. Figure 4.18, gives an overview of the revenue forecast, based on the above explained assumptions.

	NUMBER OF REQUESTS	REVENUE FULL	REVENUE % POR	AIS ENGINE
YEAR 1.	100.000	€150.000	€30.000	€20.000
YEAR 2.	200.000	€300.000	€60.000	€40.000
YEAR 3.	300.000	€450.000	€90.000	€60.000
YEAR 4.	400.000	€600.000	€120.000	€80.000
SUB-TOTALS	1 MLN	€1.5 MLN	€300.000	€200.000
			+	
			POR TOTAL	€500.000

Figure 4.18 Overview of revenue estimate Cadex and PoR

4.9 Implementation strategy

Even though Cadex would generate benefits for all parties. Yet, it is still perceived as difficult to convince the data suppliers to join the platform. Also, the relevant shippers must also be found and approached in order to create the data demand. As earlier described relevant shippers are parties that ship over 1500 TEU a year via the port of Rotterdam. In order to determine what parties should be approach first, an implementation strategy is proposed.

Connecting Data suppliers

With BoxInsider, PoR already made a couple of connections with data suppliers, among which the terminals in the port of Rotterdam. These parties are therefore also connected to Cadex from the beginning.
According to the interview with Portbase)2020c), the most logical next firts step would be to connect most inland terminals in northwest Europe. Other interviewees also mentioned that shippers most likely expect that these data suppliers are connected to the platform, since PoR is also associated with its hinterland connections. Most of the inland terminals work use the same TOS, so there's not much work in developing API's.
The second step would be to focus on connecting short-sea data terminals outside the port of Rotterdam. Rotterdam is a very strong short-sea port and short-sea is a very time critical sector, so shippers will be interested in real-time cargo data. Furthermore, large digital competitors are less focussed on this segment. In appendix L a couple of platforms and solutions that were considered relevant competitors are discussed briefly.

First, Cadex can be focused on short-sea terminals located in North-Western Europe and later also on short-sea terminals located in other parts of Europe. At short-sea ports, the terminals often run on local TOS's, developing connections between these systems and the platform can therefore be interesting, however more costly. Cadex would be one of the first platforms that that makes this cargo data available to shippers. Assumed is that these small data suppliers are lacking the resources to do this themselves and are therefore interested in the partnership this platform offers. When the data suppliers are very reliant on the digital capability of DBS in order to connect them to shippers, the margin of the platform could maybe be increased.

When most hinterland terminals and short-sea terminals are connected to Cadex, PoR would conquer a strong position in North-western Europe. By building this new port infrastructure, the digital connections, PoR is increasing its control and relevance in the field of data exchange. The connections hold value, because ones built, they can be used for the platform, but could in addition also be used by other parties or other digital purposes with some adjustments. Whenever, a competing party is planning to interfere in the shorts-sea or hinterland area of PoR, they can either chose to build all these connections from scratch or to contact PoR for the usage of existing connections. With this new port infrastructure, PoR is less likely to be bypassed by other competing players who are also involved in cargo data exchange.

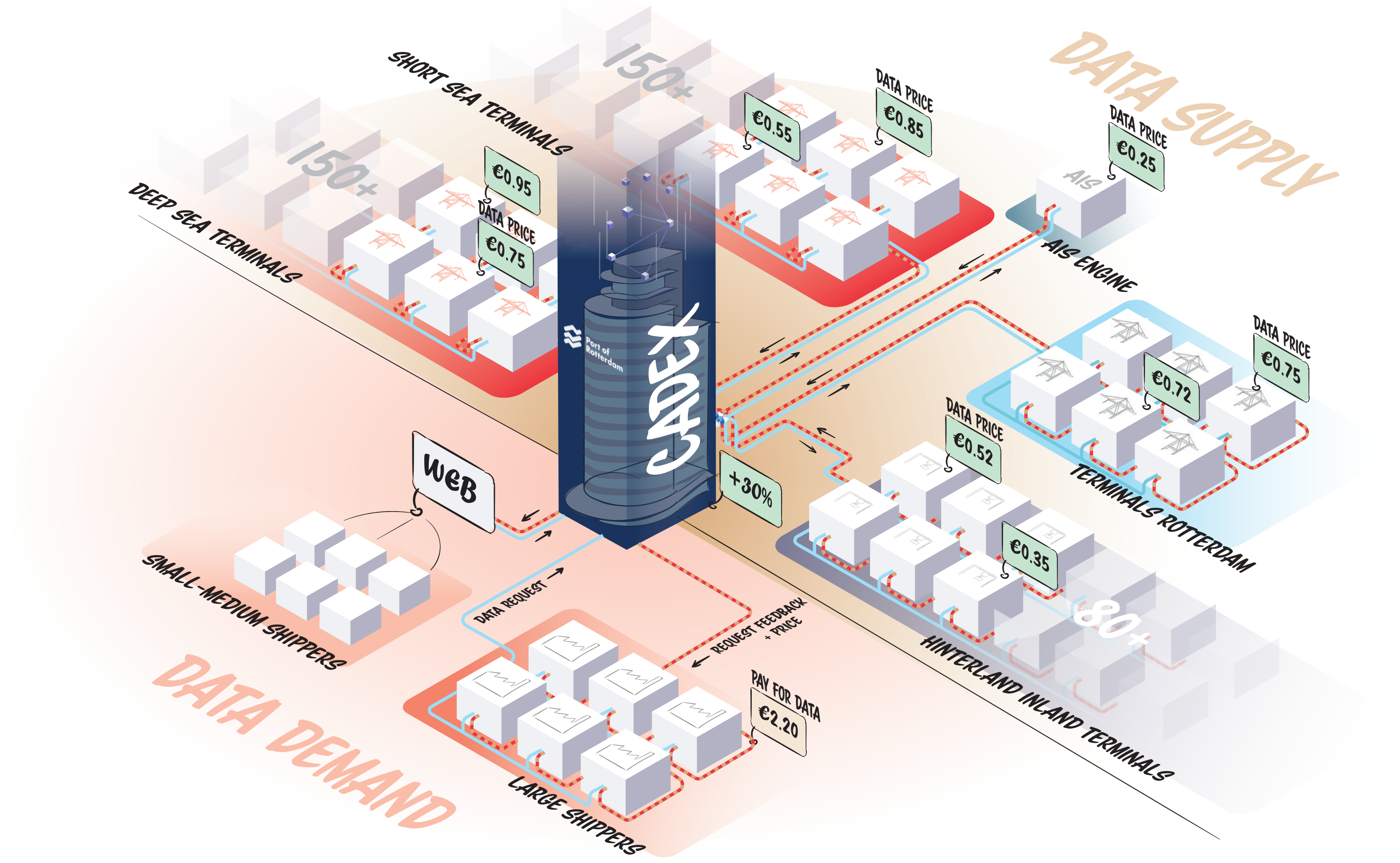
In a later phase PoR could also focus on the deep-sea, feeder and the transhipment segment. In this segments large competitors like Tradelens are also active, so it might be harder to intervene. What is interesting is that most deep-sea terminals run on the same TOS, built by Navis. The innovation department of Navis is also located in Rotterdam, so they might be easy to approach for PoR. Developing an API that connects the platform with Navis' TOS is a one-time investment, whereby subsequently hundreds of potential data suppliers could be connected worldwide.

Approaching data suppliers and data demanders

There are two methods determine what connections should be focussed on and what parties should be approached.

1) PoR can select a party where large quantity of containers is shipped to or from out the port of Rotterdam, this party is a potential large data supplier. Next there can be find out which relevant shippers make use of this connection, the so called common shippers between Rotterdam and this potential large data supplier. According to the interview with Portbase (Portbase, 2020b), the general numbers of trade lanes are known, how many containers move from the port of Rotterdam to another port annually. However, who the owners of the containers are, is not known by both ports. Although, only the general numbers are known by PoR, their data can be combined with another database which keeps track on the product categories that are imported and exported. The Observatory of Economic Complexity is an online data visualizing tool that composes data about countries and the products they exchange and is based on the data from United Nations Statistical Division (COMTRADE). With this tool two countries can be selected and viewed how what they import and export from one other which is expressed in worth, percentages, growth rate and types of product divided over thousands of categories. Combining these datasets could give a rough indication of what industries are involved in a specific trade lane between the port of Rotterdam and the selected other port. Based on these insights, multiple common shippers can be found and approached simultaneously. Subsequently, PoR consultation the largest common shippers, can together approach the potential data supplier to join the platform. In this way the relevance of Cadex can be made clear to the data supplier.

2) PoR can also select an important shipper to the port of Rotterdam that they want to maintain and increase its relevance to. This can be large shippers located in the hinterland of port of Rotterdam who ship most of their containers via the port. Most of these large important shippers are known by PoR, e.g. Heineken, and some are already in contact with of the shippers and Forwarders department. These shippers can be approached and together with these shippers, data suppliers that are relevant to them can be approached. So the connections are built around this shipper. In this way the relationship between PoR and the shipper can be enhanced. Furthermore, it could be convincing when PoR together with this large shipper approaches a data supplier, since this shipper is also an important (physical) client of the data supplier. By creating the platform's connections around a shipper, it's not necessary to create a very wide network at once. Instead, it will be possible to build and use the system with only a few data suppliers (one terminal, one hinterland terminal and one terminal form another port). This might work as advantage for PoR, since they are the largest port of Europe, other smaller ports might see it as an opportunity to collaborate to create a better customer satisfaction. In the end this could also result in a larger number of containers.
In both approaches, the data suppliers that are approached share a common shipper client with PoR and assumed is that these data suppliers are also interested in creating higher customer satisfaction by joining Cadex.

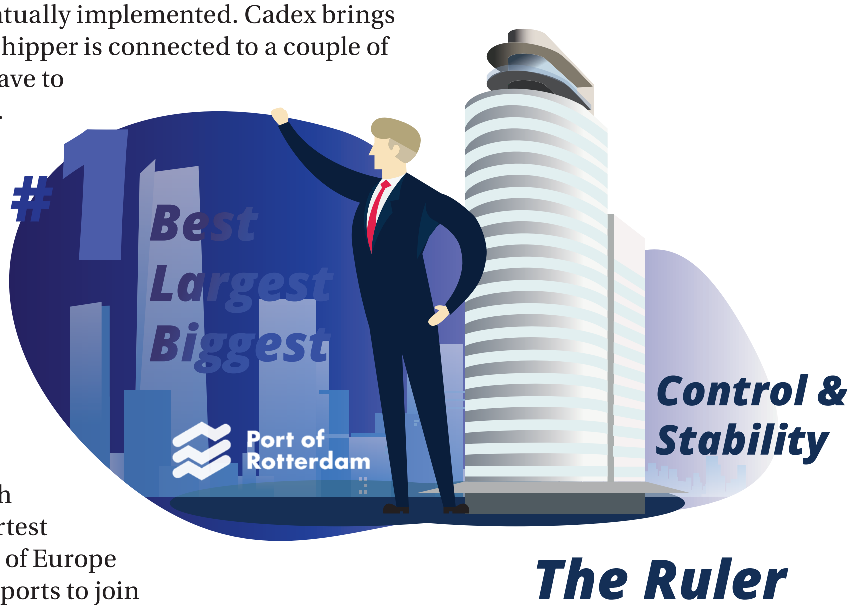


4.10 Company fit: the Archetypes

In the design of Cadex, the main values of all three archetypes were included to ensure a company fit for both PoR and DBS. This could avoid future internal frictions and increases the chance of making it to the implementation phase.

Fit with the Ruler

For the Ruler archetype it is very important that Cadex does not harm their reputation and power position. So mistakes must be prevented. This can be solved in the way Cadex is eventually implemented. Cadex brings added value even when only one shipper is connected to a couple of data suppliers, so not all parties have to be connected from the beginning.
In this way PoR could carefully select preferred shippers or preferred data suppliers to connect to the platform and thereby stays in control. The more data suppliers and data demanders are connected to the platform the more valuable the platform gets for both sides and PoR.
Furthermore, the platform shows the digital capability of PoR, which enhances their reputation as smartest port. Their position as largest port of Europe could also be a reason for smaller ports to join Cadex, to be part of a large network. The built connections hold value, once built, they can be used for the platform and in addition also be used by other parties or other digital purposes with some adjustments. Whenever, a competing party is planning to interfere in for example the shorts-sea or hinterland area of PoR, they can either chose to build all these connections from scratch or to contact PoR for the usage of existing connections.
Furthermore, Cadex is designed for trust and aims to facilitate a data exchange between supplier and demander. Both the data suppliers and data demanders have an own say in the platform due to the tools offered, which makes adjustable and somehow collaborative. This could create loyalty of both parties to Cadex, which makes the barrier for new entrants higher and thereby places PoR in a stronger position in the field of data exchange. One aspect that might goes against the value of maintaining and gaining more control, which corresponds to the Ruler archetype, is that data suppliers are free to determine the price of the data and what data is shared to whom. So some control is sacrificed on an operational level, yet on a strategic level PoR actually is gaining control by building this new port infrastructure, the digital connections.

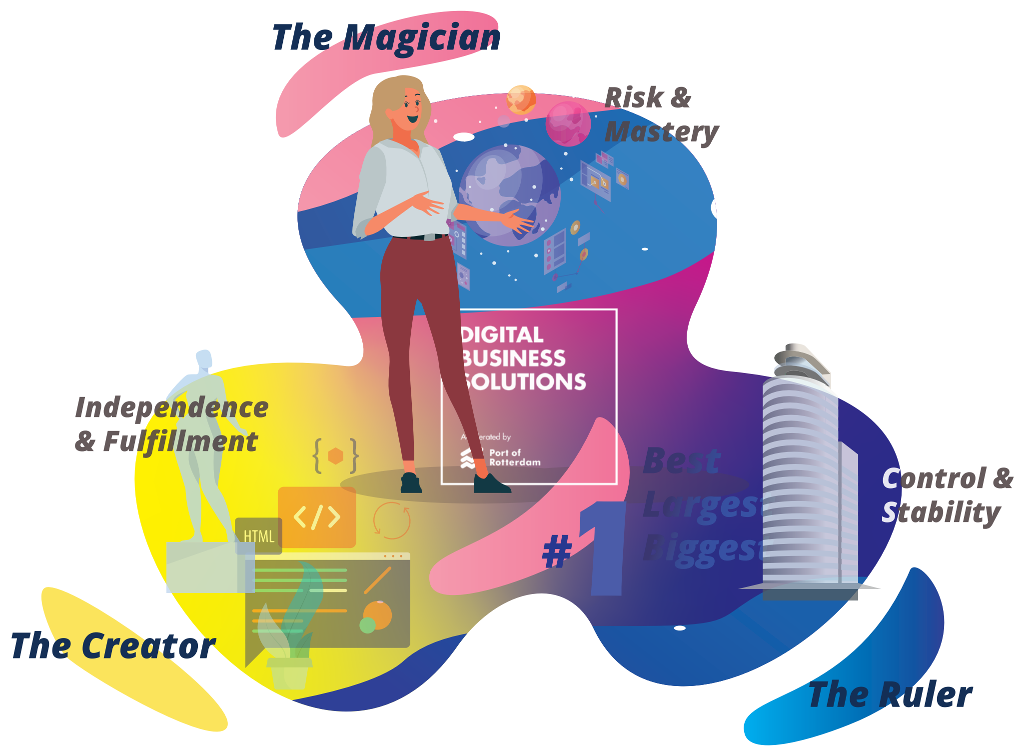


Fit with the Creator

Cadex can be seen as an innovation that turns away from business as usual for PoR. The platform is designed for the long term, so a digital product that it will endure. It also anticipates one the same threat PoR is facing, which is that data suppliers have the feeling they have to innovate in order to stay relevant in a more and more digitalising world. With the platform both PoR and data suppliers are involved in the digital transformation. For the data suppliers the coopera-tively character of the platform and the ability to set their own prices and data settings could give them a feeling of involvement and thereby control. Also the historical data both parties receive about their customers can give them a feeling of control and involvement.

Fit with the Magician

Cadex also has a transformative and innovate catalyst character and is focused on a win-win outcome for all involved parties. The platform provides a techno-logical solutions that enables data suppliers to transform into an international connected party and enables shippers to access this data. With Cadex, PoR can also become a connected port, which is the last step in reaching their vision. Depending on the success of the platform, the digital activities of PoR can play a more prominent role in the company. Eventually the company could even transform from a local physical facilitator into an international digital facilitator.



4.11 How is trust embedded in Cadex

Most implications where found from interviews and literature, originated from the data suppliers and mainly boil down to a lack of trust in either the technology, business model or company behind the platform. Therefore, trust factors and credibility dimensions where translated into design requirements, how these requirements are embedded in the design is explained in this paragraph.

The platform tries to gain trust for both data suppliers and data demanders by offering solutions that anticipate on the three trust factors.

1) The user perception of technology

This factor is involved in in multiple levels of the platform, from very in detail considerations, e.g. a secure technology to exchange data using high end encryption, to more general considerations like the overall product architecture. In this thesis the in detail considerations were left out. The platform makes sure that requested data and data feedback only is exchanged between shipper and related data supplier and makes use of existing technologies to manage these connections, so no unconventional or unproven technologies are used. Furthermore, the figures presented earlier in this chapter can be used to explain both data suppliers and data demanders what modules are present in the platform and how these interact with their systems.

2) Ease of use

For offering ease of use also the capabilities of the users should be considered, since the platform is focussed on business to business, some required level of digital capability, knowledge and experience can be expected from the user side. However the digital capability differs between companies, therefore Cadex offers two different solutions for the data demanders, a web version and an API version. The web version displays the feedback data in a graphic overview, and request can be added by filling in the required fields. This solution can be used by all shippers, without needing a large digital capability. Since, this solution can be more time-consuming when large quantities of containers are shipped, there is an API version. This enables larger shippers, who often also have a large digital capability, to connect to the platform from-out their own systems. The platform and technology is easy to use since all complex system integrations are done with tailored API's and adjustments can be applied using simple user interfaces. The settings of the API's can be done via the DSM, Finance manager and Desired Data tool. Payments between parties are also centrally arranged by the platform.

3) Risk

Data suppliers are afraid that their data might end-up at the wrong parties, that could use this data for improving their competitive advantage. Data demanders could be afraid that there is paid for data that is not relevant or not delivered to them. On the platform, only data is exchanged between data demander (shippers are the legally allowed party to make this request) and data supplier, the owner of the data. No data is sold to third parties. With tools like the DSM and desired feedback data, the platform hands over control to its users. Shippers are offered control over what they want to share and what data they desire. Also the data suppliers are offered control over what they are willing to share. Furthermore, the platform uses the principle of no use, no pay. Shippers pay per request, and only post-pay for the data they desire and is delivered to them.
How Cadex is associated with credibility by both data suppliers and data demanders is explained in the four credibility dimensions.

1) Honesty

Cadex offers benefits for all involved parties, as described in the desirability paragraph . The aim of the platform is not to only generate revenue for PoR by making profit on data exchange between supplier and buyer. The platform aims for offering added value for PoR's shippers located in their hinterland. The development of digital infrastructure enables data suppliers and demanders to connect to the platform, the network that herby is created is utilized by both sides and offers benefits to all involved parties, data suppliers, PoR and data demanders. Suppliers are offered a fair share, since the majority of the price paid for the data goes to the data supplier. Moreover, the data suppliers are offered control over their conditions, in the finance manager they can set their own asking prices. Shippers only pay for desired data that is delivered to them.

2) Expertise

DBS has already gained relevant experience when Boxinsider was developed. Since BoxInsider already contains many functionalities that are essential for the platform it can be seen as a string proof of concept that DBS is able to build the required modules and connections. Furthermore, PoR can use its extensive network and existing relationship it has with both shippers and data suppliers like terminals.

3) Predictability

Next to developing Cadex, PoR is the service provider of the platform, covering aspects like maintenance, connection set-up, hosting, connection security and stability. Whenever a problem occurs in the connection PoR has responsibility to solve the problem. By making use of API's, information is always delivered or requested in the same pre-arranged format. Since the whole platform is fully automated, information can be exchanged twenty-four seven, all days of the year. Shippers can also find which data suppliers are present on Cadex and view and accept their conditions.

4) Reputation

Reputation is a dimension that is derived from recognised past performance, like the predictability the performance of a similar product like BoxInsider could be reused. Also the reputation of being the smartest port of the world can be used, since Cadex reinforces this position. Besides, the results of the analysis on archetypes can also give an understanding of how the outside world might view PoR and DBS from their perspective. Although DBS would develop Cadex, is remains a department of PoR and therefore it is assumed, that most external companies will view both DBS and PoR as one organization. An organization that embodies the Ruler archetype. This archetype uncovers strengths and weaknesses that could either enhance or counteract the platform. The strengths of a Ruler company is that it is perceived as a company that is predictable, reliable, safe, takes responsibility, is decisive and shows leadership and expertise. Weaknesses are being a company that wants to enhance and maintain its power position, is political and thereby slow to act and can come across as authorial or bossy. In the presentation of Cadex to potential users, the strength can be emphasised to convince them that the platform is safe, reliable and build with expertise. The weaknesses can be overcome by explaining how Cadex gives control to the users, offers benefits to both sides, has the aim to create added value for shippers and a higher customer satisfaction for data suppliers and PoR.

Chapter 5

This chapter describes the general conclusions of the thesis and the limitations and recommendations for further research.

Conclusions & Recommendations

5.1 Conclusion

Digital transformation in sea-ports can offer benefits for many players involved in the logistic chain. In order to stay relevant, PoR should invest in developing new port infrastructure: digital connections that facilitate data exchange between logistic chain stakeholders. For decades, both the port of Rotterdam and PoR benefitted from two physical growth strategies: 1) expand the port area, and 2) attract more throughput. The first strategy is reaching its physical limits and the second strategy is increasingly under pressure, since competitors like the port of Antwerp and Mediterranean ports have grown faster than Rotterdam in recent years, relatively speaking. Differences between ports become smaller, which is likely to result in a competition on price and, thereby, lower ROI of PoR physical activities and investments. In order to attract more, without competing on price, the port of Rotterdam should be more attractive to parties who either split their cargo between ports or do not make use of the port of Rotterdam yet. In this thesis, a strategic digital opportunity for PoR was found and explored.
The thesis explored the design of a digital platform around container data for DBS, which contributes to the competitive position of the port of Rotterdam and the business model of PoR. The result is Cadex, a data platform that facilitates cargo data exchange between data suppliers, e.g. terminals and data demanders, the shippers.

The developed vision of DBS, connected ports, was further elaborated upon. Connected ports can be divided into four categories of data that could be exchanged between stakeholders in the logistic chain. A gap in the PoR digital eco-system was found around cargo data, since Portbase and PortXchange are currently focusing on other categories. Interviews revealed that the data demand of shippers in the Rotterdam hinterland is currently not met. Especially international data about a shipper's cargo is either missing or has to be assembled by shippers themselves from a variety of platforms (a.o. via phone calls).
National and international data suppliers are willing to share data but only to parties that are involved in the same port call. Since PoR and data suppliers sometimes serve the same customer, the common shipper, both parties have the same interest in creating added value for these shippers.

The designed platform, Cadex, matches cargo data demand and cargo data supply. Cadex offers shippers real-time data about their containers, e.g. 'terminal gate-in' or 'container loaded on ship', that enables shippers to act upon containers that deviate from the planned schedule. Data suppliers are offered a revenue model for their data.

Desirability of Cadex

Cadex offers benefits for all involved parties. By making cargo data easily accessible, it could save shippers significant costs that come with transport, the deprecation of their goods, the management of their logistics and their inventory. Especially in time sensitive trade, like fresh goods or factory parts, this data is valuable. In addition, it could contribute to a lower carbon footprint of shipments. The data is directly derived from the data owners, data supplies, like sea-port terminals, and hinterland terminals and can therefore be labeled as reliable data.

The data suppliers benefit from the revenue model that the platform offers for their data and the data they receive about their clients. In addition, connected data suppliers offer their shippers a higher customer service. The improved visibility Cadex brings for the shipper could make them decide to ship more throughput via this party instead of via other unconnected parties. So, the platform can be seen as a win-win situation, for both the shipper and data supplier.
PoR benefits directly from the data exchange by charging a percentage of the price. Moreover, PoR receives historical data about their clients, which improves their knowledge about the clients they serve and could be input for improvements in the port of Rotterdam. Furthermore, a better customer service is offered to shippers that make use of the port of Rotterdam.

Feasibility of Cadex

Given the strong network of PoR, its relationships with its shippers and the experience DBS has with building similar digital connections and integrations between shippers and data suppliers, the feasibility of the platform can be verified.

Viability of Cadex

Most implications that come with data exchange, originate from the data suppliers and mainly boil down to a lack of trust in either the technology, business model or company behind the platform. Therefore, there has been a strong focus on how to design for trust. Literature review has shown that trust is affected by three trust factors and four credibility dimensions. The platform solves this lack of trust in multiple ways. It makes sure that requested data and data feedback is only exchanged between shipper and related data supplier, that the platform and technology is easy to use, since all complex system integrations are done with tailored API's, and that adjustments can be applied using simple user interfaces. It lets data suppliers determine which data they are willing to share by making use of a data share manager and offers a data finance manager, where data suppliers can determine their prices. Furthermore, shippers pay per delivered request and most of the revenue goes to the rightful data owner: the data supplier. For PoR, the platform offers a new revenue stream to their current business model, which is shown in figure 5.1. This revenue is a percentage of the price paid by the shipper for the requested data. This revenue is used to cover cost like investments needed for the development of the platfrom and connections, the maintance and hosting, and the remaining part can be seen as profit margin. Moreover, PoR retreives unsensitive data about its customers and their shipments that could be used to start new innovation projects to improve physical processes in the port of Rotterdam.

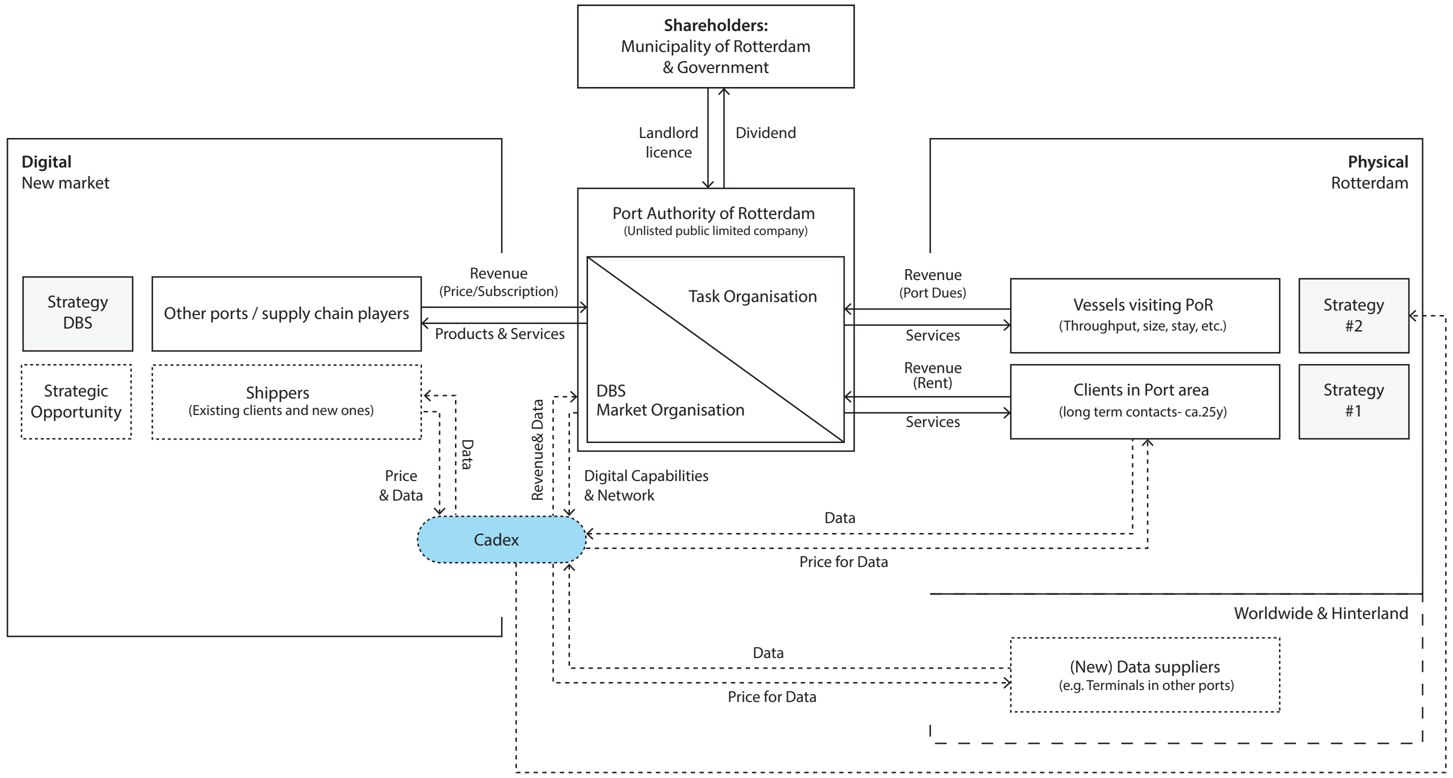


Figure 5.1 Abstract representation of PoR's Business model including Cadex

Implementation barrier of Cadex

The differences between DBS and PoR can be seen as one of the barriers for DBS to implement Cadex. These differences sometimes lead to disagreements about strategy, vision and the contribution DBS' products have to the port. Organisational theory found about hybrid companies indicates that tensions would arise due to the combination of conflicting characteristics within one organisation. However, this theory does not cover an in-depth analysis about these conflicting characteristics. Therefore, literature from the field of branding was used to frame the characteristics of both PoR and DBS. PoR clearly embodies a Ruler archetype and DBS is embodying a mixture of the Creator, Magician and the Ruler archetypes. Friction could arise from a collision of archetypal values. By knowing each other's archetype and corresponding values, one could better anticipate on expected behaviour of the other entity. It could be anticipated if an action would lead to encouragement or resistance. From this branding theory point of view, it can also be seen that the original strategy of DBS conflicts with the archetypal values of PoR. Furthermore, a design that takes into account both entities archetype(s) and fits with their main values, avoids future internal frictions and has a higher chance of making it to the implementation phase. In the design of Cadex, the main values of all three archetypes were included to ensure a good company fit. One aspect that might go against the value of maintaining and gaining more control, which corresponds to the Ruler archetype, is that data suppliers are free to determine the price of the data and which data is shared to whom. So, some control is sacrificed on an operational level, yet, on a strategic level, PoR is actually gaining control by building this new port infrastructure, the digital connections.

Strategic value of the new port infrastructure

The new port infrastructure that Cadex brings could contribute to the competitive position of the port of Rotterdam, which would lead to more throughput, the second growth strategy. DBS contributes to the port of Rotterdam by building this digital infrastructure that makes cargo data available to shippers. With this data, shippers can improve their container transport chain performance, the most important port selection criteria for them. The added value the platform brings could also contribute to a higher customer satisfaction and, therefore, improves the qualitative (satisfaction and reputational) selection criteria as well. Cadex could improve the score of the port Rotterdam on the selection criteria and, therefore, it contributes to a higher competitive position. Still, the quantification of the additional throughput remains difficult.

Developing this new port infrastructure is a long-term investment, since the connections hold value. Once built, these connections can be used for Cadex, but could, in addition, be used by other parties or for other digital purposes with some adjustments. Whenever a competing party is planning to interfere with, for example, the shorts-sea or hinterland area of PoR, they can either choose to build all these connections from scratch or to contact PoR for the usage of existing connections. Furthermore, Cadex is designed for trust and aims to facilitate a data exchange between supplier and demander. Both the data suppliers and data demanders have their own say in the platform due to the tools offered, which makes Cadex adjustable and somehow collaborative. This could create loyalty of both parties to Cadex, which makes the barrier for new competing entrants higher to approach these parties. This places PoR in a stronger position in the field of data exchange. Without this new port infrastructure, PoR is more likely to be bypassed by other competing players who will reap the benefits of the digital transformation in sea-ports.

5.2 Recommendations and limitations

Despite the extensive research that has been done during this project, several limitations need to be discussed and (corresponding) recommendations are mentioned.

Limitations and recommendations on research

• The obtained interview insight has been generated from a limited number of stakeholders. Due to the impact of the corona crisis on the logistic sector, there was decided that shippers and terminals were not contacted for input for the ideation phase and validation of the concept. So, DBS needs to validate the concept with shippers and terminals as this has not been done due to time-constraints of this project and attention shift amongst shippers to face the covid-19 crisis. Two interesting elements that need to be validated are:

1) The benefits for shippers, some literature and findings from interviews were found and used to indicate these benefits, however these must be validated by shippers. The benefits include the possible savings, increased sustainability and reliability. When a more reliable understanding of the benefits is present, DBS could use this information for the data pricing strategy of Cadex. Prices were currently set to prices comparable with BoxInsider.

2) Validate with data suppliers if they may have difficulties with determining the right price for their data. High prices probably will lower the desirability of the platform at the data demand side, the shippers. PoR could also propose a fixed price range, but the desirability of this must be validated. Further, there can be validated if the data suppliers consider the business model to be fair. There can also be researched if data suppliers are willing to cooperatively invest in the API that connects their TOS to the platform and thereby makes the data available to more parties. Furthermore, there can be researched if they would want to pay for the data about the data demanders or give discounts to the shippers that share this information.

• Due to the broad scope of the project during the first stage of the project, the competitor analysis has been performed on a broad skill. It is recommended for DBS to map out more the possible competitors specifically cargo data exchange platforms.

• It is recommended to do more research on the relationship and effects of digital services on the selection criteria of the decision makers. Limited research is done on the possible effects, however it is of importance, since the influence of Cadex on the decision criteria can either be positive or negative. Thereby Cadex could have an effect on the second growth strategy, attract more throughput in the port of Rotterdam.

Recommendations on the design

• A big treat for the platform is that the data suppliers and shippers could withdraw from the platform easily without any negative consequences on this action. With quitting data suppliers, like terminals, the service will lose quality and data coverage. Quitting shippers will make the demand lower of a suppliers data lower. When a feeling of ownership and control over the platform can be created, this could contribute to their loyalty. A method to create this feeling of ownership is to use co-creation in the early development process of a product. Both the shippers and data suppliers could be included in the development of the platform, especially in the design of the dashboards their input could be very useful to create a more desired product.
Why use co-creation? Co-creation is often used to inspire stakeholder's willingness to explore business opportunities and to maintain their commitment over time. Co-creation invites stakeholders to actively take part in the development and thereby creates ownership of the strategic design process and the eventual outcome, this ownership reduces the perceived risk of innovation and increases the change that the innovation will make it to the implementation phase. It also promotes ongoing collaborations.

• DBS has to refine the UI elements of the platform, for this they can also make use of co-creation with stakeholders. Due to time constrains the emphasis of the design phase has been on designing for trust and the presented UI elements are only a rough indication of which functionalities these interfaces must contain. DBS could make use of co-creation to define the UI elements and desired functionalities on the platform of both the data demand and data supply side.

Recommendations on the implementation

• During interviews with Portbase it became apparent that Portbase might be an interesting partner to develop the platform for or in cooperation with, since they already are also planning on developing digital connections with hinterland terminals. Portbase also has good relations with shippers located in the hinterland of Rotterdam. Furthermore, they also have a digital integration with the Dutch custom's system, a party which could also be connected at the data supply side of the platform, this would allow data demanders to see if his/her container is being checked and if all submitted documentation is ok. The Dutch customs on their turn have a good relationship with the customs of the UK, so a digital integration with this party might be easy to achieve. Given the developments around Brexit, the platform might be a solution for a lot uncertainty caused by Brexit for shippers that export and import goods to the UK.

Not only the port of Rotterdam is a strong short-sea port, the Netherlands in general has strong short-sea connections. Portbase could also help develop the platform for other Dutch port authorities (e.g. Amsterdam and Moerdijk). DBS could develop digital connections with short-sea ports and Portbase could arrange that the port of Amsterdam and Moerdijk are also connected to Cadex and that their shippers also can make use of the platform. In this wat shippers are offered a more complete platform that a Cadex for all (large) Dutch ports.

• Since the digital connections can be used for other purposes than only cargo data exchange, DBS should investigate whether it might be interesting to share the new port infrastructure with other digital eco-system players and DBS products and thereby improve their value. With adjustments and other agreements with data suppliers, Portbase could also use the connections to exchange relevant vessel, cargo and port data with data suppliers, e.g. ISPS data as explained in appendix H. The same goes for PortXchange that could use the connections to retrieve and exchange vessel related data, they can use this data to improve the JIT sailing on the physical connections between the port of Rotterdam and the data supplier. The connection can also be used for Deliver, a digital product of DBS in developed in cooperation with ABN Amro. There are several global flows in container trade: the physical flow of containers, the paper flow that is now becoming digital and also the financial flow. This financial flow is characterized by the payments that sometimes come weeks later after the physical flow was executed. By using Block-chain technology DBS has managed to tie those flows together, and create a single point of truth for all these flows. The product can be compared with a traditional notary who communicates this 'single truth' between commercial and non-commercial platforms. With Deliver insurers or bankers now know exactly where, when and at which party a container is located and what action was performed. In this way they can finance an entire trade lane at once and its possible to distribute the money immediately when a container arrives at another party.
By collaborating with Portbase, Portxchange and Deliver, the developed digital infrastructure can increase in value for the data suppliers, shippers, carriers and port authorities. Next to cargo data exchange it could incorporate the financial flows between shippers and logistic chain players, it could enable better JIT sailing and can exchange B2G data between ports.

• In order to cope with the recent Chinese influences in Mediterranean ports, a cooperation between Rotterdam, Antwerp and Hamburg might be necessary. It could be interesting to develop Cadex together with the port authority of Antwerp and Hamburg from a geopolitical perspective, in order to maintain a strong position in Europe. Since competitors are bought by Chinese state-owned enterprises and that have large financial resources. These large investments in the competing ports could eventually harm the positions of Rotterdam, Antwerp and Hamburg. Therefore, it might be a strategic move to involve them in the development of Cadex and together build a strong digital platform for North-Western Europe.

• DBS could investigate if forwarders are also an interesting target group for Cadex. The Forwarder segment was beyond the scope of this graduation project, however they might also be an interesting target group that could be connected to the platform on de data demand side. A significant aspect of a forwarder's work, is to inform clients about the status of their cargo and making arrangements for these clients to deliver their cargo according to schedule. The data available on the platform could support forwarders in their work and also holds value for them, making forwarders potential clients for the platform.

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Appendix