



**PORT OF ROTTERDAM**  
**Adaptive Port Masterplanning for Europoort**

Final Report

**CIE 5060-09 MSc Thesis**

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# Preface

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This report is the research carried on for my Master Thesis of Hydraulic Engineering at TU Delft; and it is part of the cooperation agreement between the Port Research Centre at Port of Rotterdam and TU Delft. For me, this was an insightful and priceless opportunity to work at Port Planning within the Port Development department at the World Port Centre in Rotterdam. Furthermore, this was the perfect ending for my Dutch adventure and one of the nicest memories I have from The Netherlands.

First of all, I would like to thank everybody within Port Planning; you made me feel part of the team from the very first day. Thanks Merche for the daily chats in Spanish; Roel and Chenny you rock, guys; Linda and Jelle, for being always open with insightful and nice discussions; Cees for your support and unique jokes; Kees and Michel, for your daily fellowship and for being always ready to join a non-planned brain storming session related with my research; and the rest of the team for being great colleagues, always open minded and very welcoming with me. Of course, special thanks to my daily supervisors at Port Planning, and members of my Thesis Committee, Martijn and Peter, you made this possible and I will be always grateful with your support, time advocated and your friendship; it was great teaming up with you!

Secondly, I owe my thanks to many professionals within Port of Rotterdam and also outside of the port that took their time to help me during the different stages of my research, either for the initial interviews, for the workshop sessions, for the brain storming meetings, or for all of them. Without you, this work would never become reality. Your contributions were very valuable and highly appreciated.

Thirdly, I want to express my appreciation to PIANC, and especially due to the support provided by PIANC Argentina for my MSc at TU Delft in The Netherlands. Thanks Raúl and Sebastián. Besides, thanks to my family and friends whom continuously encouraged me, and particularly to my girlfriend Vale, who is my daily supporter (and that is not an easy task).

Finally, my gratitude goes to my Master of Science Thesis Committee that was always advising me in a very nice and comprehensive way. Thank you Poonam for inspiring me with your lectures of Adaptive Port Planning and for your constant help. Thank you Marcel, for introducing me to the world of engineering management towards success, valuing engineering and opportunity framing. Thank you Tiedo for everything; for chairing this committee; for encouraging, guiding and bringing clarity during my whole stay; for trusting and promoting me to do my MSc Thesis at Port of Rotterdam, even though my limited Dutch skills, *maar dank je voor elk moment dat we deelden, en voor het me thuis voelen in Nederland.*

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# Summary

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*“The secret of all victory lies in the organization of the non-obvious” - Marcus Aurelius, Roman Emperor (ca. 150 AC).*

Waterborne transport infrastructures play a crucial role in global integration, and ports are key components to materialise this amalgamation. However they are constantly challenged to keep fulfilling their functions in a changing environment. Port of Rotterdam, the largest port in Europe and the Western hemisphere too, faces those challenges on a daily basis. In order to maintain and enhance the future efficiency of the Harbour Industrial Complex, strategic adaptations based on long-term planning are required. This is more relevant on those existing port areas such as Europoort, where basic infrastructure is approaching the end of their life cycle, and fragmentation of original plots led to inefficient use of the land and some waterfront areas.

In order to meet these needs, this study presents the application of Adaptive Port Planning framework (Taneja, 2013) to the existing Europoort Masterplan for increasing its robustness while ensuring that the port has the license-to-operate and the license-to-grow in the long-term. The Adaptive Port Planning approach goes further than the traditional port planning approach throughout incorporating uncertainty and flexibility considerations. Furthermore, this project also integrates the PIANC Green Ports approach (PIANC, 2014b), as well as other existing frameworks towards a sustainable growth of the port.

To achieve the proposed goals, it was first necessary to define success for the Europoort area. This pioneering exercise on existing port areas resulted in a comprehensive list of indicators for monitoring the evolution of the port. Thereafter, main uncertainties underlying the existing Masterplan were identified and categorised as vulnerabilities and opportunities by means of an extensive literature review and several tools of Adaptive Port Planning such as brainstorming sessions, workshops and interviews with many professionals at Port of Rotterdam. Even if it is rather difficult to segregate vulnerabilities and opportunities for specific areas, this was possible in case of some uncertainties, while others were found relevant for the entire Port of Rotterdam. Finally, concrete actions to reduce the identified vulnerabilities and seize opportunities were included within current planning strategies. These actions include facilitating land reuse; optimising use of the available land and waterfront areas; improving the overall performance of the port by monitoring the functioning of existing terminals; enhancing ecosystems and nature by thinking beyond legislation; improving social environment and life quality, hereby stressing that Port of Rotterdam planning is not constrained to current port area's boundaries; and at last, but not least reducing infrastructure lifecycle costs.

Europoort Masterplan 2030+ is the main outcome of this research. It summarises all the proposed actions for dealing with uncertainty through including flexibility and sustainability into the planning. It is also important to note that the Europoort Masterplan 2030+ is based on strategic cargo concepts, and not on cargo segments. Particularly, these strategic cargo concepts for the Europoort are: Energy Port, Fuel Hub, and Standardised Cargo Port. Each of these strategic cargo concepts are linked with flexible basic infrastructure (multi-purpose & multi-user quay walls and jetties), which allows adaptation from one use to the other envisioning minimum downtimes during the lifecycle of the assets at Port of Rotterdam.

For a successful implementation of the proposed approach, some recommendations to adapt present internal organisation and project development processes are given. Consolidating conceptual designs with a multidisciplinary project team during initial stages of possible future projects (phase 0); including flexibility and ecosystem services valuation to support project's decision-making process; including opportunity framing (Bakker, Kleijn, & Hertogh, 2014) and Value Engineering (SAVE, 2014) as enablers of innovation within projects; and controlling terminal's and facilities' performance by an expert team after the capitalisation of a project, are foreseen as a key aspects for smooth transitions from planning to realisation of sustainable and flexible growth at Port of Rotterdam.

In conclusion, this study presents an applied case of long-term planning under uncertainty for existing port areas at Port of Rotterdam. The main result is a set of actions in the form of **Europoort Masterplan 2030+** for tackling non-obvious (uncertain) future problems through embracing uncertainties now, and converting them into opportunities. The objectives of all of those proposed actions are intrinsically related with maintaining the competitiveness of Port of Rotterdam in the future and the promotion of positive changes in the culture of the organisation. Moreover, these encourage smooth and pro-active transitions from the planning to business, but always keeping in mind a strategic long-term thinking to enhance the benefits for the generations to come and the reduction of inequality thru the originated added-value for society at Port of Rotterdam.



# List of Symbols & Abbreviations

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APMP	: Adaptive Port Masterplan
APP	: Adaptive Port Planning
ASCE	: American Society of Civil Engineers
BP	: British Petroleum
BRICS	: Brazil, Russia, India, China and South Africa
CAPEX	: Capital Expenditures
CBA	: Cost-Benefit Analysis
CCS	: Carbon Capture and Storage
CPB	: Central Planning Bureau, but it should be Netherlands Bureau for Economic Policy Analysis
DCF	: Discounted Cash Flow
DER	: Dose Effect Rate
DPM	: Diesel Particulate Matter
DTA	: Decision Tree Analysis
DTAT	: Dynamic Turn Around Time
ECT	: European Container Terminals
EFQM	: European Foundation for Quality Management
EMBT	: Economically Most Beneficial Tender (or “EMVI” in Dutch)
ESI	: Environmental Shipping Index
EU	: European Union
FSRU	: Floating Storage and Regasification Unit
GAAP	: Generally Accepted Accounting Principles
GHG	: Greenhouse Gas
GNP	: Gross National Product
HIC	: Harbour Industrial Complex
HLH	: Hamburg-Le Havre range
IAPH	: International Association of Ports and Harbours
IER	: Improvement Effect Rate
IMF	: International Monetary Fund
IPCC	: Intergovernmental Panel on Climate Change
IRR	: Internal Rate of Return
IWT	: Inland Waterway Transport
KPI	: Key Performance Indicators
LNG	: Liquid Natural Gas
MGA	: Mutual Gains Approach
MIT	: Massachusetts Institute of Technology
MP7+	: Masterplan 7 (improved version) for Maasvlakte 2
MP13	: Europoort Masterplan 2013
MP15	: Harbour Industrial Complex Masterplan 2015
MSL	: Mean Sea Level
MSc	: Master of Science
MV1	: Maasvlakte 1
MV2	: Maasvlakte 2
N/A	: Not Applicable
NEI	: Nautical Efficiency Index
NO <sub>x</sub>	: Nitrogen Oxide
NPV	: Net Present Value
NSI	: Nautical Safety Index
NV	: Naamloze Vennootschap (Limited Liability Company)

OECD	: Organisation for Economic Co-operation and Development
OPEX	: Operational Expenditures
PIANC	: Permanent International Association of Navigational Congresses <i>Now: The World Association for Waterborne Transport Infrastructure</i>
PD	: Port Development (Port of Rotterdam Authority Department)
PM	: Particulate Matter
PoR	: Port of Rotterdam
PoRA	: Port of Rotterdam Authority
PoRInt	: Port or Rotterdam International
PP	: Port Planning (Area team within Port Development)
PPP	: Purchasing Power Parity
Q&A	: Questions & Answers
RAE	: Real Academia Española (Royal Spanish Academy).
RMT	: Review of Maritime Transport
ROA	: Real Options Analysis
RoRo	: Roll-on / Roll-off
RWS	: Rijkswaterstaat
SAVE	: Society of American Value Engineers
SCBA	: Social Cost-Benefit Analysis
SEI	: Safety and Environmental Index
SO <sub>x</sub>	: Sulphur Oxides
SQ	: Research sub-question
SSM	: Strategic Stakeholder Management
SWOT	: Strengths-Weaknesses-Opportunities-Threats
TBD	: To Be Defined
TUD	: Technische Universiteit Delft (Delft University of Technology)
ULCC	: Ultra Large Crude Carrier
UN	: United Nations
UNCTAD	: UN Conference on Trade and Development
USA	: United States of America
USACE	: United States Army Corps of Engineers
VE	: Value Engineering
VLCC	: Very Large Crude Carrier
VLOC	: Very Large Ore carriers
WACC	: Weighted Average Cost of Capital
WEF	: World Economic Forum
WRR	: Wetenschappelijke Raad voor het Regeringsbeleid (Dutch Scientific Council for Government Policy)
WwN	: Working with Nature
YP-Com	: Young Professionals Commission

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# Chapter 1. Introduction

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Since ancient times, navigation and ports play a crucial role in human kind evolution and way of living. One of the main columns for richness and expansion of ancient civilizations relied on maritime power, sea trade and ports. Nowadays, on the one hand the world is completely different from former times; but on the other hand, the situation has not changed that much. Efficient transportation systems are primarily driving the economy development and prosperity. Therefore, with around 80 percent of global trade carried by sea and handled at ports, the maritime transport remains an essential factor (UNCTAD\RMT, 2013).

Here a pause is compulsory to explain what a port is. The definition does not vary a lot from one language to the other. In Spanish, English or Dutch, it is almost defined in the same way: *a town or city with a harbour or access to navigable water where ships load or unload* (Dale, 2008; Oxford University Press, 2014; Real Academia Española, 2014). However, this definition seems to be completely outdated. Ports are much more than a place to load and unload cargo and/or passengers. Ports have evolved into very complex patterns becoming global logistic hubs, industrial clusters, business cores and innovations & knowledge centres (Bosch, Hollen, Volberda, & Baaij, 2011). Ports also include recreation facilities, cultural districts, environmental enhancement areas, residential housing complexes and historical heritage. Hence, to put it simply, ports, cities and ecosystems are, at the same time, intrinsically integrated and disconnected. However the path to increase port-city-nature performance is on-going (OECD, 2013).

However globalisation, new technologies, scarcity of nature areas, uncertain economic trends, increased government regulations and growing sector competitiveness are constantly threatening port systems and international shipping services (UNCTAD\TDR, 2013). To overcome these challenges in a sustainable way, comprising people, planet and profit (PIANC, 2014b); every component of the maritime trade chain needs to be properly prepared, and ports are one of the main links in that chain.

Rotterdam started to develop as a trading city in the 14<sup>th</sup> and 15<sup>th</sup> century with the creation of the Oude Haven and the Nieuwe Haven, as it is shown in Figure 1-1.



Figure 1-1 The Oude and the Nieuwe Haven on the right bank of the Nieuwe Maas (Rotterdam Municipal Archives)

It was in the 17<sup>th</sup> century when Rotterdam became the leading commercial hub in the Beneden-Maas region overtaking Dordrecht (Port of Rotterdam, 2014b). Since then, Port of Rotterdam (PoR) kept

growing until becoming the world's busiest port. This lead position based on total throughput was maintained from 1962 until 2002. Nowadays, it is the largest port in Europe and the eighth in the world with 440.5 million tonnes as total throughput in 2013 (Port of Rotterdam, 2014d). In 2013, the total area of the Harbour Industrial Complex (HIC) reached 5,971 hectares, including the added issuable land in Maasvlakte 2 (MV2). A general overview of the HIC is shown in Figure 1-2 and Figure 1-3.



Figure 1-2 Satellite view of the Harbour Industrial Complex (Port of Rotterdam, 2014k)

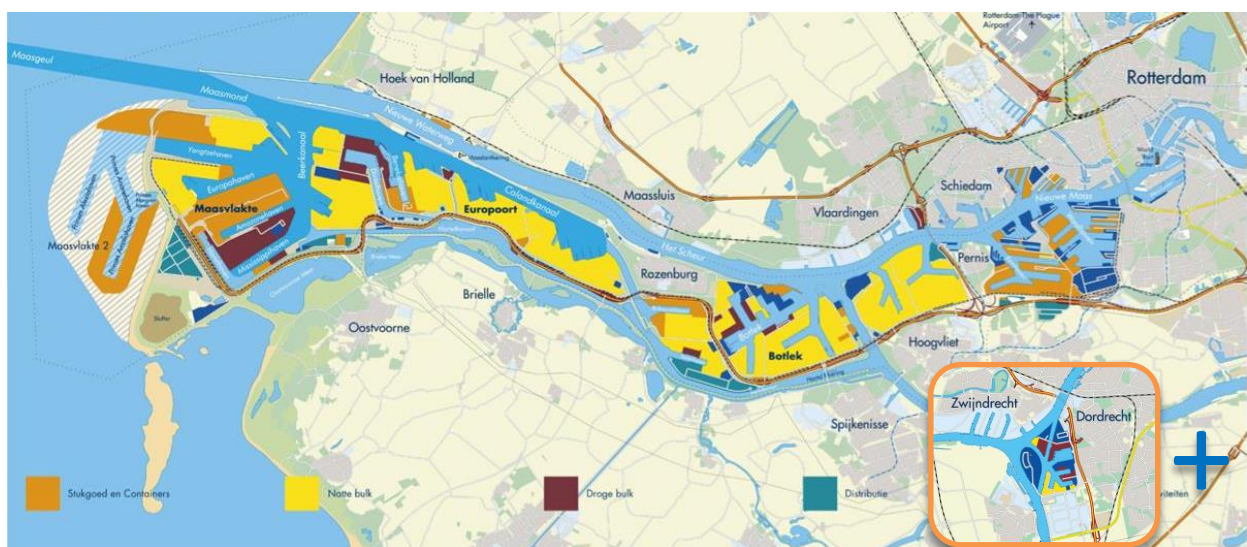


Figure 1-3 Aerial view of PoR with each port sector delimited. From left to right: Maasvlakte 2, Maasvlakte 1, Europoort, Botlek, Eemhaven, Waalhaven on the left bank; Merwehaven and IJsselhaven on the right bank (Port of Rotterdam, 2014k)

Nonetheless, Port of Rotterdam is immersed in a very dynamic region with extremely high competition among the different ports of the Hamburg-Le Havre range. Although the next European competitor is handling less than half of PoRs' total throughput; PoR shall keep an active front runner state to preserve its foremost position. Hence, applying innovative solutions to minimize current and future risks should be one of the principal statements. This shall be achieved in a sustainable way, by integrating economic, social and environmental aspects; and considering all possible interrelations (PIANC, 2014b; UN, 2012).

Previously noted challenges are uncertain and play a crucial role for port planning and design. Despite this, several of them are not taken into account in traditional port planning (Taneja, 2013). Likewise, not recently developed areas at PoR, such as Botlek, Europoort and Maasvlakte 1, are not an exception.



## 1.1. Problem definition

This section briefly discusses the problem motivation for this research, which mainly is preserving Port of Rotterdam as a front-runner port in the world.

### 1.1.1. Existing infrastructure at Port of Rotterdam

Port infrastructure is the set of basic services and facilities, arranged in a specific configuration, that are needed for the creation and operation of a port. In junction with the road, railroad, pipeline and air transport systems, ports define the infrastructure of a country which is one of the four basic requirements of global competitiveness (World Economic Forum, 2013). Nevertheless, worldwide developments were and are continually challenging ports' capabilities to comply with current and future demands. There is no need to stress the importance for The Netherlands to preserve what is acknowledged as the best port infrastructure in the world (World Economic Forum, 2013), in which Port of Rotterdam plays a crucial role to keep enhancing and maintaining Dutch global competitiveness.

Despite of last major investments in the HIC, some core areas of the port still require attention. Among those, Botlek and Europoort, that started to be developed in 1950s and 1960s (Port of Rotterdam, 2014b), are of special interest. At that moment, there were only few limitations for port expansion in the area. As a result, infrastructure and port layout developed in accordance to clients and market demands of those times. In addition, Port of Rotterdam Authority (PoRA) was not executing a clear active policy towards port expansion until 1990s. Primarily, it was around 20 years ago when a more commercial-driven strategic development started to be carried on at managerial level. However, despite of this change, the implementation phase of those strategic visions and plans was hindering a smooth and organized enhancement of Europoort and Botlek areas. Besides, due to the lack of this proper integration between commercial interests and strategic infrastructure developments, some problems were faced later on. It is in 2012, when the Port Planning team at PoRA started to integrate and implement the lessons learnt during the past years. But it is still an on-going process.

Consequently, nowadays some peculiar port configurations, non-regular land lease areas, empty spaces without access to the waterfront, non-uniformly distributed services, and mixed zoning uses are found either at Botlek or Europoort. General overviews of both areas are shown in Figure 1-4 and Figure 1-5.

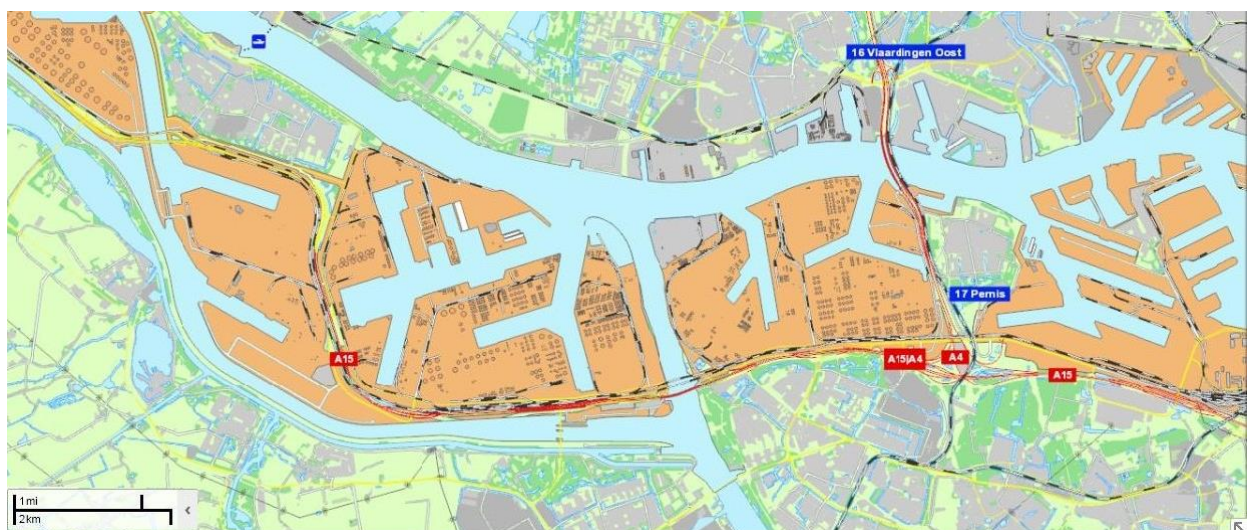


Figure 1-4 Botlek aerial view (Port of Rotterdam, 2014k)

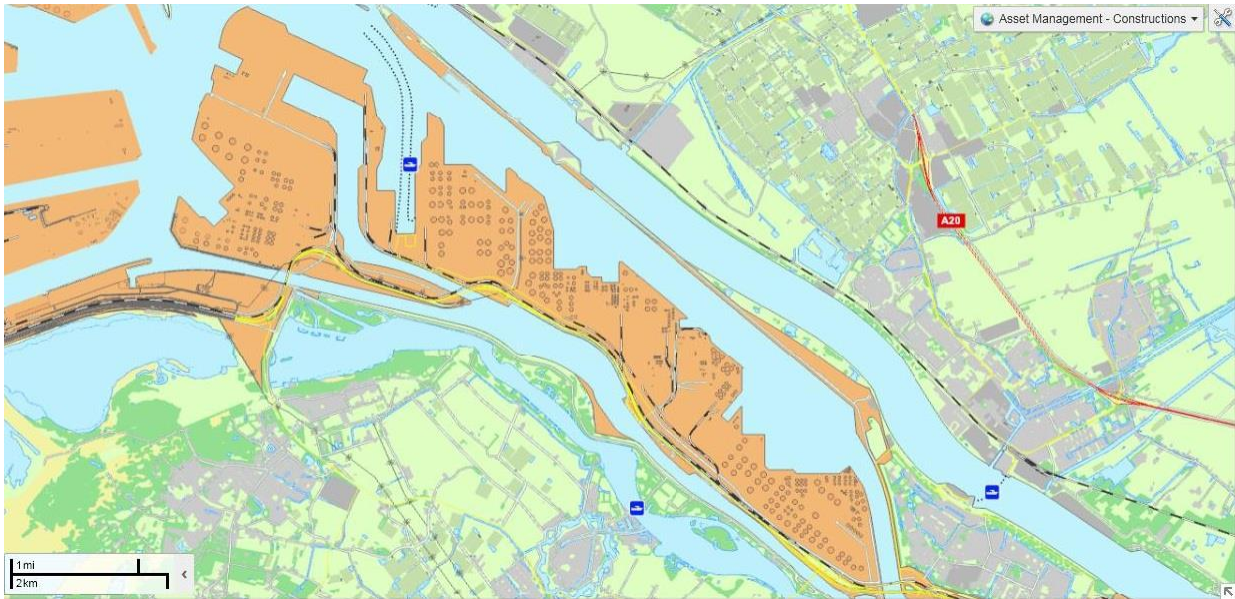


Figure 1-5 Europoort aerial view (Port of Rotterdam, 2014k)

Besides, current port economic trends, new technologies, old infrastructure, larger demands on the water areas, both population and port growth combined with land scarcity resulted in the need for efficient management of the land. All this defies the future efficiency of PoR. Thus, adaptation of existing infrastructure, development of new facilities and land zoning present a huge challenge in order to optimize the use of finite resources: port land with its nautical related areas and infrastructure.

### 1.1.2. Uncertainties confronting port planners

Uncertainty is described in several ways within existing literature. In Spanish is defined as the contrary of certainty; and certainty is the complete and clear knowledge of everything (Real Academia Española, 2014). In English is defined as the state of being uncertain. And uncertain is outlined as not to be relied on; not known or definite (Oxford University Press, 2014). Some other explanations may denote uncertainty in a graphical and literate way like the Nobel Prize in Literature 2010, Mario Vargas Llosa, who compared uncertainty with “*a daisy whose petals are never fully plucked*”.

So uncertainty is in everyday life; and port infrastructure planning is not an exception. It faces up several uncertainties. The major unknown parameters conditioning port planning and design are possible crisis on global demand, trade and finances; changes in global production patterns; availability and uses of natural resources; shift of economic influence to developing regions; demographic distribution, population aging in developed countries and population growth in emerging countries; scarcity of land; transport-related technological innovations; climate change and natural disasters; environmental preservation; energy costs and sustainability growth (UNCTAD\RMT, 2013).

In particular, Botlek and Europoort are areas much more sensitive to the mentioned uncertainties than the newly developed areas of the port, such as MV2. Several reasons are found to explain the previous statement.

Firstly, during the last years, major efforts done by PoRA were primarily focused on the planning and progress of MV2. This is the only area at the HIC that is fully developed with a comprehensive approach and with major interventions from PoRA. Secondly, the companies materializing the industrial core in Rotterdam are mostly located in Botlek and Europoort. This industrial area, in junction with some other

industries in Maasvlakte 1, represents more than 55% of the revenue of PoR and occupies more than 60% of the port lands, generating 13,000 direct jobs and more than 60,000 indirect jobs (Port of Rotterdam, 2010, 2014d, 2014j). Among these industries, oil refineries, crude oil terminals, chemical and petrochemical companies represent almost half of the total throughput of PoR. The complexity of these sectors is even larger considering the possible depletion of fossil fuels reserves in the future. Besides, global efforts towards a more sustainable energy model may lead to a change of the predominant paradigm in this field. As a possible result and due to the overcapacity of refineries in Northwest Europe, the dismantling of one or more of the refineries may trigger the beginning of a drawback scenario for the biggest liquid bulk port in the world (Port of Rotterdam, 2013e). Lastly, some concern is raised about the continuity of some specific companies at Europoort.

Therefore, it is very challenging for port planners to find solutions in early phases that solve these uncertainties in the future. Nevertheless, if solutions are achieved during planning phases, extra value is generated, and this value should be quantified in order to make real those solutions (Ramírez, 2002; Zhao & Tseng, 2003). However this last step is even more challenging within current practices.

To summarize, the fact is that *“uncertainty is here to stay, we must recognize it, prepare for it, adapt to it, manage it and profit from it”* (Taneja, 2013).

### 1.1.3. Planning for 2030 and beyond

As stated, when dealing with port infrastructure adaptation, planning is done under conditions of uncertainty, whereby many future scenarios are possible. Hence, if a port cannot achieve possible required adaptations and changes in each proper moment, it will lose cargo and consistently, it will become less competitive.

This adaptation should be planned and not only be an impulsive occurrence of order. It should be thought and implemented in advance to be one step ahead. It should also try to avoid only a client-driven reactive behaviour as a prevalent state-of-the-art. In summary, it should be a pro-active tactic that generates resilient and sustainable solutions. Likewise, these solutions are based in planning assumptions that are time dependant. The variability of those assumptions, in a certain period of time, determines the different planning horizons. These planning horizons are very important because they set the duration of the plan. Moreover, the diverse planning strategies are directly defined by each planning horizon (Dewar, Builder, Hix, & Levin, 1993).

Nevertheless, each planning horizon is also associated with a particular level of uncertainties. Consequently, for a given planning horizon, there is a certain level of uncertainty that determines the planning strategy to be implemented. The planning strategy should contain a proper valuation method, including a comprehensive value of flexibility (Taneja, 2013).

Nowadays, almost every area at PoR is planned for the year 2030 as time horizon (Port of Rotterdam, 2013b, 2013d, 2013f). There is no need to mention that unless an extreme event occurs, PoR land and its basic infrastructure will remain in use for longer periods of time than current masterplans. Therefore PoRA current planning policy aims at short and/or medium-term solutions. Although efforts in newly developed areas like MV2 are carried on thinking beyond the year 2030. Therefore, this present situation highlights a weak point in the long-term planning and its adaptability for future uncertainties. This status quo may have larger impact in Botlek and Europoort due to the fact that they did not receive

too much attention during the last decades, if compared with some other areas. Thus, in case of uncertain future developments requiring changed functions or use, it is essential that infrastructure and land use can be flexible to meet possible new requirements. To put it simple, a balanced lifecycle approach is desirable (PIANC, 2006, 2013; Toorn & Gijt, 2013). This means maximising the service lifetime, length in which infrastructure remains effectively in use without adaptation. It implies matching infrastructures' economic, design (or technical), commercial and compliance lifetimes (BSi, 2008). This is not an easy process, at least when not designing specific world class infrastructure that sets global standards (i.e. Panama Canal, Suez Canal, et cetera).

For hydraulic structures, such as port infrastructure, the design lifetime is dependent on the type of structure and its function (as for every structure). Usually the design lifetime is in between 25 to 100 years (USACE, 2003). Hence, it is clear that for new infrastructure to be developed at Botlek or Europoort, the planning horizon is not matching with the infrastructure service lifetime. This results in underestimation for the long-term planning. Besides, existing infrastructure and land use should be thought in order to maximize the economic, technical (or design), commercial and compliance lifetimes. Therefore, incorporating flexibility and adaptability in any port planning process to cope with medium- and long-term future uncertainties is a must.

Finally, it is also important to point out the need to match ideal development situations in the long-term for every stakeholder, and not only for PoR. Therefore, PoRA should define the framework articulating every interrelation, within clear boundaries, to accomplish a sustainable progress and to maintain PoR as the global prime port. Consequently, PoRA needs to take the lead in implementing also a comprehensive approach dealing with medium- and long-term planning. It is indispensable to keep moving forward converging and improving the several actions already taken by PoRA. To accomplish this, Adaptive Port Planning (APP) framework is proposed (Taneja, 2013). This planning approach goes deeper into the analysis than the traditional port planning by incorporating uncertainty and flexibility considerations.

## 1.2. Background

This section presents related information about the previously discussed problems.

### 1.2.1. Evolution of PoR infrastructure and PoRA policies

After World War II, Europe required an industrial centre to rebuild large areas in the continent. To do that, several resources were needed and Rotterdam was the perfect gateway for importing those products. Besides, increasing demand for fuels in Europe high-rocketed the construction of refineries. Accordingly, businesses in PoR at that time were queuing up. Four major refineries were constructed in a very short period of time in Botlek and Europoort during the 1950s and 1960s. First Shell set up business in 1959; followed by Gulf in 1962 (currently Q8-Kuwait Petroleum Europoort), British Petroleum (BP) at the beginning of 1965 and Mobil Oil at the end of the same year. At that time in Rotterdam and its surroundings land was available and PoRA leased it at very low price. Besides environmental regulations were not even in the horizon and neighbouring communities were not manifesting an important opposition to the expansion of the port. With this favourable scenario, liquid bulk throughput exponentially grew. Fast rising petrochemical industries needed land to growth their operations and PoRA focused on it with a clear client-driven scheme. Moreover, PoRA developers did not fully thought the challenges the port would face 50 years later. The predominant way of thinking

was mainly planning in a static way, based on single-point forecasts and target-oriented with responses to strong indicators. Consequently major plans for PoR were developed covering much larger areas than current HIC footprint. However, the oil crisis of 1973 sank those plans; shifting the situation from a temporarily shortage of space to an over-availability of land within the existing developed areas. Instead of the initial expansion plans, only a few investments were done during the 1970s and 1980s, essentially on new evolving segments, like containerized cargo. The attention on ship-to-shore infrastructure was also partially left aside during that period of time (Port of Rotterdam, 2014b).

Unlike those pioneering container companies and bulk stevedoring companies, industrial companies (mainly petrochemical) that wished to establish a production facility in Rotterdam had no need for costly quay walls. Hence, until the end of 1980s, it was the port formal policy that PoRA would build quay walls for its customers, but no jetties or dolphins. Jetties were generally regarded as being too dedicated and client-specific; thus left to the petrochemical companies to invest in. Besides industrial clients usually were very wealthy and had no need for PoRA to invest in their jetties. They were also used to do that themselves and not outsourcing to third parties, as it represented a minor percentage of their investments. Nonetheless, by the end of 1980s, Rotterdam's petrochemical companies were struggling and desperately looking for new investments. PoRA wanted to support and facilitate these new investments by taking the capital expenditures necessary to construct new jetties out of the companies' responsibilities. By doing so, the companies could concentrate on investing in their core businesses: the industrial plants and production facilities. At the same time, even the largest industrial clients were starting to look for ways to diminish their capital expenditures. In addition, from a commercial point of view, it was hard for PoRA to explain why a new container terminal settling in Rotterdam was provided with quay walls by the port authority, but a new industrial company had to construct its own jetties and mooring facilities. Therefore the management decided to stop with this division and change the policies. As a result, the first industrial customer-jetty was built by PoRA in 1990/91. It is the Caldic jetty at Europoort. PoRA only constructed the jetty infrastructure including the foundation piles, the deck and the mooring dolphins. The superstructure facilities (pumps, manifolds, pipelines, et cetera) were designed, constructed and managed by the client itself, and it is in this way until now. This policy change turned out to be a success. It was a major contributor to a long and fruitful string of petrochemical investments in PoR, such as Caldic, ARCO/Lyondell, Eastman Chemical, BP, ExxonMobil, Argos, Booy Clean, Abengoa, Euro Tank Terminal and Vopak (Port of Rotterdam, 2014b, 2014i). Alternatively, in accordance with PoRA policy's evolution and aims, a stronger argument started to emerge: safety and quality within the HIC. By constructing and providing jetties, PoRA can vouch for and safeguard their quality and safety. In contrary, that was not the case with private-owned jetties. Even still now when PoRA does not exercise ownership of the infrastructure, it may result in complicated situations. However, an active attitude of PoRA can intercede with the customers to preserve everywhere within the port, safety and quality standards.

To bring a far-reaching overview, some extra background is discussed about other sectors at PoR as well. In the 1960s, for the very first time, the decision to reclaim land in the port was done and materialised. The outcome was Maasvlakte 1, where some companies set over there in the 1970s. The formerly purpose of this area was to allocate steel furnaces and steel factories. However, that never happened due to unexpected circumstances in global and European economic trends. Nevertheless, this extra capacity in a large-scale approach, and a quota of luck, allowed ECT to build the Delta Terminal in early 1980s in Maasvlakte 1. Thus, PoR positioned as the major European container port taking the advantage over any other in the region. On the other hand, environmental awareness started

to become a perplexing situation for PoR and Europe, but it also played a key role on enhancing Dutch life quality. Those historical and first green initiatives were translated into the port with the construction of the Slufter (Port of Rotterdam, 2014b, 2014i).

All these things, among others, converged in mid 1990s and conducted PoRA to move from traditional civil engineering-driven management to a more commercial-engineering-driven management. This change led to a longer-term planning embracing in a broader manner PoRA interests, at least if compared with previous situation. Several plans were shaped, some of them very successful, as the one that concluded with the already mentioned MV2 construction. Some other plans, like the Year Plan 2006-2010 (Port of Rotterdam, 2005) with insightful strategic ideas for the port, were not very effective. Although those plans were much in line with current Port Vision 2030 (Port of Rotterdam, 2011), they did not succeed, mainly due to lack of a proper implementation phase. It was a learning process, but this deficiency in the implementation phase, resulted into sensitive situations for a balanced and sustainable development of PoR.

In addition, conflict of interests between commercial willingness and the evolution of infrastructure developments appeared. These plausible clashes resulted in very costly ulterior adaptations in different sectors of PoR. Some other important complications at PoR showed up, scarcity of waterfront and land were and are very thoughtful topics to be also considered in a holistic long-term plan.

Therefore to integrate in a harmonic way, every sector of PoR, into a comprehensive port planning; PoRA decided to create a new department a couple of years ago: Port Development (PD). This was also motivated by the successful planning experience of MV2. PD aims developing the port industrial complex by ensuring efficient, secure, flexible and future-proof –suitable within the environment-growth. Likewise, PD pursues to accommodate traffic flows, establishment of business, and to maximize the use of available land. PD also wants to add value in the port and the industrial complex, as well as preserving the financial return for PoRA. All this should be articulated in accordance with the aspirations of the Port Vision and Business Plan (Port of Rotterdam, 2011). PD was successfully created and started to operate in a short period of time. Within Port Development department, the Port Planning (PD-PP) team was set to define PoR planning in order to keep operating and growing. However, as it was mentioned in the Introduction, this is a starting process, that is increasing its effectiveness step by step in order to strengthen the position of PoR. To conclude, it is important to point out that the aim of this research is to contribute for the enrichment of this practice.

### 1.2.2. Uncertainty

*“No one is so brave that he is not disturbed by something unexpected”, Julius Caesar*

Several times, questions are raised doubting about the briefly described flexible planning strategy. How can PoRA plan for uncertain futures in the long-term? is a daily question when discussing with PoRA planners. Therefore, shifting predominant way of thinking within PoRA is an initial major challenge.

Adding extra value in the port planning phase by incorporating flexibility is one of the main goals for this research. To achieve that, some paths may be explored depending on the type of uncertainty acknowledged.

For instance, nowadays a particular situation can be found primarily at Europoort. Some land lease contracts are going to expire in some years. Moreover an important part of those contracts are in

relative small parcels. However as it is predictable, not every contract will expire at the same moment. This is a natural consequence in almost every long-lasting port areas that started to be leased several years ago, and occasionally for many times. At the beginning generally the port areas are leased as large parcels. But due to uncertainties (economy trends, technology changes, et cetera), some businesses may succeed, meanwhile others may not achieve the expected results. Subsequently, PoRA claimed back the areas where the businesses did not succeed, to be leased again for new industries, causing the mentioned fragmentation. This complex puzzle of terrains with mixed uses or without access to services or waterfront should be prevented on the areas under development and reconstructed gradually in the already developed areas.

Therefore concerning port planning, grouping land lease expiring dates may result in merging terrains to adapt the land use in the future. This can be done by incorporating technical and commercial discussions with the clients that want to develop and/or set a new activity at PoR to reach a common understanding and approach.

Concerning infrastructure, two paths may be researched. Long-term adaptable, flexible and/or reusable infrastructure may be studied and not only for the port. This should be done in junction with the terminals. On the other hand, short-term infrastructure could be developed in expiring contracts areas unless they ensure a commitment to intensify the use of the land. Nonetheless, the second alternative presents several difficulties from technical and economical point of view.

Summing up, massive and expensive infrastructure or changes on the layout should not be accomplished without having a complete long-term planning beyond 2030. Thus, new infrastructure developments should consider possible long or short lasting situations for each particular business, but also for several other possible businesses in case the starting up one is not succeeding. Thus, build flexible infrastructure that with minor modifications and/or adaptations, would allow matching economical, commercial, compliance and technical horizon is highly important to attain PoR sustainable growth and operations under uncertainties.

### 1.2.3. Current planning process

Present planning process at PoRA, developed and applied by PD-PP, is the sum of many years of lessons learnt. It is a process under continuous improvement, at least since the creation of PD. It is based in a medium-term strategy specified in the Port Vision 2030 (Port of Rotterdam, 2011) and the Commercial & Business Plan 2013-2017. The strategic sector goals are derived from specific sector's masterplans, i.e. Masterplan Botlek-Vondelingenplaat 2013 (Port of Rotterdam, 2013b), Masterplan Europoort 2013 (Port of Rotterdam, 2013d), Masterplan Maasvlakte 1 (Port of Rotterdam, 2013f), et cetera.

The Port Vision is committed to a strong combination of the Global Hub and Europe's Industrial Cluster. In particular, the development strategy of Europoort and Botlek-Vondelingenplaat is focused on reinforcing the concepts of Energy Port, Chemical cluster & Fuels hub. This means that a particular emphasis is envisioned in the segments of bio-based & chemical industry, crude oil, refining and independent tank storage. In addition, it is intended the strengthening of Ro-Ro terminals in the area and the retention of other segments. One of the main differences between these two sectors is that for Europoort, PoRA also aims for reinforcing the dry bulk sector. For all these activities, PD-PP studies *what* market developments are possible, *which* impacts create on the available space, *where* can be accommodated the best and *if* this should be achieved.

Based on the information collected by PD-PP “Gebiedsmanagers” or Area Managers, each Masterplan is built and then yearly updated on the principle of an Annual Masterplan Cycle for Port Planning (Port of Rotterdam, 2014f). During this cycle the masterplan strategy is updated in the light of new understandings. Consequently, it results on further integrated studies, allowing the creation of a more detailed and defined plan. Although, this guarantees masterplans with a concrete and up-to-date implementation actions; these steps were recently developed at PD-PP and are still under progress.

Despite, it is a quite detailed follow-up scheme that generates many insights; as mentioned, there is still a long way to mature a complete long-term planning due to current predominant focus on short-term operational goals and actions that hampers the implementation of flexible solutions.

As it can be expected, there are more than a few challenges to overcome. To cite some examples, matching companies’ ideal development desires and port planning ambitions is a test they need to go through. Besides, matching the interest of every stakeholder and PoRA for any project within the port area is another challenging test, especially those related to ecosystem services and social aspects. These processes should be in a dynamic way, between PoRA and those companies operating and stakeholders influencing at the port. Therefore, for possible client’s request; PoRA needs to have a very clear pro-active procedure to answer those demands. This process should also set beforehand; clear “go” and “no-go” actions containing explicit clarifications in each case. Therefore if a company’s requirement is not in accordance, or may result in a detrimental situation for some possible future developments, PoRA needs to set the limits by finding a common understanding position to keep growing and operating in the long-term. This would imply in some cases not accepting some client’s demands. In summary, PoRA should set the standards and boundaries for the companies operating at the port with a progressive tactic, as it is already doing in some particular segments, e.g. transport modal shift. In other words, synergy amongst PoRA, terminal operators, companies functioning at the port, and every stakeholder influenced by the port, should be achieved to be precursors in finding integral solutions in a puzzling and demanding circumstances.

Considering only short- and medium-term horizons in spatial planning and goals, while neglecting or ignoring long-term, may lead to significantly extra cost in future modifications in the port.

Hence, by including flexibility and sustainability into planning land reuse is facilitated; uses of the available land is optimised; ecosystem is enhanced, social environment is improved and infrastructure lifecycle costs may be meaningfully lower than on traditional masterplanning.

### 1.3. Purpose of the study

This research comprehensively applies APP framework provided in “The Flexible Port” (Taneja, 2013) for planning port existing areas. It is focused on dealing with the uncertainties based on the concept of flexibility to create robust solutions. The research is carried on for Europoort area, and it considers a long-term horizon. Actions for the selected area are fully addressed. Furthermore, some additional tools for enhancing the planning process of existing port areas are initially proposed. At last, techniques for valuing different items are briefly explored including flexibility, ecosystem services and social valuation.

The outcome is an Adaptive Port Masterplan (APMP), also named Europoort Masterplan 2030+, which is presented in *Chapter 4*. The intention is to use this proposed masterplan approach for extrapolating



this practice and its derived processes to other areas within PoR. Therefore, recommendations to implement the developed procedure within PoRAs' organisation are given as well. It is important to mention that every projected step also tries to combine APP framework with PIANC Working with Nature (WwN) philosophy and PIANC-IAPH Sustainable Ports approach (PIANC, 2014b, 2014c).

To sum up, this research anticipates being an applied case of planning under uncertainty for existing port areas at PoR. The concept of tackling possible future problems now, through embracing uncertainties, converting them into opportunities and valuing different factors within those opportunities, is the major goal. This purpose is naturally related with the intergenerational principle, the reduction of inequality thru originating added-value for society, and clearly at the end with the competitiveness of PoR in the future.

## 1.4. Research description and methodology

Firstly, an extensive literature review is carried out thru evaluating existing PoR masterplans, port vision and port strategies in general. Besides, relevant documents to apply in a concrete way APP framework are discussed as well. In addition, several meetings and brain storming sessions with professionals working at PoRA are held to attain better insights of current processes and the internal functioning of the organisation. To complete the literature review, numerous future scenarios are integrally analysed for identifying underlying assumptions within current PoRs' masterplan and vision, and for defining possible future actions to deal with these assumptions. This scenario analysis is strongly supported by the attendance to many national and international lectures, seminars and congresses. Lastly and with emphasis on Europoort, an attempt to identify main categories for success of existing port areas is conducted.

Secondly, APP framework is followed. Therefore, a wide-ranging definition of success is initially obtained based on the findings of the literature review; to be comprehensively improved later on throughout workshop sessions with PoRA key professionals. This definition of success for Europoort is also based on those acknowledged categories within the literature review. Subsequently, underlying assumptions from the achieved definition of success are recognised and linked with every reviewed document comprising the research carried out for the scenario analysis too. Every identified assumption is further assessed as vulnerabilities or opportunities during the second part of the workshop sessions. Finally, critically thought actions to increase the robustness of current plans for Europoort are presented. All of them, linked or not with flexible designs, are the direct consequence of implementing APP framework for this existing port area. The closing stage for this part of the study is the proposal of new long-term masterplan approach, which is based on concept cargo segments linked to flexible basic infrastructure.

Some of those identified actions led to initiate reflections about developing a tool to support port planning processes. Thereafter, a general guidance to implement an Adaptive Port Planning tool is provided in this report based on every previous findings. In the same line, different valuation methods recognised from the literature are discussed and combined to be further (and gradually) included within PoRA decision-making procedures.

To conclude, with all the experiences collected during extensive analysis at PoRA, and thru the literature review, various recommendations to adjust PoRA internal organisation are suggested to meaningfully put into practice this approach towards a sustainable growth for Port of Rotterdam.

### 1.4.1. Research questions

The main research question is:

***How can the Europoort Masterplan be made more robust through the application of Adaptive Port Planning (APP) framework while ensuring that the port has the license-to-operate and the license-to-grow in the long-term?***

To answer the main research question, the following sub-questions (SQ) are needed to be addressed:

- SQ1. What is current state of Europoort concerning its future development?
- SQ2. What is current definition of success for Europoort?
- SQ3. What are the basic underlying assumptions in current objectives, and in the definition of success for Europoort?
- SQ4. What are the main vulnerabilities and opportunities that can be identified for Europoort in medium- and long-term?
- SQ5. What are the main actions to increase robustness of the basic masterplan for Europoort?
- SQ6. How can flexibility, social and ecosystem services be valued to compare different alternatives in current Port Planning processes at Port of Rotterdam Authority?
- SQ7. How can APP framework be incorporated in a comprehensive way into existing planning organisational processes at Port of Rotterdam Authority?

In summary,  $\sum SQ_i =$  Main research question.

### 1.4.2. Chapter index

The structure of the thesis is as follows:

- Chapter 1. Introduction and problem definition.
- Chapter 2. Literature review & scenario analysis
- Chapter 3. Europoort beneath the lens of APP framework
- Chapter 4. Europoort Masterplan 2030+
- Chapter 5. General guidance for a case study at Europoort.
- Chapter 6. Implementation of APP within PoRA internal organisation.
- Chapter 7. Final remarks.

Finally, and within the conclusions of this research, some interesting topics for further research are suggested.

# Chapter 2. Literature review

In this chapter literature used for the research is extensively analysed and described. Most relevant sources are investigated in order to understand PoR current situation, and scientific state-of-the-art of the pertinent topics for this research. Accordingly, parts of the literature review answers research SQ1:

## What is current state of Europort concerning its future development?

In summary, present port development processes and strategies at PoRA, all the methodologies to be applied in this study, and a future scenario analysis are critically examined and presented.

## 2.1. Port organisation and strategies & Europort present situation

This first section Chapter 2 aims to describe PoRA organisation, especially in relation to most relevant port planning processes. Thus, Port Vision 2030 (Port of Rotterdam, 2011) and current PoRA strategies are exhaustively evaluated. To sum up, existing commercial status at Europort is reviewed.

### 2.1.1. The Port Authority

PoRA is a public limited company (NV) integrated by two shareholders: the Municipality of Rotterdam and the Dutch State, however it is run as a commercial company. PoRA is manager, operator and developer of Port of Rotterdam (PoR) and its industrial area. It operates in two domains: shipping and the port area (Port of Rotterdam, 2014g). PoRA leases, on long-term contracts, port sites to businesses. The main sources of income are rents and harbour dues. Besides, it invests in the development of new port sites, in public infrastructure in the port area, and in customer-specific infrastructure, e.g. quay walls & jetties. To effectively handle shipping, PoRA also invests in traffic management systems, traffic control centres and patrol vessels (Port of Rotterdam, 2014h).

### 2.1.2. Mission and strategy

The aim of PoRA is to enhance Port of Rotterdam’s competitiveness as a logistic hub and world class industrial complex. A more detailed description is shown in Figure 2-1.



Figure 2-1 Port of Rotterdam Authority ambitions (Port of Rotterdam, 2014g)

### 2.1.3. Organisation structure

The organisation chart of PoRA is shown in Figure 2-2. In the same figure, Port Development (PD) is highlighted due to the relevance within this research. PD is responsible for development and allocation, repossession, redevelopment, sale and/or purchase of port sites and commercial properties.

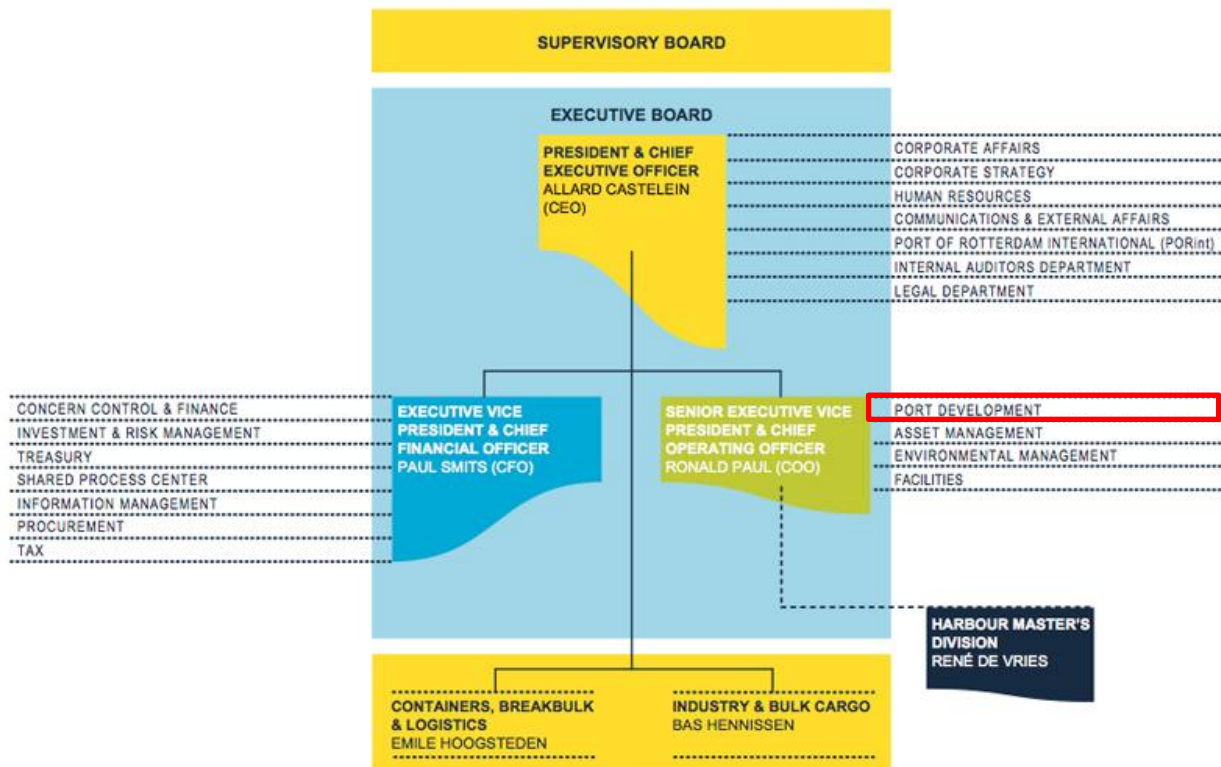


Figure 2-2 Port of Rotterdam Authority organisation chart (Port of Rotterdam, 2014h)

To successfully meet PD duties, several teams are cooperating within the department. Port Planning (PP) is one of those teams. It is integrated by area developers, designers and port planning managers (“Gebiedsmanagers” or Area Managers). The last ones are responsible for developing locked opportunities in each area of the port (Dordrecht, Waalhaven - Eemhaven, Botlek, Europoort and Maasvlakte 1). Although the already existing cooperation amongst PD professionals, and also with professionals from other departments, almost everybody agreed that integration may be enhanced. As usual for every organization, communication is crucial, however for PoRA is even more important in order to maximize opportunities that allow PoR to keep operating and growing in the long-term.

### 2.1.4. Port Vision 2030

Existing documents within the port authority delineate PoR vision for the coming years. Amongst those, Port Vision 2030 (Port of Rotterdam, 2011) is the main document dealing with this for the coming 15 years, and it describes PoRA strategy in a well-structured way. This document was approved by the city council of Rotterdam on 15 December 2011. Main introduced topics are:

“Gemeente Rotterdam”, Port & city:

- Clean energy, shifting from fossil resources.
- Reduce ecological footprint.

- Business sector: integrated chain in a small area.
- Education enhancement to set standards at the city allowing YPs to work at PoR afterwards.
- European port not restricted to a Municipality or a country including every stakeholder (*DelTri Platform*).

*Deltalinqs, Port and industries' association Rotterdam:*

- Social support
- Balance between existing and new customers. Besides the equilibrium should be kept between land uses for deep water related activities and existing activities.
- Consistent policy from the government
- Third Maasvlakte?
- Rhine-Scheldt delta: future integral development

As it can be observed, the main proposed priorities are: improving hinterland connections, becoming a leader in the field of innovation, and enhancing education in associated fields.

#### 2.1.4.1. Management Summary

1. **Port Vision** already sets the horizon with a clear keyword: **Flexibility**.
2. **Trends** impacting on the future of the port (economics, resources, CC, et cetera) are presented. Four scenarios are translated in terms of throughput forecasts for 2030 with a starting point in 2010 (430Mt): Global Economy (750 Mt), European Trend (650 Mt), High Oil Price (575 Mt) & Low Growth (475 Mt). Their origin is explained in subsection 2.1.4.4 *Forecasts of throughput*.
3. **Port & Industry** are highly correlated forming a Global Hub and an Industrial Cluster, both leaders in efficiency and sustainability. Transition to sustainable energy production and bio-based chemicals is in full swing.
4. **Setting the course** by increasing the transition to non-fossil feedstock, in minimising energy consumption and emissions and in achieving a fast, reliable, efficient and sustainable logistics system. Ten success factors are mentioned: investment climate; space; accessibility; shipping; environment, safety and living environment; work; city and region; laws and regulations; knowledge, development and innovation; and Europe.
5. **Agenda** includes the actions to achieve the mentioned goals:
  - a. **Industrial Cluster:** Bio-based chemical & industrial sector. Integration Antwerp & Rotterdam.
  - b. **Global Hub:** more efficient supply chain and expansion of the European inland hubs, as well as rail and inland shipping infrastructure.
  - c. **Improve of accessibility** modal split and proactive traffic management.
  - d. **Living environment enhancement** by reducing nuisance and developing a better transition between the port and green areas, on the one hand, and intensification of city's use of the border zone in the City Ports area, on the other.
  - e. **Technical and social innovation.**

#### 2.1.4.2. Starting point: The port in 2011

It is mentioned that Rotterdam can develop with a dual focus (instead if the more usual single focus) on efficiency and innovation. Besides, competition within the port is seen as an important factor to

innovate in the long term. The port is also part of a *spatial structure* embedded in residential and natural areas. In addition, the port and its industries *need the people* who work there.

- A SWOT analysis is carried on, from which the following main items are highlighted:
- The hinterland connections require huge improvements in efficiency.
- The strong position of (energy) production based on fossil fuels can hinder the transition to more sustainable forms.
- Large growth opportunities are found in the market for mineral oil products and vegetable oils.
- Biomass is a potential growth market for co-firing in coal-fired power stations and for dedicated biomass power stations in the long term.

From the situation in 2011, the port vision is developed following the process shown in Figure 2-3.

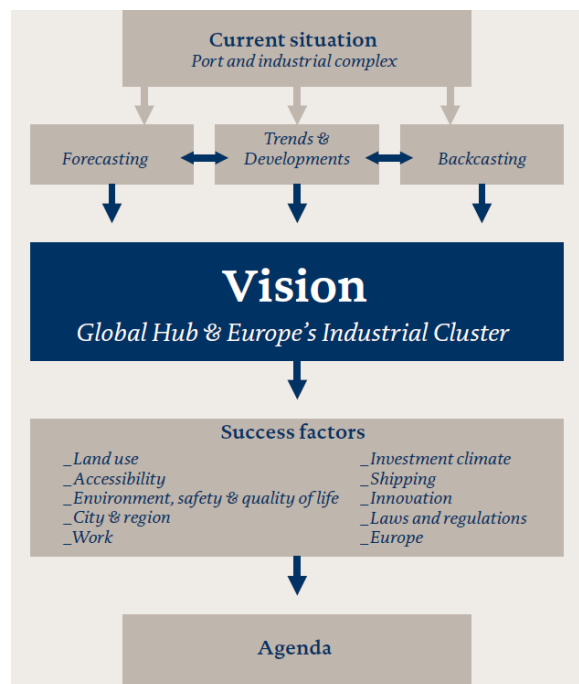


Figure 2-3 Port Vision process (Port of Rotterdam, 2011)

There are opportunities to keep Rotterdam as one of the top worldwide ports, but as can be expected there are threats too. Large investments, and long amortisation periods, reveal the need of a long-term vision. Required changes cannot be done overnight.

### 2.1.4.3. Trends, estimates and developments

In this subsection, the possible trends and estimates thought in 2011; are described. There are some opportunities to be involved in activities in the field of reuse of raw materials, which will generate new cargo flows. Sustainability is used as a differentiator with other ports. Sustainable and carbon-neutral production becomes an attractive criterion when choosing a business location. Besides, there are large opportunities for bio-based chemicals. It is proposed to shift into energy efficiency, recycling residual materials and carbon capture, storage and reuse.

Crude steel production, refining and basic chemicals will decrease in Europe. The flows of raw materials will decrease too, whereas the flows of semi-finished products will increase (i.e. chemicals and crude steel). Rotterdam can become, together with Antwerp, the most vital chemical cluster in Europe.

### 2.1.4.4. Forecasts of throughput

It is stated that the most influential factors in forecasting cargo flows are: Economic growth; Volume of world trade; Oil prices; and Environment policy. Four scenarios were drawn up by the CPB Netherlands Bureau for Economic Policy Analysis: Low Growth; European Trend; Global Economy & High Oil Price.

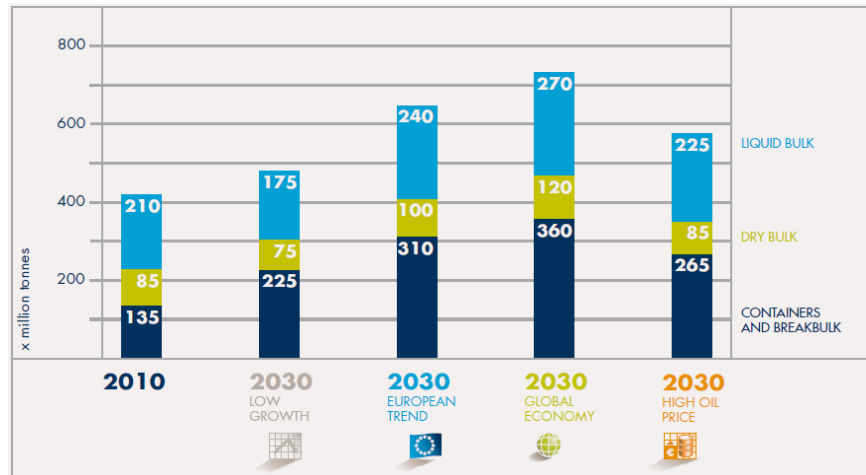


Figure 2-4 Total throughput in 2030 (Port of Rotterdam, 2011)

These scenarios were expressed in terms of total throughput for PoR as shown in Figure 2-4. Total throughput is growing in every scenario, but not for every cargo segment in each scenario. It is important to clarify that nowadays PoRA is planning in a deterministic way for a goal in between European Trend and Global Economy scenario. However some extra checks concerning available land space in 2030 were also done for all the scenarios.

#### 2.1.4.4.1. Forecast scenario consequences in each sector

**Liquid bulk:** mineral oil products, chemicals and vegetable oils are important growth markets. However, for Low Growth scenario there is a limited growth in basic chemicals, otherwise significant growth is expected. There is a general declining trend on crude oil throughput, nevertheless in the Global Economy scenario slightly increases. This is due to the fact, that the refining capacity in North Europe determines the handled amount of crude oil in the other three scenarios. Therefore, when the market is not shrinking; crude oil is replaced by many more alternatives, such as, chemical products, mineral oil products and vegetable oils; depending on the chosen raw material.

**Dry bulk:** the increase will be limited or will fall. For every scenario the main decline will be the iron ore handling (blast furnace capacity in North-West Europe will be reduced) and as consequence less coking coal. The greatest decline will be for High Oil Price scenario. However, if iron ore import declines, the import of steel will increase (EU steel consumption is increasing in every scenario). Coal throughput will increase until 2020 (new coal energy plants), then will remain stable or will decrease in case High Oil Price and Low Growth scenarios. Other dry bulk (building materials, industrial minerals, ores and concentrates) and agribulk are expected to remain stable, but decreasing for High Oil Price and Low Growth scenarios. Transshipment of dry biomass is a real growth market.

**Containers and other cargo:** container handling is a significant growth market in all scenarios. The transshipment of raw steel products is a growing market (more semi-finished and finished products).

### 2.1.4.5. Global Hub & Europe's Industrial Cluster

A multifaceted port is able to respond well to changing circumstances. Integration among companies and users is desirable. Competitiveness is increased by diversity of companies and ports in the area. Moreover, environment enhancing is a must for sustainable growth while living quality is enriched.

#### 2.1.4.5.1. Global Hub Vision

Connectivity is the word, and these five characteristics will be relevant:

- Global and intra-European cargo flows (intercontinental flows too).
- Chain efficiency. Every international supply chains and networks are integrated into one system (low supply chain costs, reliable transport & smallest ecological footprint per tonne kilometre).
- Sustainable hub. Possible shift to LNG fuel for inland shipping.
- Integrated port networks. Inland hubs for rail and inland shipping (like Venlo and Duisburg).
- High-end activities in the region
- A global port network is one of the main goals of PoRA (e.g. Sohar, Porto Central, et cetera).

#### 2.1.4.5.2. Europe's Industrial Cluster

The Rotterdam complex will have to change to compete with other industrial clusters in the world. Characteristics to be enhanced:

- Integrated businesses: exchange among companies, comprehensive supply chain integration.
- Connections between regional complexes: Antwerp, Terneuzen, Vlissingen, Moerdijk, et cetera.
- Diversifying and increasing sustainability of energy generation. Now within PoR ~4000MW are generated. In 2030 is expected to generate ~9000 MW. The aim is to promote cleaner energy sources. Carbon Capture and Storage (CCS) devices are essential. Smart-grids are needed.
- Producing clean fuels. Growth on bio-based chemicals. High-end activities in the region.

### 2.1.4.6. Setting the course

Prosperity for the port and the industry should be the same objective. But, inadequate road network, environmental restrictions (expected from 2030 onwards) and not enough efficient logistics system may be the major challenges. Therefore, once again, flexibility and adaptability is a must.

#### 2.1.4.6.1. Investment climate

The aim is to attract private investments of €2 billion per year for the period 2011-2015 (main focus Europe's Industrial Cluster, then Global Hub). In total from the private sector are expected around of €25 to €35 billion up to 2030. The following actions are needed:

- Delivering value for money with the Rotterdam "port product"
- Strengthening partnerships between governmental authorities, businesses and PoRA.
- Favourable fiscal climate and active joint acquisition.
- Improving effectiveness and speeding up decision making and procedures.
- Swift and predictable dispute resolution.
- A client-oriented, flexible, reliable and result-oriented Port Authority.



#### 2.1.4.6.2. Land use

Land is vital for expanding existing business and for setting new business. One of the premises is that this growth will be realised entirely within the existing port area. The main criteria are improvement in land use productivity and efficient use of land. “The right company in the right place” is the motto:

- Providing space for container growth.
- Room for development in energy and industry. Mainly focused on a gas cluster, carbon capture and storage facilities and further expansion of bio-based industries.
- Room for strengthening the Rotterdam Fuel Hub. Europort will become the European fuel hub (average throughput per hectare will have to increase sharply). Measures to be adapted:
  - Companies’ unused strategic reserves and underused plots will be (re)developed;
  - Unallocated plots will be developed, connected to the water and then allocated;
  - Connecting infrastructure, mainly consisting of pipelines, will be built;
  - Cluster formation, co-siting and shared use of quays and jetties will be stimulated;
  - Where possible, storage of strategic (oil) reserves will be replaced with storage of products with higher throughput levels;
  - Investments will be made in expanding the port’s marine facilities.
- Maintain dynamic character of the petrochemical cluster. The chemical, biochemical and petrochemical industries in the clusters at Europort-Botlek-Brielle-Vondelingenplaat, give Rotterdam its strong position.
- Dordrecht and Moerdijk. The aim is to function as one fully-integrated complex.
- Reserve land for the period after 2030. Save land for Oranje tunnel (2030) and Blankenburg tunnel (2020). It is expected that the port will have insufficient unloading facilities.

#### 2.1.4.6.3. Accessibility

Hinterland connections will become even more important to achieve PoRA goals. Therefore, the transportation network must be optimized in collaboration and consultation with regional parties and central government. The main actions are:

- Improving efficiency through alignment and controlling bodies. Try to use existing infrastructure at full potential. Improvements within the port and industrial area itself are needed (railways, inland vessels, et cetera). Network-wide proactive traffic management is vital.
- Strengthening the hinterland network by increasing the intermodal inland terminal network. Inland terminals adopting even more and more the role of portal to seaport terminals. Creation of transfer centres. Finally, these things will lead to a higher integration amongst seaports.
- Realising a modal shift. More cargo by water and rail, less by road.
- Reliable and robust infrastructural network in and around the port. Investments needed:
  - Blankenburg tunnel (2020) & Oranje tunnel (2030).
  - Calandbrug (railway bottleneck for 2020).
  - Noise nuisance at Rozenburg.
  - Capacity of the port’s rail yards will be reached by 2020. Improve rail access to Moerdijk.
  - Extend port’s pipeline network and crosslink between Rotterdam & Antwerp are needed.
- Reliable infrastructure network to the hinterland. Volkerak & Keekrak lock complexes will limit the IWT capacity between Rotterdam and Antwerp, even more if Seine-Nord canal is built.

#### 2.1.4.6.4. Shipping

The common thread is the integration of information and the more centralised planning of shipping movements, in line with the improvement of logistics processes in the port itself. Efficiency, sustainability and safety are often part of the same process. The main goal is to improve efficiency in handling sea-going and inland vessels to achieve faster turnaround times, reducing chain costs and making PoR a more attractive hub. Open data exchange between ship owners and (inland) terminals, marine service providers and the (National) Harbour Master is very important to achieve.

#### 2.1.4.6.5. Environment, safety and quality of life

Growth within the limits of (stricter) laws and regulations is compulsory. A direct consequence will be the allocation of the supply chains with the smallest ecological footprint in the world. Merging the port and the city is an important goal, and the nuisance problem in the living environment should be tackled. Keep growing as the leader port in Europe, but enhancing citizens' life and nature.

#### 2.1.4.6.6. Work

In order to realise the Global Hub and Europe's Industrial Cluster; it will be necessary to increase the number of technical and logistics graduates, get young people interested, up-to-date human resources policy and strength facilities at the port (high quality working environment).

### 2.1.5. Commercial Strategy

The Commercial Plan describes which cargo segments (e.g. dry bulk, petrochemicals, containers, et cetera) and activities (e.g. refinery, storage, logistics, et cetera) the port should focus on, and how it should position itself with regards to competing ports and where in the supply chains. It is one of the main components of port planning; however it has major relevance in the operational near future, but not on the long-term planning. Figure 2-5 shows current yearly updating procedure to be followed.



Figure 2-5 Commercial Plan methodology, which foresees as maximum five years (Port of Rotterdam, 2013c)

Initially, possible market developments and trends are analysed, and then revenues versus growth of the port is checked updating market share progress.

Secondly a SWOT analysis for each market segment is carried out in order to evaluate the competitiveness of the port; and taking into consideration each value proposition per segment, the strategic and commercial strategies are drafted.

Finally, the result is the Commercial Plan per segment. This plan mainly focuses on growing concepts, related to strategic cargo concepts such as **Container Port**, **Fuel Hub** and **Energy Port**. From those concepts, actions are derived in the form of Must Win Battles. Furthermore, it is important to clarify that these strategic cargo concepts are further treated in *Chapter 4 Europort Masterplan 2030+*.

### 2.1.6. Strategic Stakeholder Management (SSM)

As it can be appreciated in NW Europe since mid-1970s, public support for ports has deteriorated to the present situation leading to a rather negative image of port areas. This condition brought clear adverse consequences for every port related activity. PoR was not an exception, it became less attractive for employees; besides social perception for the contribution and value of the port to the community plummeted; therefore less public supported and supports port development. With no need to stress these circumstances any more, it is clear that the license-to-operate and the license-to-grow are constantly under pressure due to existing and new stakeholders in the port area. To summarise, PoR has very strong constraints for its development.

To shift the situation, stakeholder management becomes a key element to achieve the future **growth of the port**. The creation of added value for businesses, clients and stakeholders is becoming a standard practice for PoR development that implies working in partnership to invest in attractive preconditions, influencing relevant regulations, and directly investing in the license-to-operate.

The adopted negotiation strategy for PoRA stakeholder approach is the Mutual Gains Approach (MGA), developed at Massachusetts Institute of Technology (MIT) in 1981 (Fisher, Ury, & Patton, 1981). The basic principles can be abridged as follows:

- Both sides have legitimate interests to be recognized and advanced.
- The issues are approached as problems to be solved with proactive attitude (focus on interests).
- Listen to every involved party builds trust and enlarge the pie.
- Always try to seek for sustainable alternatives.

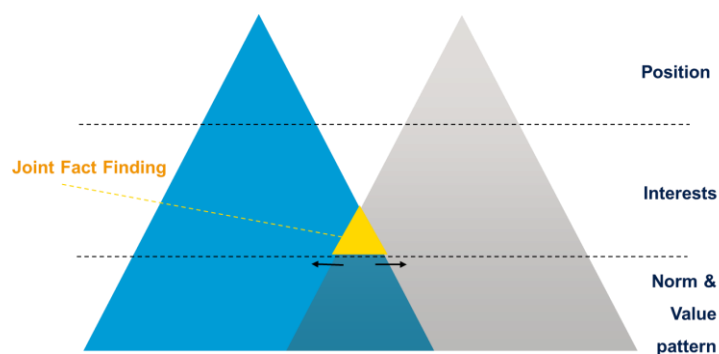


Figure 2-6 The Golden Triangle, finding common interest for both parts: always seek for win-win situations. Each triangle represents one stakeholder (Port of Rotterdam, 2013k).

The interests of every stakeholder are of relevance, and the goal is to find common ground to reach joint interest as big as possible. This is explained by the Golden Triangle shown in Figure 2-6. In summary, by showing genuine interest in the concerns of stakeholders, being transparent and remain reliable are the basic columns to succeed and be trusted in order to allow PoR to keep growing.

In order to structure and apply the MGA, a process is defined within SSM. This process is characterised for being a cycle divided in four quadrants or phases as can be appreciated in Figure 2-7.

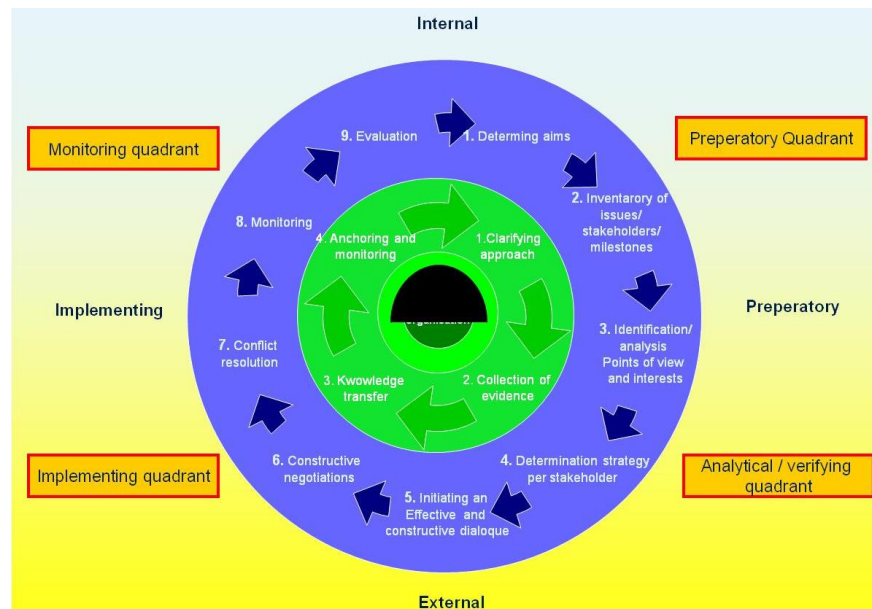


Figure 2-7 Strategic Stakeholder Management cycle and Proactive Issue (Port of Rotterdam, 2013k).

The analytical quadrant focuses on the analysis of issues and the involved stakeholders. Besides, the distinction between existing projects and new projects should be identified within this phase. The bases for the negotiations are also set in this stage. Then in the implementing quadrant, the constructive negotiations take part including the conflict resolution. According to the stakeholder's impact on the negotiation process, PoRA involvement degree is defined (Port of Rotterdam, 2013k; Visser, 2014).

Finally, it is important to point out that SSM is not implemented as a standard practice for port planning projects. Nevertheless, possible future stakeholders' pressure is taken into consideration for planning purposes but only in case stakeholders are seen as possible obstacles for development of specific projects. Currently, stakeholders are not well-thought-out in planning faces of existing port areas. Thus, they are not fully considered as dynamic actors that can be part of the solution for port planning issues at Europoort by adopting a pro-active approach in early planning phases.

### 2.1.7. Growth of the port

In previous sections it was mentioned the importance for PoR to keep operating and growing, therefore a more structured and detailed definition of the implications of these statements is required.

One of the aims of PoRA is to keep growing as port; therefore to succeed with this task an integrated management should be carried on by PoRA. When mentioning integrated, it is referred to every stakeholder affected by port growth, and this should be based on a Mutual Gains Approach. To allow this growth, two important factors should be distinguished, the license-to-operate and the license-to-grow as it is shown in Figure 2-8.

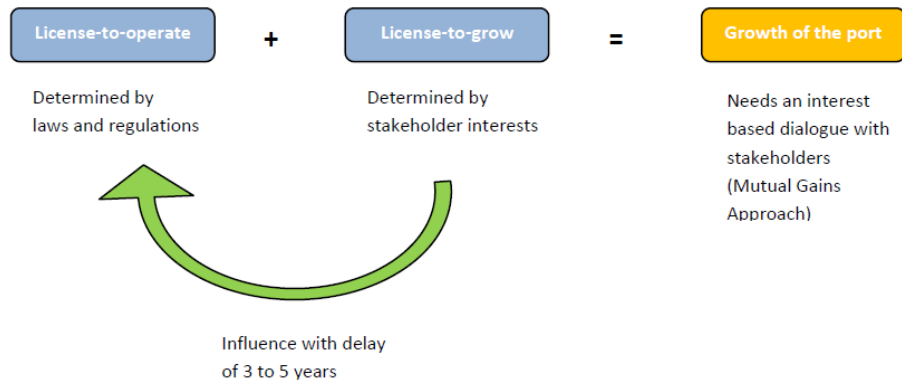


Figure 2-8 Growth of the port (Port of Rotterdam, 2013k; Visser, 2014)

On the one hand, the license-to-operate is conditioned by constantly increasing European legislation. While on the other hand, the license-to-grow is heavily conditioned by more and more involvement of stakeholders in any decision process. These two factors are key components that should define the mind-set of PoRA leadership. Nevertheless several choices are possible, but there is only one which allows PoR to grow and operate in the future. This is thinking beyond legislation and involving everybody within the decision processes (PIANC, 2014b).

Nowadays PoRA is managing this practice through the Strategic Stakeholder Management (SSM) program presented in subsection 2.1.6 *Strategic Stakeholder Management*.

### 2.1.8. Europoort current spatial distribution & contractual situation

To analyse the contractual land status within the port area in a land lord model, five main divisions can be identified to evaluate current situation (Port of Rotterdam, 2014n):

- Land leased to clients.
- Contract options (clients reserve land within the contract; they have to pay rent for this option).
- Reserved land (when a client expresses the willingness to use a plot, PoRA reserves this for future development of client’s activities, and however the client does not have to pay for it).
- Reserved land for PoR uses (or for further developments to facilitate client’s operations).
- Available land to be leased (empty plots).

Nowadays, Europoort presents a complex situation regarding the status of the total available land. On the one hand, more than 15% is not in use. This is mainly because several plots are contract options for clients or reserved land (for clients or PoR) or empty plots. Most of these “not in use” plots are not well-connected with the waterfront, and/or isolated from hinterland connections.

On the other hand, although most of client’s contracts in the Europoort area are expiring after 2030, uncertainties related to the continuity of their activities in the port are really high. Furthermore for some specific clients these uncertainties are dramatically growing. Primarily the underlying reasons are that some terminals are settled at Europoort for the last 30 to 40 years, and they did not invest sufficiently in the area to remain as front-runners terminals in the world. Consequently, at this moment they have outdated facilities, and superstructures, thus they require large investments to increase their efficiency and achieve competitive production rates. Moreover, some of these investments are far delayed in time, increasing the risk for specific terminals of shutting down activities in Rotterdam in the near future. A detailed status of Europoort’s land distribution can be found in *Annex X*.

### 2.1.9. Summary & comments

Incorporating flexibility is mentioned in the Port Vision 2030 (Port of Rotterdam, 2011) as a core need. However, no further details are given about the meaning of flexibility and how to materialize it.

Currently, PoRA is basing its future planning and developments in a deterministic approach with forecasts somewhere between the European Trend and Global Economy scenarios. Furthermore, there is a lack on explanations dealing on how to match current situations with future possible scenarios. In addition, to achieve several of the quoted focuses, it is required to fully implement a distinct way of developing the industrial port complex by proactively think beyond current legislation, always bearing in mind sustainable growth (PIANC, 2014b). So far, this is missing in several of the reviewed internal documents. Nonetheless, it is contemplated on the SSM approach, but until now concrete applications are not fully implemented, at least within the planning of Europoort.

On the one hand, it is important to mention that some documents state that 2030 is very close. Meanwhile, some others consider that is too far ahead. Naturally, this is related with the different functions in the organisation. Nevertheless, the point is that for port planning strategies no longer time-horizons are contemplated. Only Maasvlakte 2 is analysed beyond 2030 (TGI, TU Delft, & TNO, 2014). Due to its current spatial situation, Europoort arises as a sensitive area for future developments. Thus, it is the area to focus in from the planning perspective.

To summarize, flexibility is already mentioned at Port of Rotterdam as a key component that gives shrewd and remarkable considerations. Nonetheless, an even more robust and long-term vision should be re-thought. It is relevant for PoRA to re-adapt its strategy without considering only one-path approach for a medium-term horizon. Start maximising long-term opportunities for the port complex now, is a must to build on PoR future strengths.

## 2.2. Incorporating flexibility for dealing with uncertainties within a sustainable framework

This section addresses the literature review related to the methodologies, frameworks, and tools proposed for reducing uncertainties within long-term planning processes. The main framework used within this thesis is Adaptive Port Planning (Taneja, 2013). Recognisably, this rehearsal leads to increasing the robustness of current plans with a structured method.

Valuation techniques are also briefly discussed; amongst them some insights related to ecosystem services and social valuation, are provided. Accordingly, this section introduces thoroughgoing practices to incorporate sustainability as unique strategy for port development (PIANC, 2014b). Finally, some complementary approaches for integrating all mentioned practices in different stages of a development (opportunity framing and value engineering) are also given.

### 2.2.1. Adaptive Port Planning (APP) framework

The method is proposed by Poonam Taneja on her PhD Thesis, “The Flexible Port”. It is the combination and adaptation of two existing methods to fit port planning needs. The thinking behind APP is that adaptation may be needed at any moment as an answer to triggers. It is a continuous procedure that basically aims to increase the lifespan of waterborne transport infrastructure by increasing flexibility in the planning, contracting and design phases (Taneja, 2013).

### 2.2.1.1. Definitions

Some definitions are needed before going through the relevant steps of the framework. Thus, specific explanations for assumptions, critical assumptions, risk, vulnerabilities, opportunities, and triggers are crucial for understanding APP framework. These are thoroughly described within “The Flexible Port”, section 5.2.2 (Taneja, 2013).

### 2.2.1.2. Steps in APP

The six steps of Adaptive Port Planning framework with their correlation to every research sub question (SQ) and chapters of this thesis are represented in Figure 2-9.

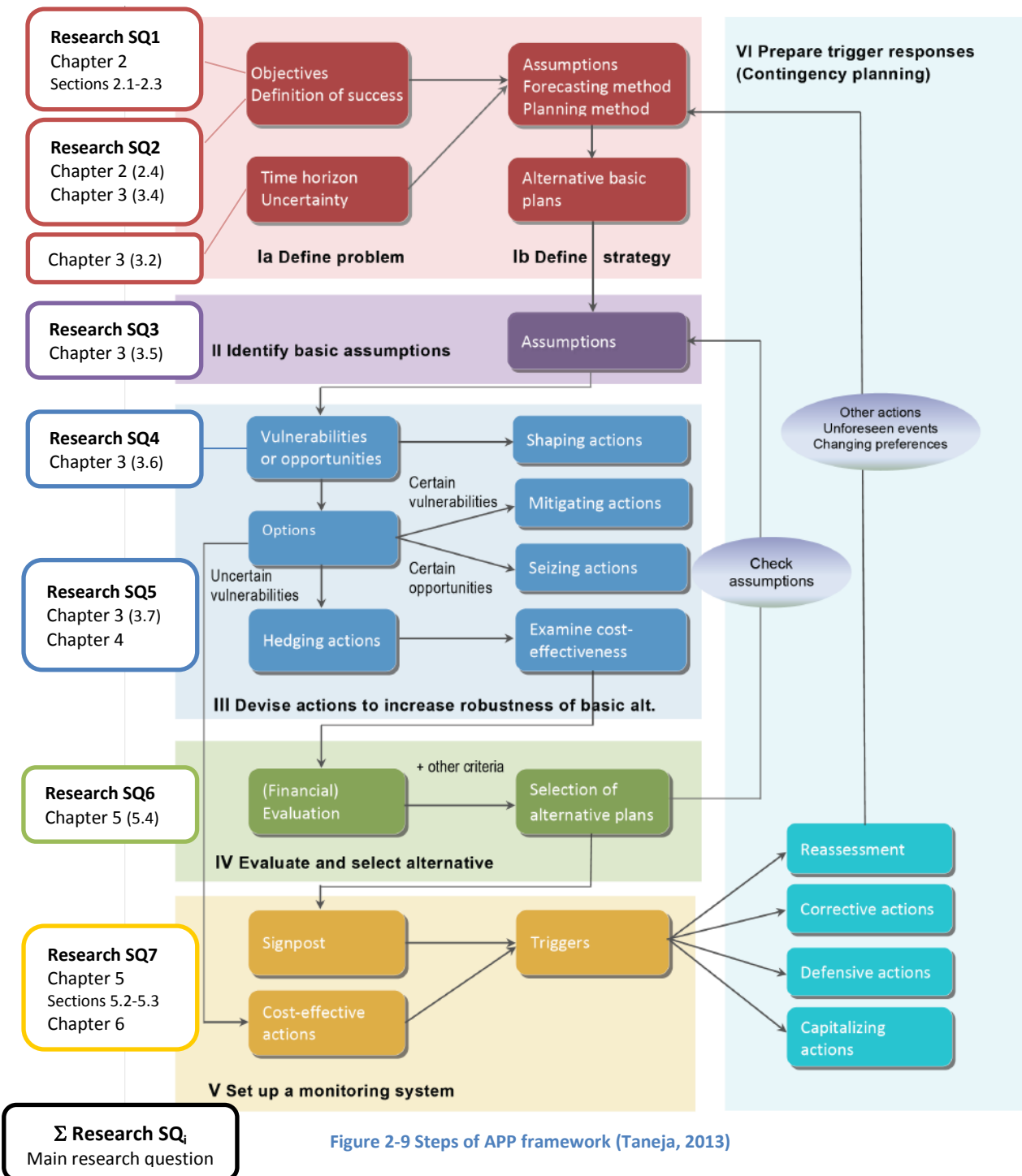


Figure 2-9 Steps of APP framework (Taneja, 2013)

The **first step of APP** framework is divided in two sub-phases:

*1a Define the problem and project.* This phase includes the identification of the objectives and the recognition of the constraints or boundary conditions. This sub-phase implies the identification of:

- Planning time horizons.
- Goals and definition of success for Europoort.

*1b Define strategy.* Within this phase depending on the time horizon selected, the planning strategies are set, including forecasting methods, specific techniques and tools. In case of an existing masterplan, this is used as initial basic plans. Thus, a detailed analysis of the existing masterplan is required to identify underlying assumptions and relate them to the definition of success.

The **second step of APP** framework consists in identifying the basic assumptions. This involves thinking about the future of the plan. Once those assumptions are identified; it is important to screen and categorise them as opportunities or vulnerabilities. In this step plausible alternatives are analysed.

The **third step of APP** implies increasing flexibility and robustness for the acknowledged vulnerabilities and opportunities of each alternative. Therefore it is possible to associate different type of actions for each vulnerability or opportunity.

The **fourth step of APP** requires evaluating and selecting alternatives. The comparison of alternatives involves the definition of a project and the performance of diverse valuation techniques.

The **fifth step of APP** is associated with the definition of a monitoring plan with associated triggers for achieving a planned reaction.

The last and **sixth step of APP** is the definition of a contingency plan, where the trigger responses are explicitly described.

Finally, it is imperative to remark that a successful enforcement of flexibility within the port relies on adaptive management practices, as well as the procedures and the internal organisation of PoRA.

### 2.2.2. A quick scan of Discounted Cash Flow (DCF) methods

Within this subsection current valuation techniques are briefly described. Most of them are extensively discussed in “The Flexible Port” (Taneja, 2013).

Discounted Cash Flow (DCF) methods are briefly presented, because are part of current practices at PoRA. Basically these are used for evaluating commercial port projects throughout financial business cases. Traditional DCF methods provide economic viability and consistency when the degree of uncertainties is low. Additionally, for defining and evaluating the results of every financial model dealing with project’s development, some items need to be accounted for (PIANC, 2014a):

- Required investments or Capital Expenditures (CAPEX, e.g. new assets & lifespan extension);
- Costs during operations or Operational Expenditures (OPEX, e.g. maintenance);
- Benefits or revenues (e.g. port dues and land lease at PoR);
- Inflation rates, loan conditions & taxes



### 2.2.2.1. Net Present Value (NPV)

In finance, to analyse and assess new business opportunities, cash flows are discounted because the value of money varies over time. Thus, the present value of future cash flows is related with a period of time and a certain discount rate (i.e. opportunity cost of capital). The higher this discount rate is, the lower the present value of a future amount of money will be. Thereafter, Net Present Value (NPV) is defined as the sum of discounted present values of cash inflows (Benefits) and outflows (Costs = CAPEX + OPEX), over a period of time (Moyer, McGuigan, Rao, & Kretlow, 2011).

This is one of the most used techniques for evaluating the feasibility of realising infrastructure projects. It is only focussed on the financial part including the time value of money. This results in profit (positive NPV) or losses (negative NPV) during the entire lifetime of an investment. In addition, by using different discount rates for mutually exclusive projects, risks can be assessed (Taneja, 2013).

### 2.2.2.2. Internal Rate of Return (IRR)

The internal rate of return (IRR) of an investment is the discount rate at which the net present value of costs equals the net present value of the benefits. As IRR is a percentage, seems appropriate to be used for comparing alternatives. However it should not be used to rate mutually exclusive projects, or to compare two investments of different duration.

Nonetheless, due to its simplicity that allows the comparison of percentages, many companies use this approach. PoRA is one of those companies (Port of Rotterdam, 2014e).

### 2.2.3. Cost-Benefit Analysis (CBA)

Cost-Benefit Analysis (CBA) refers to the ratio between present valued costs and benefits. In this approach all the societal impacts of a capital investment over a period of time are discounted and assessed. This is divided on direct and indirect cost and benefits. Direct costs and benefits are merely related with the finances of a business development. On the other hand, indirect costs and benefits are associated with second order and multiplier effects for the surroundings; such as reduction of travel times, creation of jobs, enhancement of the public infrastructure, among other societal benefits (Taneja, 2013). Consequently, the combination of direct and indirect CBA, it is named as SCBA, or "MKBA" in Dutch (Centraal Planbureau, 2013). For comparing alternatives of mutually exclusive investments, it may provide good insights when using objective processes (Eliasson, Börjesson, & Lundberg, 2013). However, critics to SCBA method are present, some are the implicit subjectivity on the trade-off prices, the inherit assumptions on possible benefits, incomplete SCBA, uncertain estimations and easiness to quote the dominate (Mouter, 2014).

On the one hand, alternatives to overcome this situation propose combining pure financial CBA with Multi-Criteria Analysis (MCA) to avoid establishing monetary valuation for some criteria. In this way a balanced scorecard with various criteria can maximise the approach (Taneja, 2013).

On the other hand, a SCBA framework was developed and implemented in the Netherlands for infrastructure projects (Kwast, 2013; Rijkswaterstaat, 2014b). Some examples on Dutch large infrastructure projects can be found (Rijkswaterstaat, 2014a). However it is still an ongoing discussion; meanwhile mentioned drawbacks are always present keeping the dilemma open (Sager, 2013).

## 2.2.4. Valuation of ecosystem services in Social Cost-Benefit Analysis (SCBA)

In addition, literature review includes a quick scan of possibilities for valuating ecosystem services. However, first it is mandatory defining ecosystems and their services. According to “Ecosystems and Human Well-being: A Framework for Assessment” (UNEP, 2003):

*“An ecosystem is a dynamic complex of plant, animal, and microorganism communities and the non-living environment, interacting as a functional unit. Humans are an integral part of ecosystems.”*

Additionally ecosystem services can be defined in four categories: Supporting services (necessary for the production of every other ecosystem service), Provisioning services (products obtained from ecosystems, like energy), regulating services (e.g. carbon capture, waste decomposition, water and air purification, et cetera), and Cultural services (UNEP, 2005).

Many recommendations for valuating ecosystem services arose during the past years (OECD, 2010a; Raffaelli & Frid, 2010; UNEP, 2008). However, there is a large gap that needs to be fulfilled before being implemented in policy-making strategies and in regular worldwide practices (UN, 2012). It is important to take into account the high degree of uncertainties related with transferring these values. Then, this also implies stakeholder engagement, thus communication strategies are crucial for implementing these methodologies (UNEP, 2013). Nevertheless, in the Netherlands attempts towards including the valuation of ecosystem services within infrastructure decision-making processes have been carried out for several years. One of the most worked out methodologies is a nature-inclusive SCBA (Ruijgrok, 2004), where all present and future (dis)advantages of a project/measure can be weighted. It incorporates monetary trade-off of those (dis)advantages.

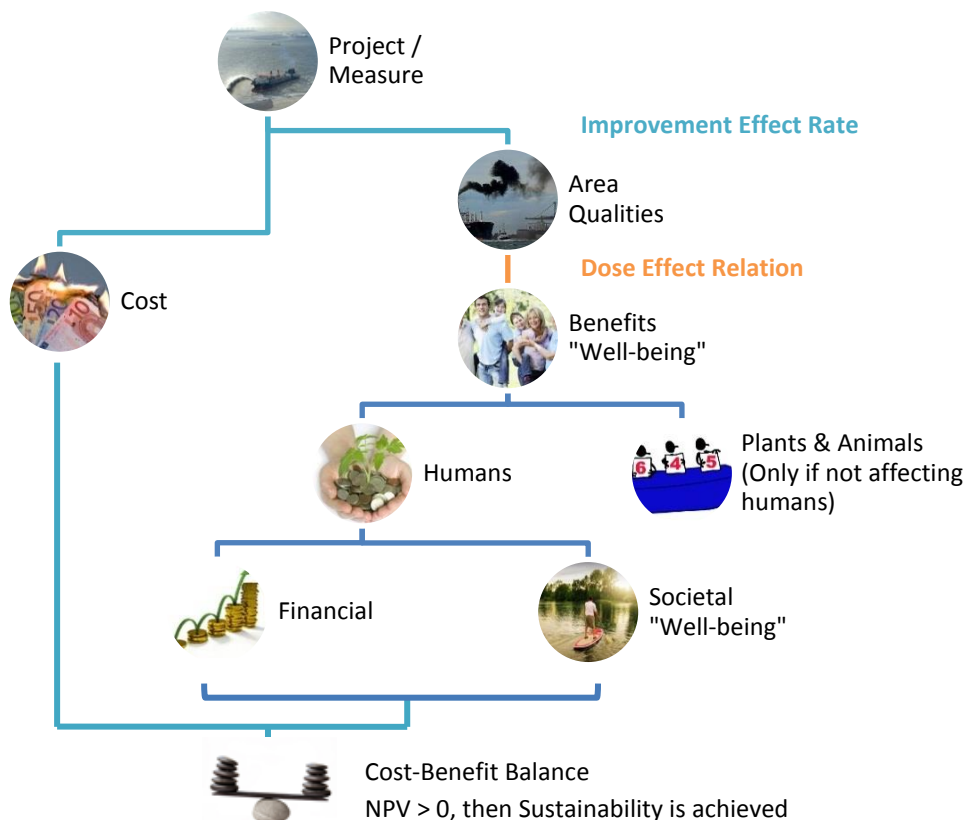


Figure 2-10 Social Cost-Benefit Analysis (SCBA) chart, including valuation of nature, based on Elisabeth Ruijgrok approach (Ruijgrok, 1999, 2004) and suggested by Rijkswaterstaat (Centraal Planbureau, 2013; Rijkswaterstaat, 2014b)

As traditional financial CBA, in case the benefits are larger than the costs, a project/measure is considered to be a sound investment, not only financially, but as a whole. This means that generates a positive well-being for the society and the environment. Besides if the NPV is larger than zero, it intrinsically implies that the project/measure is sustainable. A conceptual chart summarises the discussed approach in Figure 2-10. This method was already applied for different Dutch projects (Ruijgrok, 2012) and suggested by Rijkswaterstaat within its Centre for Economic Expertise (Rijkswaterstaat, 2014a, 2014b).

Therefore within a nature-inclusive SCBA, positive and negative impacts on nature, water, soil, air and other environmental qualities are incorporated. This is very important to be highlighted, because based on current situation, if those parameters are not monetary included would be directly left aside due to current ways of decision-making processes.

Valuation of ecosystem services as well as societal benefits, are key elements to be implemented in order to shift current management paradigm into pro-active strategies with a high degree of corporate social-environment responsibility (PIANC, 2014b).

### 2.2.5. Other valuation techniques & Real Options Analysis (ROA)

Scenario analysis, decision tree analysis, simulations and Real Options Analysis (ROA) are thoroughly examined for valuing flexibility within “The Flexible Port” (Taneja, 2013).

Conversely, “The option to value investment opportunities” (Turnhout, 2011) successfully addresses the application of ROA to enhance PoRA decision-making processes. This is carried out throughout the valuation of investment opportunities (including possible uncertainties and flexibility). The research process was conducted for one option, though it clearly shows the advantages of extending the methodology to whole port areas, like Europoort. Moreover, this approach brings supplementary insights for small scale projects, like the construction of commercial jetties or quay-walls. As a direct result of the conducted studies, the transition from current deterministic financial models at PoRA to the implementation of ROA is highly advised. This can be done either to fully replace present practices or as additional tool for reaching advanced managerial information. Intensifying the knowledge of professionals involved in the process should be also pursued with linked training courses.

### 2.2.6. Opportunity framing

Sometimes, due to the pressure for delivering results, it is observed the occurrence of a premature convergence in a project. This entails choosing and executing a solution in early stages without having a clear understanding of the rationale behind it. Generally valuable alternatives are left aside due to this management behaviour. Therefore, opportunity framing is foreseen as the framework that sets the steps for a robust project initiated from an identified opportunity (Bakker et al., 2014).

Opportunity framing is a way of thinking and it should be put into practice from the initial point of a project. The approach requires a permanent and fluent interaction with the stakeholders to reach a larger chance of success and avoid possible premature convergence (Hertogh & Westerveld, 2010). The key steps for a successful performance for a project are:

- Outline projects’ scope
- Identify the success of the project

- Establish essential values
- Identify possible SWOT for the project

Opportunity phases continuous beyond the planning and executing phases, it also plays a crucial after delivering the project. It is important to highlight that projects shall be envisioned, managed and operated as a unique entity. Completion of a project on its own is a temporary goal for showing positive management performance. Hence, user, social, environmental and economic benefits should always remain as the core objective.

Finally, although the management of the project may become a challenge, the broader the scope of the project is, the larger the possibilities of success are. Of course this would depend on the characteristics of the project, but it is important to bear in mind that the project organisation is responsible on how broad the scope of the project would be (Bakker et al., 2014).

### 2.2.7. Value Engineering (VE)

Value Engineering (VE) evolved from World War II due to the necessity of replacing scarce materials. Then, in 1959, the Society of American Value Engineers (SAVE) was created. They defined VE as *“the systematic application of recognised techniques which identify the function of a product or service, establish a value for that function, and provide the necessary function reliability at the least overall cost. In all instances, the required function should be achieved at the lowest possible lifecycle cost consistent with requirements and/or performance, maintainability, safety, and aesthetics”* (AASHTO, 1987).

Accordingly, VE seeks to optimise the value of a project during its whole lifecycle. VE tries to meet clients’ needs at the lowest cost. SAVE International®’s standard job plan consists of six phases (SAVE, 2014), nonetheless in practice it is usually extended to eight steps (Bakker et al., 2014; Geffen, 2005):

1. Preparation: defining the goal and extent.
2. Information: Collect core information to achieve a complete knowledge of the project.
3. Function Analysis: identify and seize the essential functions of the project (associate costs).
4. Creativity: Elucidate ideas to fulfil defined functions. Opportunity framing (Bakker et al., 2014).
5. Evaluation: Synopsis of ranked ideas (pre-criteria) creating potential value improvements.
6. Development: Select and elaborate those alternatives maximising value.
7. Presentation: stakeholders’ engagement, present results and discuss with all key players.
8. Report and implement: Summarise and document every step. Implement the project.

Working with experienced multidisciplinary teams usually brings the best results. Besides creativeness and relevant expertise on the type project under evaluation is needed (SAVE, 2014). In summary, the previous sentence denotes that phase 3, Function Analysis, and phase 4, Creativity, are the central part of the approach. An Opportunity Framing workshop can boost the results of the creative phase (Bakker et al., 2014). Finally, it is important to highlight that VE should be included from the beginning of a project, if not its later implementation may not be effective to balance spent efforts with the creation of extra value (Castro Arenas, 2011).

### 2.2.8. PIANC-IAPH “Sustainable Ports”

This guide for port authorities provides an integrated approach related to environmental issues of ports. This is summarised within one concept: the Green Port. Main conclusions and recommendations

are: pro-active attitude of the port authority for developing the region and logistic chain in a close relation with every stakeholder. Any port development should always be in harmony with its environment, by integrating front-runner practices and technologies towards a green growth which is meant to be the only sustainable growth. To sum up, Green Port posture is a pro-active long-term vision that always moves ahead current policy; thus it constantly induces the needed change in the direction of real sustainability (PIANC, 2014b).

### 2.2.9. Flexible contracts

In order to fully implement flexible solutions, it is needed to completely put them in practice. This means that aside of the planning, design, and valuation techniques; flexibility requirements should be included within contracts as well. Thus, landlord ports have basically two procedures to follow, stipulate a flexible design and tender it on the market, or specify the desired functionality allowing the market to propose a flexible solution.

The first alternative is a common method for tendering a project. However the use of Economically Most Beneficial Tender (EMDT or “EMVI” in Dutch) is increasing in the Netherlands, especially within the scope of Design & Build contracts. Nevertheless, it is mandatory to include these criteria in the specifications when contractors are asked to introduce flexibility. This should be also considered in the ulterior evaluation process; so the lowest bid will not be awarded by definition (Jumelet, 2014). Contractors and every stakeholder should be also engaged from very early stages of a project (Bakker et al., 2014). Nonetheless, achieving a comprehensive success in a project for every actor involved still remains as a challenge (Loenhout, 2013).

Thereafter, three methods are presented within “The Flexible Port”, the second and third are recommended for considering possible economic benefits from flexibility (Taneja, 2013):

1. Traditional DCF + qualitative criteria;
2. Use of discrete scenarios;
3. Stochastic approach.

Additionally, contractors should not be considered as unique providers of innovation and flexibility within a project. Developing and keeping knowledge within PoRA is a key component too.

Finally, once the execution phase is complete, flexibility should also be included within commercial contracts with PoRA clients in order to incorporate adaptable solutions during the lifecycle of basic infrastructure. Consequently contracts may be reviewed based on the risk portfolio of the companies operating at the port (Vermerris, 2014).

### 2.2.10. Summary & comments

This section provides sufficient background for framing and structuring the research process. It starts by summarising main steps of APP framework to be applied. Then, this is partially extended with insights dealing about valuation methods including Social Cost Benefit Analysis (SCBA or “MKBA” in Dutch) with the enclosure of Ecosystem Services; and Real Options Analysis (ROA).

Moreover, Opportunity Framing and Value Engineering are discussed because these approaches are closely related to materialise flexible solutions that maximise opportunities for port development. As

this maturity requires to be attained in a sustainable way, the Green Port approach is briefly presented, although it represents one of the main conceptual pillars of this study. Finally, procurement procedures need to be adapted for implementing all these discussed approaches; thus flexible contracting is also reviewed.

To conclude, it is important to mention that all these approaches are presented to be fully integrated within APP framework and for realising an even more robust approach.

## 2.3. Planning and project decision-making process at PoRA

Present port development processes at PoRA are concisely described. Most of the presented information is summarised from PoRA literature. However, numerous meetings with professionals from almost every department at PoRA were held to attain an even broader understanding of the organisation. The professionals whom collaborated with this research are shown in *Annex A*.

### 2.3.1. Masterplan Europoort

With no need to stress the relevance of this information as starting point of the research, it is also important to highlight that PoRA masterplans are wide-ranging and compact documents aiming to increase its internal distribution.

These are based on the data collected by each “Gebiedsmanager”, and are yearly updated according to the PD-PP Annual Masterplan Cycle (Port of Rotterdam, 2014f), as shown in Figure 2-11. The main purpose of this updating cycle is to adequate current plans for precise operational actions (specially for short- and medium-term).

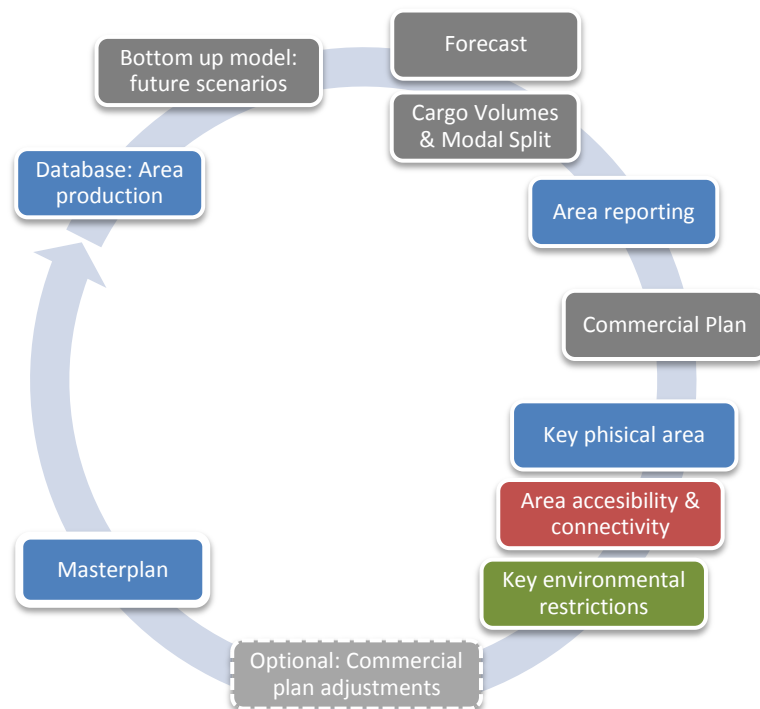


Figure 2-11 Annual Masterplan Cycle for planning existing port areas (Port of Rotterdam, 2014f)

Until 2013, each port area at PoR used to have individual masterplan documents (Maasvlakte, Europoort, Botlek, Waal-Eemhaven & Zeehaven Dordrecht). At that time, every individual document

was harmonised for achieving a complete and coherent overview of the port as a whole. However from 2014 onwards, it was decided to unify every individual masterplan into an integral masterplan for the entire Harbour Industrial Complex. This was done to enhance even more its far-reaching presence on daily activities amongst different departments at PoRA.

Europoort Masterplan 2013, MP13 (Port of Rotterdam, 2013d) and Harbour Industrial Complex Masterplan 2015, MP15 (Port of Rotterdam, 2014c) are the documents considered. Their cover pages are shown in Figure 2-12. The aim of the masterplans is to translate into spatial planning both the *Port Vision 2030* (Port of Rotterdam, 2011) reviewed in subsection 2.1.4, and the *Commercial Strategy* (Port of Rotterdam, 2013c) briefly discussed in subsection 2.1.5. Area productivity of current terminals also plays a key role for planning existing port areas, and it is treated in detail in subsection 2.3.2.



Figure 2-12 Cover pages of MP13 & MP15 (Port of Rotterdam, 2013d, 2014c)

On the one hand, the masterplans abridge abundant information gathered and administered by the “Gebiedsmanagers” or Area Managers.

On the other hand, The chosen way of communication is by a short-term list of actions and two maps for each port area with the spatial distribution of each cargo segment. One of those maps shows the current situation, and the other illustrates a plausible spatial distribution in 2030 estimated with a deterministic forecast, as described in 2.1.4.4 *Forecasts of throughput*. Considered cargo segments are:

- Iron ore & scrap;
- Coal cargo;
- Agribulk;
- Biomass cargo;
- Chemical & Bio-based industries;
- Crude oil & refineries;
- Gas & Power;
- Tank storage;
- RoRo;
- Empty depots;
- Distribution centres & railway logistic centres;
- Maritime Service Industries & other port related businesses;
- Other dry bulk & liquid bulk cargo; and
- Other general cargo.

Current masterplan for the Harbour Industrial Complex (every existing port area) do not consider actions beyond 2020. This is done to present concrete operational actions to other professionals within PoRA in the best possible way. Nevertheless, it is important to stress that none of the port areas are thought further than 2025-2030. Maasvlakte is a kind of exception due it is recently developed and it presents some plans beyond 2030, but not more than 2035-2040.

From the masterplan, and through each “Gebiedsmanager”, projects are initialised. However, some other projects are directly started by the Business Managers, as it is clearly explained afterwards in subsection 2.3.3 *Project development process*.

All this is part of the considerable efforts done at PoRA to put into practice current masterplan for existing port areas. At last, to follow up each initialised action diverse elements are used, like project management, environmental management, stakeholder management and asset management among others. These are also further discussed in this section.

### 2.3.2. Land use efficiency

Area productivity, or in Dutch “ruimteproductiviteit”, is calculated as: terminal throughput (in tons) divided by the leased plot size (in ha). It is intrinsically related with the land use efficiency. Thus it plays a major role in the elaboration of a masterplan for existing port areas.

Port Planning internally measures the area productivity for several terminals at PoR, and depending on the available data, historic performances are also obtained utmost past 15 years. In this way, top year area productivities are quantified for each terminal. Furthermore, PoRA Data Analysts cluster assessed terminals according to their specific cargo segment and type of operations. Therefore, an initial analysis is oriented to screen top year average area productivity for specific type of terminals within each cargo segment operating at PoR.

Most relevant categories for Europoort are:

- Liquid Bulk cargo:
  - Chemical & biomass storage and transfer;
  - Mixed storage and transfer;
  - Oil storage and transfer;
  - Crude oil storage and transfer;
  - Biofuels production;
  - Edible oil production;
  - Chemical production;
  - Refinery production;
- Dry Bulk cargo; and
- RoRo.

First results show that is rather difficult to attain average area productivity values for each cargo segment, even if these are roughly divided by specific functions or types. This is mainly due the large diversification of terminals, industries and processes. For acquiring a more clear understanding, this is presented in the graphs shown in Figure 2-13 and Figure 2-14.



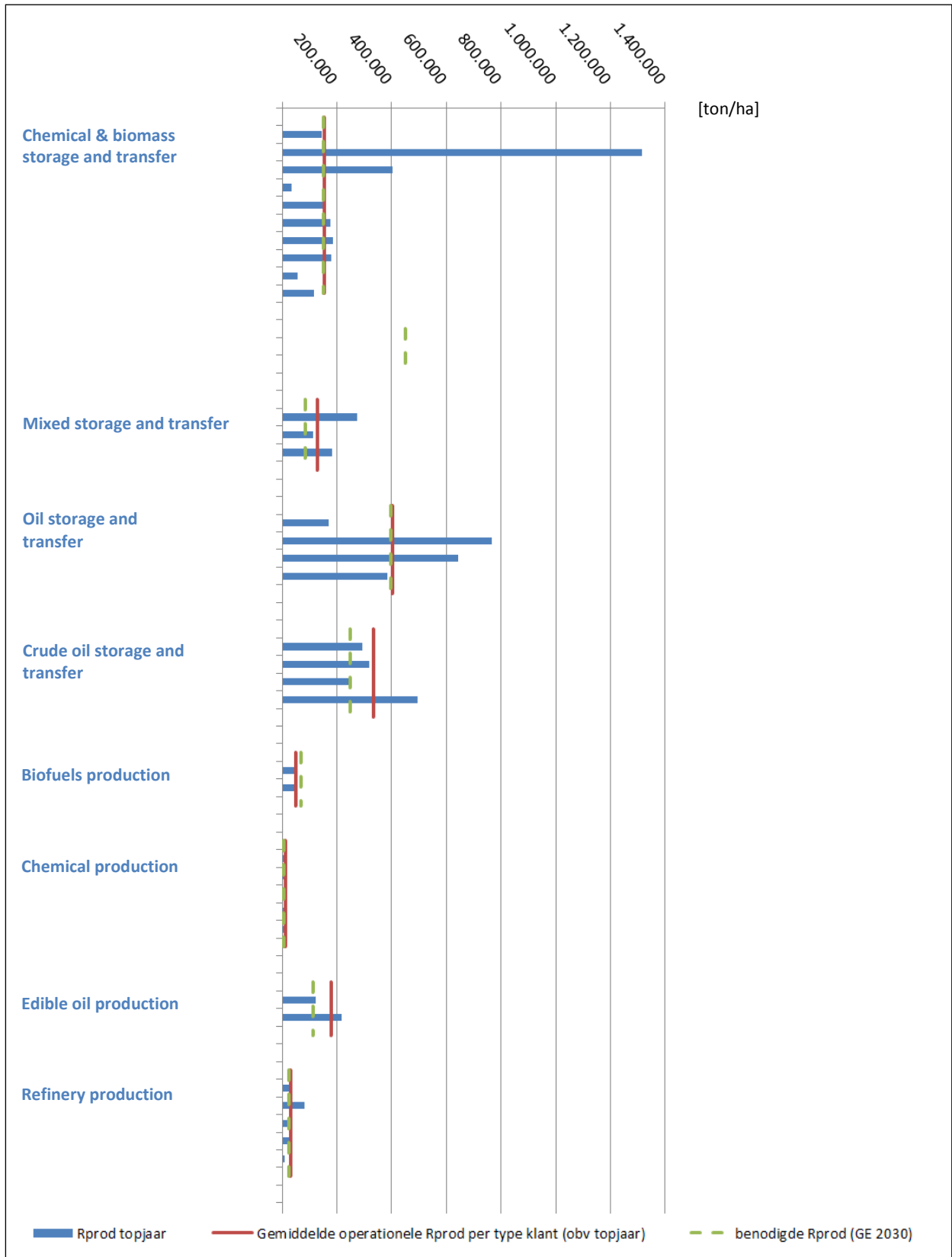


Figure 2-13 Liquid Bulk top year area productivity per monitored terminal and specific function (blue bars), compared to the average of top year area productivity (red line); and also with forecasted average area productivity in the year 2030 for the Global Economy (GE) scenario of the Port Vision (dashed green line), (Port of Rotterdam, 2014I).

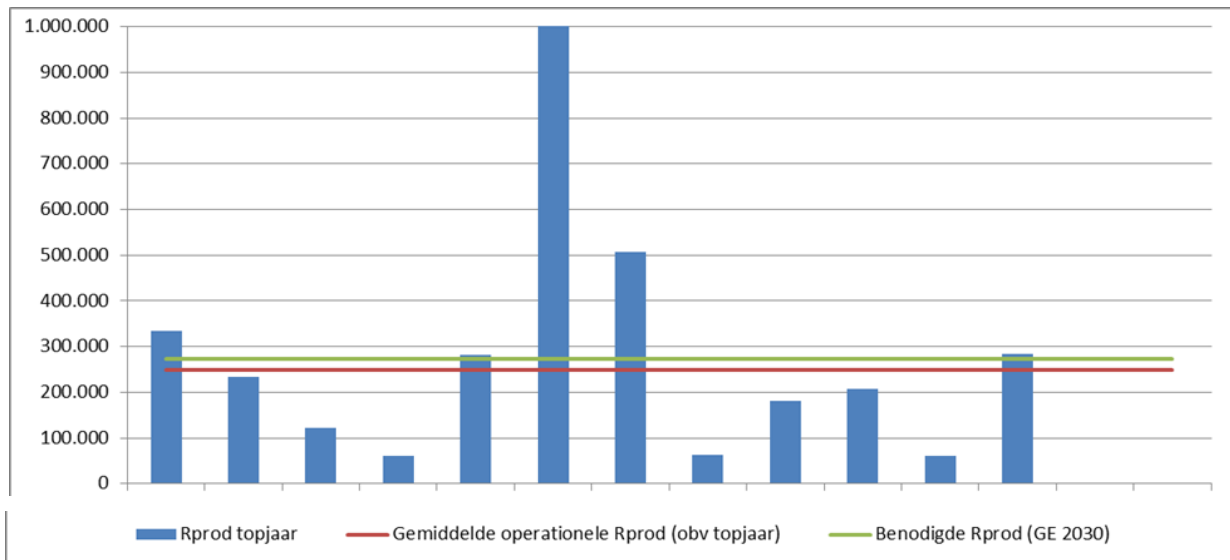


Figure 2-14 Dry Bulk top year area productivity per monitored terminal, compared to the average of top year area productivity (red line); and also with forecasted average area productivity in the year 2030 for the Global Economy (GE) scenario of the Port Vision (green line), (Port of Rotterdam, 2014).

Although the significant dispersion of single area productivity figures; average values for each cargo segment and functions are assessed. These are currently used to estimate required land space for new clients, and to forecast future area requirements according to the four scenarios of the *Port Vision 2030* presented in 2.1.4.4 *Forecasts of throughput*. Thereafter, average area productivity goals are initially set for 2030 aiming to initiate internal discussions on how to increase land use efficiency. Symbolically, these average goals are represented for the Global Economy future scenario of the Port Vision, which is also indicated in Figure 2-13 and Figure 2-14.

In addition, current database accounts for the different types of cargo that each terminal handle, though for estimating current area productivity are not individually treated yet. An overview of current output of the terminals database can be seen in Figure 2-15.

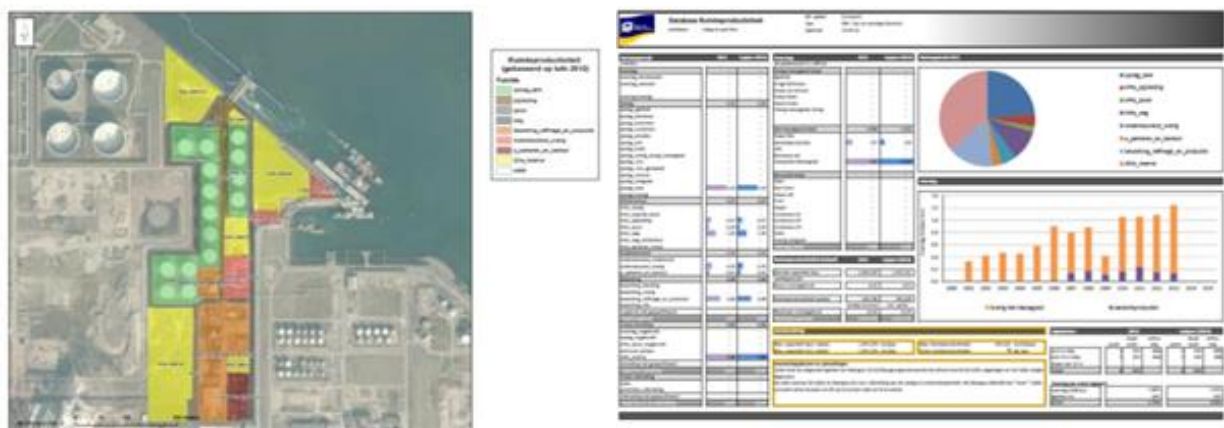


Figure 2-15 Schematic output of current Area Productivity database (Port of Rotterdam, 2014)

Finally, more detailed analysis to estimate quay and jetty productivities are also starting to be prepared within Port Planning at PoRA. These studies aim to divide quay and jetty productivity by sea going vessels and inland barges, but further efforts are needed. At the moment of finalising this research, studies for assessing berth and jetty occupancy at PoR were also on going within PoRA.

### 2.3.3. Project development process

There is a clear distinction on the way of handling commercial and public projects at PoRA. According to current practices at PoRA, projects are initialised when commercial opportunities can be materialised, or when public projects arise as direct consequence of the needs introduced in the masterplan. In any case, starting up a project is the subsequent step.

The focus of this subsection is initially given to commercial projects. These are initiated to investigate possible opportunities triggered by Business Development (Commercial Managers). Thus, Port Planning (“Gebiedsmanager”, and “Ontwerpers” or Designers in English) elaborates conceptual designs that are labelled as Phase 0 projects. A project during its lifecycle has six extra phases according to the definitions adopted at PoRA. To attain a general overview Figure 2-16 summarizes every established phase of a project development.

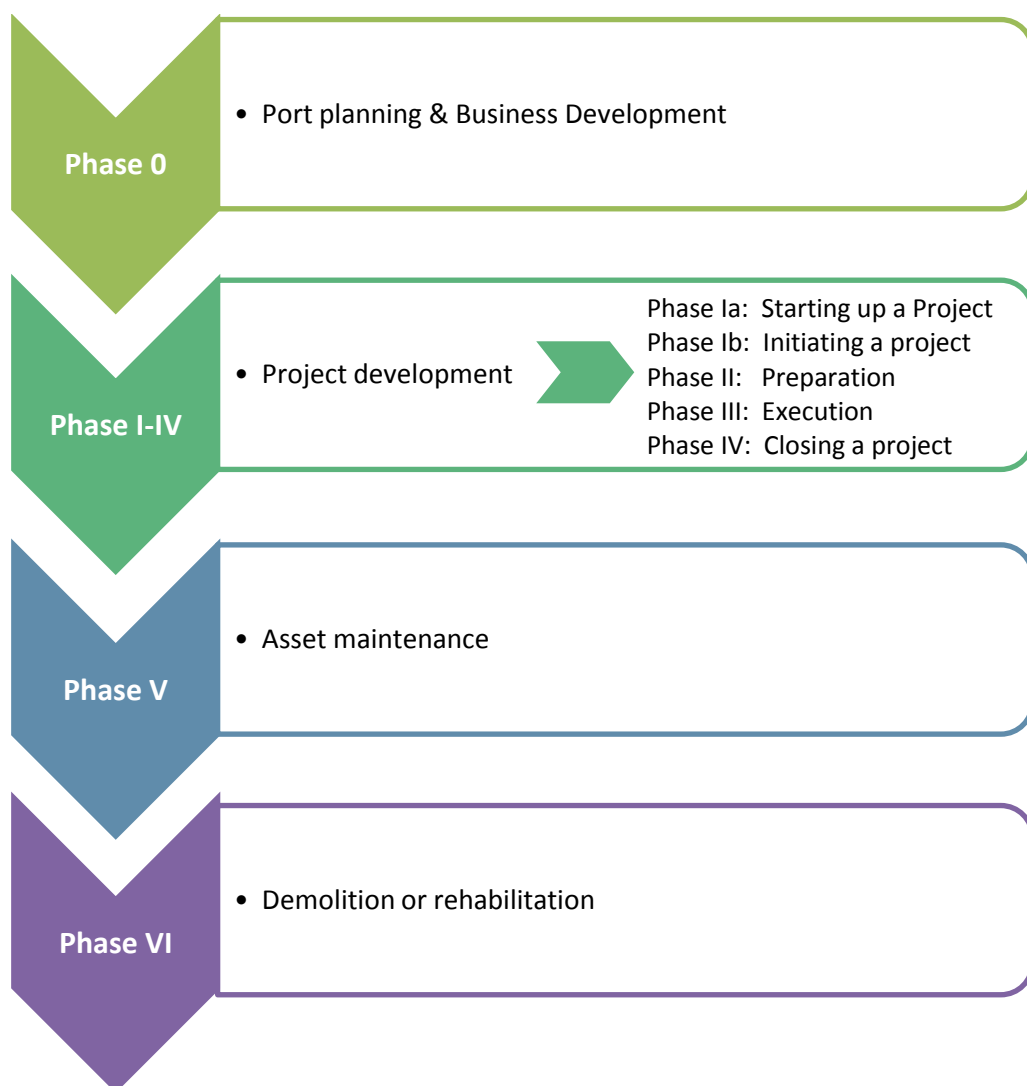


Figure 2-16 Project process at PoRA

Zooming in, each Phase 0 project includes a brief description, a short justification of the possible project and draft conceptual sketches. It also comprises a first cost estimation, potential investment period, project starting date and a rough estimated success rate. Besides tentative members for the project team can be included. These initial proposals are submitted for approval (“projectopdracht”) to the

Consultation Board (“Driehoeksoverleg”) which is integrated by the heads of the following departments within PoRA:

- Port Development (PD);
- Process Industry & bulk cargo (PIM, “Processindustrie & Massagoed”);
- Containers, Break-bulk & Logistics (CBL);
- Asset Management (AM); and
- Investment & Risk Management (IRM).

If a project is approved by the Consultation Board, it evolves to Phase I (of 6). Then, a project team is set under the coordination of a Project Manager. It comprises professionals from different departments, i.e. Designers (PD-PP), Project Engineers (PD), Contract Managers (PD), Project Control Coordinators (PD), Asset Management (AM), Environmental Management (EM), Harbour Masters (DHMR), and Investment & Risk Management (IRM). This team works in close relationship with professionals from Process Industry & bulk cargo (PIM) and Containers, Break-bulk & Logistics (CBL) departments. A detailed composition of a project team during Phase I is schematized in Figure 2-17.

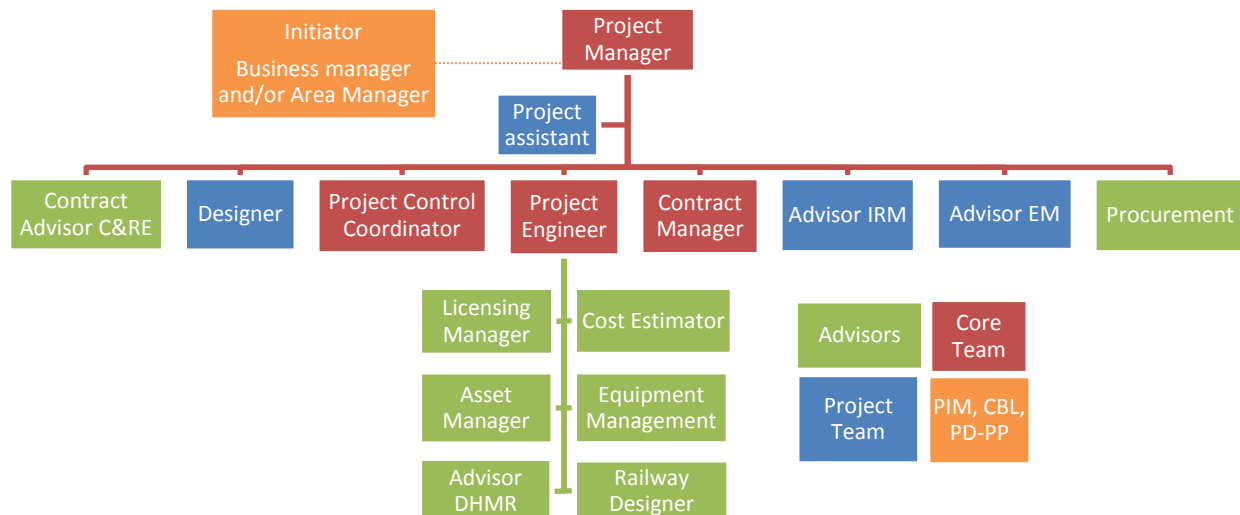


Figure 2-17 Project team composition during Phase I (Port of Rotterdam, 2013h)

Moreover, Phase I is subdivided into two sub-phases: Ia and Ib.

During Phase Ia, the project team studies different technical alternatives for the project. The selection process amongst every alternative is based on initial financial business cases. Once an alternative is selected a complete financial business case is performed with the portfolio value (and risks) to conclude with this sub-phase.

Then, during sub-phase Ib the preparation of the offer, the investment plan and negotiations with the client take place. After approval, the definitive business case is done and the portfolio value is adjusted. To conclude this sub-phase, and consequently Phase I the intention to assign the engineering services is expressed.

For Phase II the project team is slightly adjusted, the new composition is shown in Figure 2-18. This project team is maintained until the completion of the project. Phase II consists on the engineering preparation. During this phase is where the contract is signed.

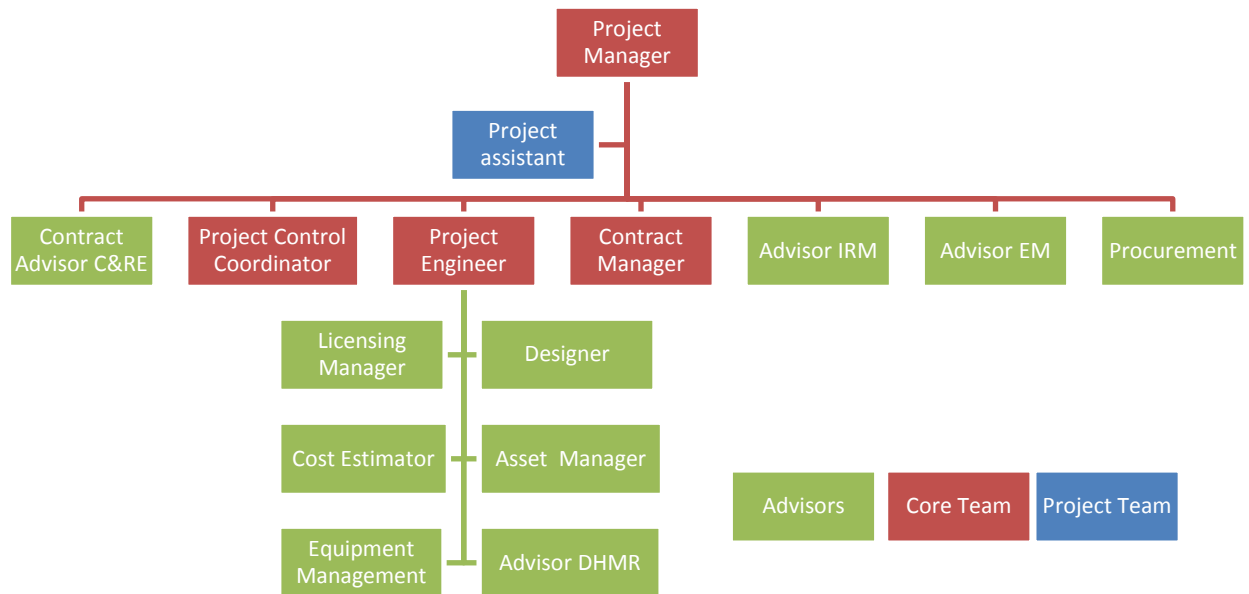


Figure 2-18 Project team composition from Phase II until Phase IV (Port of Rotterdam, 2013h)

Finally, Phase III is related with the execution of the project, and Phase IV is the closing of the project (Port of Rotterdam, 2013i). The entire and detailed Project process is shown with chart flows in *Annex X*; section X.3 “*Processchema fasering*”.

### 2.3.4. Business decision-making throughout business cases

The business cases are based on future incoming and outgoing cash flows, discounted to its present value. The outgoing cash flows are mainly related to future construction costs, maintenance costs, et cetera. The incoming cash flows are mainly related to harbour dues and income from land lease contracts, among others. Basically, business decision-making is done throughout a business case. There are two types of business cases:

- Public business case (investments in public infrastructure); and
- Commercial business case (investments in customer related infrastructure).

The focus is again given to commercial projects, where the feasibility of a business investment is determined by evaluating whether the Internal Rate of Return (IRR) is higher or lower than a minimum threshold. The IRR for commercial investments within PoRA is calculated over a fixed period of time that is disassociated from the actual technical lifecycle of projected basic infrastructure. Usually, at least an IRR of 8.5% on the investment is entailed (Aartsen, 2006) over a payback period of 25 years. The payback period is based on an average depreciation of PoR assets.

It is important to clarify that IRR and payback period in a business case may be adapted according to the risk profile of the investment. The risk profile is determined through the portfolio management which is briefly discussed in subsection 2.3.6. The mentioned adaptation of a business case can be done either by increasing the required IRR in case the investment presents high risks (or by reducing the payback period although it is not common, only for Information Technology investments). In contrary, lower IRR may be accepted in case of strategic investments. Hence, it is clear that management decisions play an important role when moving forward with commercial investments, and that estimated IRR and portfolio value are not the only decision-making parameter (Port of Rotterdam, 2014e).

Basically, a technical solution for commercial investments is initially selected based on management professional judgement and preliminary business cases that are deterministic and entirely financial driven; i.e. uncertainties, flexibility, ecosystem services and social benefits among other topics are not evaluated (Taneja, 2013).

To conclude, the interviews with professionals at PoRA showed that most of them think that current way of performing business cases is not enough. As a result of extensive discussions, it was agreed that having different evaluation figures and mechanisms would be useful and beneficial for the decision-making process considering the inclusion of flexibility, ecosystem services and social benefits in a second type of business case and throughout MCA.

### 2.3.5. Control of investments

Control of investments is divided in three components at PoRA:

- Cost control (project realisation / budget);
- Benefit control (realisation of the income) and;
- Financial Control (reliability of the financial figures, compliance -capitalization or losses aligned to Dutch GAAP- and corporate governance).

Predominantly, cost control is well managed, being MV2 a good example of succeeding in this task. Financial control is extensively prepared at PoRA, and the annual reports are the results of this process; e.g. net income of €227.5 million in 2012, turn over increase of 4.6% from 2011 to 2012, et cetera (Port of Rotterdam, 2013a).

Conversely, benefit control still needs to be improved within the port organisation. There is a general understanding of the overall port benefits, and its resulting rate of return as a whole. This is a good indicator for attaining an overall image of the port performance. However, little is known about the actual internal rate of return on investments for each area or project; hence, valuable information is missing for understanding every component at the port, in other words for a first-class planning.

Generally a good control on benefits needs clear accountability. However, port investments have a long payback period that hinders a good accountability if assets financial performance is not closely controlled during the whole lifecycle. Nowadays the focus is mainly on forecasting outgoing cash flows during preparation and construction phases of a project, and at the moment of capitalisation, but not during the commercial lifetime. So for static business cases, several of the initial basic assumptions of a business case are not valid anymore. As it is mentioned before, current business cases are deterministic and do not take into account uncertainties; so are not valid unless they are constantly controlled.

Finally, not any value is given to assets after the considered payback period in a business case. Nonetheless, as it is mentioned before the assets usually remain at the port for longer periods than 25 years. This means that depreciated assets to zero still generates incoming cash flows with very high return of investment rates.

### 2.3.6. Portfolio Management

Explaining how the portfolio is managed at PoRA is not the goal of this literature review. A helpful explanation can be found in “The Value of perception” (Visser, 2014). Its importance can be easily

understood. Basically, it allows including a risk and value-to-business profiles to any commercial investment done by PoRA.

Nonetheless, it is the intention of this subsection to point out that the portfolio management analysis is performed after a technical alternative is selected for a commercial investment. This denotes how its potential use for incorporating flexibility and social & ecosystem services benefits is not considered for selecting technical alternatives. To sum up, portfolio management is not a development tool. It is only applied when a project (technical alternative) is already selected.

### 2.3.7. Asset maintenance management

There is a large difference between asset management and asset maintenance management. In essence, asset management deals with the whole lifecycle of an asset, while asset management only considers the production, exploitation and use period, as it is shown in Figure 2-19 (Jurgens, 2014).

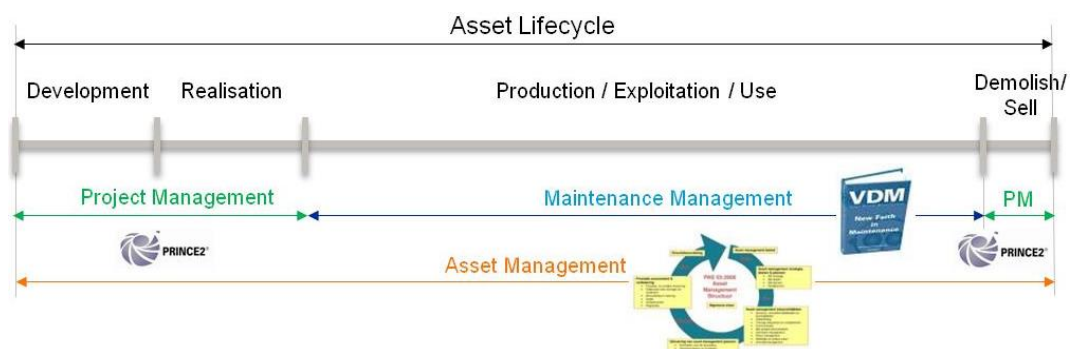


Figure 2-19 Asset management Vs. Asset maintenance (Jurgens, 2014)

Currently, PoRA identifies four roles related to asset management: Asset owner, Asset manager, Service provider and Asset user. Now, the Asset Owner, who sets policy objectives, is trying to initiate the implementation of Lifecycle management. However, current practices of the Asset Management (AM) department at PoRA are mainly related to asset maintenance.

The aim is to achieve a complete implementation of Lifecycle Asset Management procedures based on PAS 55-1 (BSi, 2008) at PoRA by 2030. This is an integral approach for the whole lifecycle considering a risk based method involving related chains and networks. This approach is fundamentally correlated with already described lifecycle method and concepts in previous section, like *Adaptive Port Planning (APP) framework* (2.2.1); *Opportunity framing* (2.2.6); *Value Engineering (VE)* (2.2.7); & *PIANC-IAPH “Sustainable Ports”* (2.2.8).

### 2.3.8. Summary & comments

This last section mainly addresses current masterplans and all correlated elements defining the decision-making process for expanding PoR activities. Given information ranges from the technical performance of existing operations, to the financial evolution and the portfolio management of the port among other important issues. Acknowledging this information is crucial as starting point for planning any existing port area. Furthermore, it represents one of the huge planning differences when dealing with existing port areas or green fields.

To sum up, the content of the chapter can be summarised through the subtitles of each section. Mainly section 2.1 describes *Port organisation and strategies & Europort present situation*; while section 2.2

deals with *Incorporating flexibility for dealing with uncertainties* within a sustainable framework; and finally, this section 2.3 specially treats *Planning and project decision-making process at PoRA*. At this stage of the report, it is accurate to say that research SQ1 is fully answered thru this, and every precedent section within *Chapter 2*. This means that current Europoort situation conditioning future developments is successfully addressed.

## 2.4. Possible future developments challenging Europoort success

In order to build up a robust long-term masterplan, several future scenarios are exhaustively evaluated to select possible developments influencing Europoort. Scenarios prepared by international bodies, national governments and related segment companies are studied. Furthermore, internally elaborated analyses within PoRA, like the Energy Scenarios (Port of Rotterdam, 2014a), are also included in this research, and for the very first time within any port planning process at PoRA.

Finally, understanding the success of an existing port area is considered compulsory to identify those future uncertainties which may affect existing port areas, either positively or negatively. Hence, an attempt to group main goals for achieving success in an existing port area is presented in this section.

### 2.4.1. Future scenarios & external developments

To identify possible future developments that may influence Europoort, a literature scenario analysis is developed. To a certain degree, this part of the investigation is facilitated by similar processes already carried on at PoRA. Though, it has been complemented with relevant literature for this research. All the studied future developments are used to identify underlying assumptions on Europoort Masterplan and the Port Vision. Used scenarios are indicated for each statement listed in *Annex B*, section B.2.

#### 2.4.1.1. Drivers of change & Energy scenarios at Port of Rotterdam

Current scenarios presented within *Port Vision 2030 (2.1.4)* are related with possible drivers of change which are presented in Figure 2-20. These may influence any port development, thus are constantly monitored at PoRA. As a direct consequence, the Energy scenarios 2040 (Port of Rotterdam, 2014a), developed by PoRA Corporate Strategy, arose during 2014. Three new scenarios are presented: Power, Fusion & Unlimited scenarios.

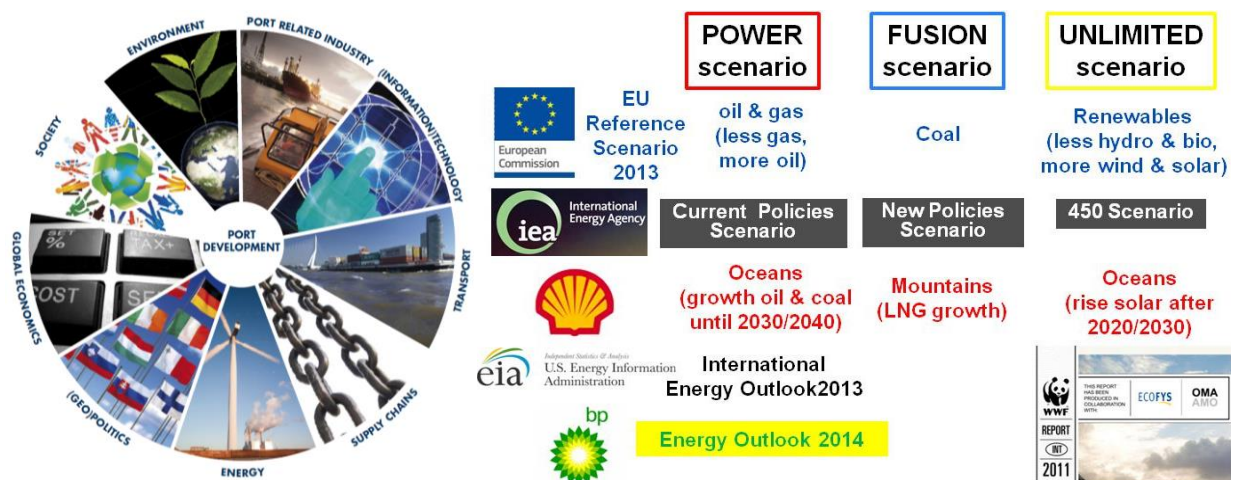


Figure 2-20 Drivers of change & Energy scenarios 2040 (Port of Rotterdam, 2014a)



These are completely related to current cargo segments at Europoort, and are also linked with many scenarios from external parties, like: Trends to 2050 (European Commission, 2013); Shell energy scenarios to 2050 (Shell, 2011); International Energy Outlook 2014 (iea, 2014); BP Energy Outlook 2035 (BP, 2014), World Energy Outlook 2013 (iea, 2013); and The Energy Report (WWF, 2011).

#### 2.4.1.2. Project MP7+: to a robust Masterplan for Maasvlakte 2 (MV2)

The project MP7+ for Maasvlakte 2 (TGI et al., 2014) is the only attempt to fully implement AAP framework for port planning purposes at Port of Rotterdam. It is developed for a green field; thus, the followed approach needs to be re-thought for existing port areas. Nonetheless, by means of a critical analysis, plenty of the worked information is useful. Of special interest for this subsection is the review of the twenty forecast studies and vision documents included within MP7+. These were selected from major companies (Shell, DHL, et cetera); consultants (Deloitte and Lloyds, just to mention some); international non-profit organizations (such as UN, FAO, OECD, among others); universities (MIT, University of Wageningen, et cetera); and other research organizations (TGI, TU Delft, & TNO, 2013).

From those documents, AAP framework was followed. Therefore, the obtained assumptions in the project MP7+ for the second step of APP are analysed, partially filtered and critically tailored for Europoort. Finally, outdated documents used for MP7+ are reassessed.

#### 2.4.1.3. Additional future scenarios from literature

The analysis is complemented and upgraded with more studies that are carefully selected for the purpose of this thesis. In summary, these extra future possible scenarios are also included:

- Updating the future (Club of Rome, 2013)
- Rijkswaterstaat Shipping Scenarios for Delta Programme (Wolters & van Dorsser, 2014)
- Transcontinental Infrastructure needs to 2030/2050 (OECD, 2010b).
- Looking to 2060 (OECD, 2012a).
- Environmental Outlook to 2050 (OECD, 2012b).
- Economic Outlook (OECD, 2014).
- Global Europe 2050 (European Commission, 2011).
- Global Trends 2030, published by USA National Intelligence Council (NIC, 2012).
- Creating and Sustaining Strategic Intent (U.S. Coast Guard, 2013).
- One Planet Economy Network (OPEN, 2011).

Some inclusions also allow to integrate current efforts carried out by Rijkswaterstaat, and other governmental bodies, like U.S. Army Corps of Engineers (USACE) Civil Works program (Cann, 2010).

#### 2.4.1.4. The Future of Globalization

An international WRR lecture was attended on November 6<sup>th</sup>, 2014 in The Hague (WRR, 2014). The keynote speaker was Professor Dr. Joseph E. Stiglitz who was awarded the Nobel Prize in economics in 2001, and shared the 2007 Nobel Peace Prize (University of Columbia, 2014). Prof. Dr. Stiglitz dissertated about the future sources of growth in the world economy, and the implications for western countries. Economic globalisation outperforming political globalisation is the main outcome. In essence, global rules are threatening the capacity of governments to protect the environment, safeguard health

and safety of their citizens, and to guarantee the stability of the economy. The defy is to learn how to temper globalisation, since governments have a hampered capability to react (Stiglitz, 2014).

Globalisation created more interdependence amongst countries (seized on world's influence). Among some of the negative impacts, for many countries globalisation brought less public services and less wages for their citizens. For developed countries including The Netherlands, this would originate a problematic context. Meanwhile, some East Asian countries took advantage of globalisation in their own way, by immediately reaching access to global markets and to global technology, but slowly reducing their own trade barriers. These have brought back some marginalised countries in the past, as foremost influencers of the global economic landscape (Stiglitz, 2014). This trend is rocketing and more than 40% of the shares of world GDP are predicted to stand within China and India by 2030. Additionally, China is now the largest global saver; consequently it is becoming the major financial centre in the world (World Bank, 2013a, 2013b). Thus, a new balance of economic and political power is, and will be, materialising where the influence of developing countries will be more considerable.

Extensive modifications in the governance of globalisation are required by reforming global institutions towards a multi-shared power. Undoubtedly, this is not a simple stride, though some changes are on their way like the BRICS bank; new perception of problems by the civil society (opposition to trade agreements); and new evidence on the importance of social sustainability (already recognised by IMF) where greater social equality is seek (Stiglitz, 2012). Additional future external developments are:

- Emerging of more multinational companies integrated by national-owned companies.
- Asia, Africa and South America growing and increasing their shares of world GDP.
- Free trade agreements will no longer be issued, thus new agreements will be set to bring knowledge and assisting local development (enhancing local institutions as well).
- Industries rising in developing countries will merge with developed countries production chains. Benefits will be maximised overseas (win-win investment). Raw materials will be domestically processed. Trade by itself will not bring progress.
- Policies to reduce inequality will be executed, i.e. reduce effects of short-term capital markets.

Moreover, it is discussed the several regional problems that EU will also encounter. Hence, the selection of investments that provide large benefits (e.g. innovation and technology) should be a primordial strategy. Besides, as Europe has become a single market, the creation of strong institutions is a must to be managed as a single market to promote convergence without the influence of local governments (and avoid divergence e.g. Spain ≠ Germany).

At last, current situation in Europe is based in a model that cannot be replicated anymore (exporting model). Every European country cannot be and/or remain primarily exporter, so partnership, and trade & aid agreements will become strategic parts of EU future towards sustainable and inclusive growth replacing current paradigm.

#### 2.4.1.5. Thoughts on described future developments

The aim of incorporating these scenarios throughout the introduced documents, reports and thoughts, is broadening and complementing the analysis with national, regional, European and global developments. This is successfully achieved, and it is explicitly used for identifying each underlying assumptions on current Europoort Masterplan and the Port Vision. Each statement in *Annex B*, section

B.2 is referenced to its related future scenarios. Besides these future developments are critically considered when increasing the robustness of current masterplan. Nevertheless, and depending on global evolutions, it is also advisable to explore some other perspectives and future scenarios, especially those coming from Asian countries.

To sum up, the reconciliation of all this information certainly facilitates an inclusive analysis that comes through *Chapter 3* of this report.

### 2.4.2. Port Success

Port success is a significant starting step for APP framework as presented in subsection 2.2.1.2 *Steps in APP*. Therefore, without a proper formulation of the planning goals for a specific port area; the desired outcomes cannot be pursued. Consequently an extensive literature review was carried out to recognize main categories for defining success of an existing port area. Although literature specifically dealing with port success is very rare; relevant articles dealing with management success, port development guidelines, global indexes related with ports, and port authorities' reports were analysed.

From all of them, it is important to mention that EFQM Excellence Model provides fundamental overall guidance to build up sustainable excellence. This means that for achieving and sustaining success, outstanding performance levels needs to be reached in order to meet or improve the expectations of every stakeholder. Consequently, obtained Results are based, and relying, on the activities (Enablers) done by an organisation (with its manner of implementing them) towards excellence. These pursued results are for: People, Customers, Society and Business. Meanwhile the Enablers are: Leadership, Strategy, People, Partnerships & Resources, and Processes, Products & Services (EFQM, 2012).

In conclusion, the intention of this part of the study is to break down recommended (guidelines), envisioned (port authorities) and/or attained (clients & global indexes) goals within EFQM results groups (people, customers, society and business). Basically, every acknowledged recommendation and goal selected for analysing port success, is based on the four stakeholders' groups presented within EFQM. Furthermore, each identified indicator presented in *Chapter 3*, section 3.4 *Definition of success* is related to the Enablers, while the goals and recommendations are associated with the desired results for people, customers, society and business. This is almost mandatory to understand the role each part of the organisation needs to play for effectively implementing a desired strategy.

Finally, Table 2-1 summarises the first step of implementing EFQM for port success. Based on the literature review and the EFQM model, the subsequent categories were identified to assess port success for existing port areas (within brackets the main EFQM Enablers & Results):

- Competitiveness (Processes, Products & Services; and Partnerships & Resources)
- Financial results (Customers; and Business)
- Use of space (Processes, Products & Services; Partnerships & Resources; Customers; and Business)
- Hinterland connections (Processes, Products & Services; People; and Strategy)
- Economic & social impacts (People; Society; Strategy; and Leadership).
- Environmental implications (People; Society; Processes, Products & Services; and Leadership)
- Safety (People, Society, Strategy, and Leadership)

Table 2-1 Port success goals extracted from port authorities documents (visions, masterplans & annual reports), worldwide port planning guidelines, experiences from the clients, and the World Bank evaluations.

Criteria	Port Vision 2030 (Port of Rotterdam, 2011)	Annual Report 2012 (Port of Rotterdam, 2013a)	Masterplan 2015 (Port of Rotterdam, 2014c)	Sustainable Ports (PIANC, 2014b)	Masterplans for Existing Ports (PIANC, 2014a)	Annual Report 2013 (Port of Antwerp, 2014a)	Sustainability Report (Port of Antwerp, 2012)	Port Vision Amsterdam (Meijer, 2011; Tielens, 2014)	Masterplan 2040 (Port of Buenos Aires, 2013)	Port Master Planning (Ports Australia, 2013)	Annual Report (Port of Melbourne, 2013)	Strategic Plan 2012-2017 (Port of Los Angeles, 2012)	Business operators (Port of Antwerp, 2014b)	Global infrastructure (World Economic Forum, 2014)	SUM
1 Competitiveness	1	1	1	1	1	1		1	1	1	1	1	1	1	13
<i>Market Share</i>		x				x		x	x		x	x			
<i>Handling times</i>	x	x	x	x	x				x	x		x	x	x	
<i>Quay &amp; Jetty productivity</i>			x	x	x				x	x			x		
2 Financial results		1	1	1		1	1	1		1	1	1	1		10
3 Use of space	1	1	1	1	1	1	1	1	1	1	1	1			12
4 Hinterland connections	1	1	1	1	1	1	1	1	1	1	1		1	1	13
5 Social & economic (business invest.) impacts	1	1		1	1	1	1	1		1	1	1			10
6 Environmental implications & sustainability	1	1	1	1	1	1	1	1	1	1	1	1			12
7 Safety	1	1	1	1	1	1	1	1	1	1	1	1	1	1	14
8 Strategic regional economy power	1	1			1	1	1	1	1		1		1		9
9 Laws & regulations	1	1	1	1	1		1		1	1	1				9
10 Innovation	1	1		1		1	1	1		1		1			8
11 Connectivity with growth markets		1		1		1		1							4
12 Port Governance & Organisation		1		1	1	1	1		1	1	1				8
13 IT Performance & communications				1	1	1		1			1		1		6
14 Supply Chain	1			1	1	1	1	1		1	1		1	1	10
16 Maritime shipping lines connections	1			1	1	1	1		1	1			1	1	9
17 Customs easiness					1					1			1	1	4



Port Authorities



Guidelines



Clients



Global Governance

# Chapter 3. Europoort Adaptive Port Planning

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Generally, port infrastructure has a useful lifetime (service, commercial and compliance) of several decades, and a technical (design) lifetime much longer. Diverse external factors may imply breaks in future scenarios, modifying one or more of the lifetime aspects.

New economic crisis, shifting of geopolitical power, new technological developments and possible institutional changes are just some examples that may influence any long-term planning. All these possible future developments are considered within the scenarios presented in section 2.4 *Possible future developments challenging Europoort success*.

Currently PoRA masterplans are well-developed, dynamically controlled (annual updates) and deterministic scenario driven; but limited on adaptability for structural uncertainties. These future uncertainties are not yet thoroughly identified, thus not included yet. This situation may lead to not robust enough masterplans. Therefore this chapter describes the process to achieve a flexible and robust planning that can allow reliable designs for very different futures at Europoort.

## 3.1. AAP steps applied to increase robustness of Europoort planning

PoRA envisions preserving PoR as Europe's Industrial Cluster and Global Hub. Consequently, it is mandatory to attain a complete understanding of the prevalent situation, and then relate it to clear objectives for achieving success. Therefore, the starting point is PoR and Europoort present state (Port Vision and Europoort Masterplan). This is extensively described in *Chapter 2 Literature review*, especially in sections 2.1.4 *Port Vision 2030* and 2.3.1 *Masterplan Europoort*.

Essentially, it is necessary to determine whether current plans would lead or not towards meeting those objectives. Mechanisms to measure parameters influencing the proposed objectives should be explicitly selected and stated as well. Hence, if some of the targets are not to be achieved in the future, decisions have to be effectively taken to reach them. This entails a constant monitoring of the planning process.

To recognise fundamental changes affecting Europoort planning parameters, and to integrate them into the Masterplan Cycle shown in *Chapter 1 Introduction*, APP framework (Taneja, 2013) is proposed. The outline is composed by several steps as it can be appreciated in Figure 2-9 within subsection 2.2.1 *Adaptive Port Planning (APP) framework*.

The scope of this research considers all the steps of APP framework to be comprehensively applied for the very first time to existing infrastructure (brown field) in order to increase robustness of the planning of Europoort. These steps are very well delimited, and consist in: defining the problem (success) & strategies (time horizons), identifying the basic assumptions, increasing flexibility & robustness of current masterplan, to finally evaluate and select alternative plans to be implemented.

The first two steps of APP framework include the identification of the objectives, indicators and underlying assumptions (vulnerabilities and opportunities). These are based on the literature review, interviews, and an in-house workshop.

Within the third step of APP framework, the associated actions for each vulnerability or opportunity are divided according to each defined planning time horizons. The proposed actions for short- and medium-

term may be shaping actions, mitigating actions, hedging actions and/or seizing actions. In the same way, long-term action needs to be identified as possible triggers. Translating these actions into the masterplan is a key phase within this step.

Within the fourth step of APP, recommendations for a case study at Europoort are given. Therefore a critical area within Europoort is selected to perform this analysis. Details on this selection process can be found in *Annex X*.

The following sections describe the applied procedure, and the used methodologies.

### 3.2. Planning strategies and its related time horizons

As it is stated in the main research question and along the whole text, the aim is to look for a robust long-term masterplan; but what does long-term means? Firstly it is needed to define what a planning time horizon is; and it can be described as the farthest point in time for the planning efforts setting the endpoint of an assumption (Taneja, 2013).

Planning time horizons are delimited to describe short-, medium- and long-term with its associated planning strategies. A pragmatic decision leads to use year 2030 as break-point for the analysis and the defined periods are as follows:

- Short-term: 2015-2020, usually named “Project Planning”.
- Medium-term: 2020-2030, categorised as “Strategic Planning”.
- Long-term: 2030-2065, where the “Masterplans” and the “Port Visions” are circumscribed.

Given names for distinguishing each planning time horizon are acknowledged from PIANC report “Masterplans for the Development of Existing Ports” (PIANC, 2014a). Within this proposed approach, years further than 2030 are considered as long-term. This is founded on the fact that the available information, dealing with the PoR future vision, is mainly thought as maximum for the year 2030.

In addition long-term time horizon is also delimited in its upper boundary. Year 2065 sets this border and it is based on the technical lifetime (50 years) of any basic infrastructure finished by the end of 2015. As it is previously explained this method tries to match different lifecycles for new infrastructure developments (technical, commercial, economical and compliance). Of course, this practical approach fixes suitable planning strategies to be applied. It is important to note that these planning time horizons are also based on the type of companies already located at Europoort, and those expected to settle in the future. Most of them require large investments and strong capital expenditures to operate as world-class industries.

Analysing beyond 2065 for port planning purposes at Europoort only becomes interesting when dealing with climate change and it is not within the scope of this report.

With the planning time horizons defined, the strategies are easily assigned based on the degree of uncertainties identified for each period of time (Taneja, 2013), as it is shown in Table 3-1. Nonetheless, the focus of this analysis is on the medium-term (APP) and on the long-term (scenario planning, a simplified version of APP). Short-term is almost not treated within the report, and it consists on specific applied actions derived from the medium- and long-term planning. It is also related to the start of a project, so significant share of cash flows may occur (e.g. depending on construction planning/phasing).

Table 3-1 Adopted planning strategies for Europort based on Table 5.1 (Taneja, 2013) and other literature indicated

Variable Time horizon	Project Planning Short-term 2015-2020	Strategic Planning Medium-term 2020-2030	Masterplan Long-term 2030-2065
<b>Degree of uncertainty</b> (Courtney, Kirkland, & Viguerie, 1997; Hertogh & Westerveld, 2010; Walker et al., 2003)	Level 1 Clear enough future	Level 3 Alternate future (with ranking)	Level 4 Multiplicity of plausible futures (unranked)
<b>Strategy &amp; framework</b>	Predict and act	Adaptive Port Planning (APP)	Scenario Planning
<b>Forecasting</b>	Single point estimate (deterministic) with sensitivity analysis	Several sets of point estimates, ranked on the perceived likelihood	Wide-ranging vulnerability analysis
<b>Alternatives</b>	Few alternative layouts or designs	Define alternatives within each scenario; focus on flexible and adaptable solutions	
<b>Project approach</b>	Deterministic business case	Stochastic business case	Qualitative evaluation of the alternatives

As described in *Chapter 2 Literature review*, the Port Vision 2030 defines four scenarios to forecast the potential cargo throughput in 2030. These scenarios are used as assistance to think about possible black swans challenging Europort, both for medium- and long-term. However, several other scenarios, presented in subsection 2.4.1 *Future scenarios & external developments* are considered.

### 3.3. Europort objectives

The main objectives for Europort are described in the Europort Masterplan 2013, MP13 and Harbour Industrial Complex Masterplan 2015, MP15. Both are summarised in subsection 2.3.1 *Masterplan Europort*. Besides several discussion sessions, carried on with many experts at PoRA (listed in *Annex A*), perfectly complement the literature information. This is crucial to recognise major goals to accomplish PoR objectives. These goals also represent guidelines to assess success of the port. The next paragraphs briefly depict the core identified objectives.

To begin with the commercial perspective, a major objective is increasing PoR competitiveness in the Hamburg-Le Havre (HLH) range. To succeed on it, increasing efficiency at Europort is crucial.

Aside of enhancing PoR competitiveness and financial situation, Europort is considered a key area to help boosting Dutch economy, specifically in the Rijnmond region. This enormous challenge relies on PoRA main vision, the realisation and conservation of Europe's Industrial Complex. For Europort (and some other areas like Botlek, MV1 and MV2) this can be translated in three principal components:

- **Fuels Hub** to keep strengthening the market leader position in fuel production, storage and trading. This denotes utilisation and improving of scale; integration and synergy amongst the industries; expanding as a hub for refining (oil and biofuel); and retaining the hub position for crude oil, LNG and as a bunker port in Northwest Europe.

- **Chemical Cluster** by integrating chemical & bio-based production. To develop a world-class cluster more connections of the chemistry industry in Rotterdam are needed. Energy efficiency and process optimization should be enhanced as well. Innovation is the core answer to those circumstances. Hence, being a front runner port in research and technology development should remain as a key driver.
- **Energy port** to ensure supply for Northwest Europe, encouraging more efficient use of energy and cleaner energy sources. To achieve this goal some specific-oriented actions are needed, e.g. the development of a biomass hub serving not only the Netherlands, but also Belgium and the United Kingdom. Besides setting a common CO<sub>2</sub> carrier (pipeline) across the harbour, repowering the existing port and issuing other wind farms (Headland, Hartel II) are key components to be developed. Finally a LNG Bunker Station in the Hartelkanaal is also important to supply the European barges fleet.

A primary consideration to enhance efficiency is also related to the use and revenues, from a scarce resource: land. In the past, the arranged prices for land lease at Europoort were quite low. At that time, the aim was to attract as many companies as possible to settle at the port. Therefore providing attractive conditions for the industries (long lasting contracts with low land lease prices for large plots) was one of PoRA ends. However current situation is different due to land scarcity, thus increasing the use of the land intensity is desired to achieve higher revenues from land lease.

Intrinsically related to land use is the usage of basic infrastructure. Commonly built wet infrastructure is exclusively used by one client. Thus other central target is to promote co-siting amongst terminals, and drum up the shared use of industrial land, quays and jetties by several companies.

In addition, Europoort can accommodate a wide range of sea going vessels, even up to VLCC & ULCC tankers or Valemax. The terminals are managing large throughputs; but this is expected to grow. Thus, satisfying future demands on waterways, inland barges, railways and pipelines is also highly relevant. Improvements on their related supply chains, mainly in terms of efficiency are needed as well.

To conclude, Europoort is not an exception within PoR, and sustainability is extremely important. Preventing nuisance situations, but at the same time intensifying the industrial activities becomes a key feature for the future of Europoort. The license-to-grow and the license-to-operate becomes only one philosophy when dealing with growth of the port. Thus sustainable growth appears as the only possible way to succeed. For that reason reaching synergy between the environment, every stakeholder and the port is very important. This means reducing nuisance while growing. To achieve this, some objectives like reducing air emissions (including odour) and emissions to the soil, are primary actions to attain. Every discussed topic in the precedent paragraphs is treated in detail within following section.

### 3.4. Definition of success

Firstly, success is briefly defined as the achievement of something desired, planned, or attempted (The Free Dictionary, 2014). However, the aim of this section is providing a complete understanding of port success for Europoort. This means answering research SQ2:

#### **What is current definition of success for Europoort?**

To start answering research SQ2, it is important to note that PoR core objectives are essentially related one to each other and cannot be interpreted separately. Hence different indicators, that can be



successfully determined, are identified. Only indicators leading to significant changes at Europoort are acknowledged.

These are clustered within the seven goals categories presented in section 2.4.2 *Port Success* of the Literature review:

- Competitiveness;
- Financial results;
- Use of space;
- Hinterland connections (and supply chains);
- Economic & Social impacts;
- Environmental implications; and
- Safety.

In addition, the possibility of assessing these indicators for achieving success at Europoort is imperative. Thoroughly evaluated allow to track the performance of the plans and provide information on whether the goals may be achieved or not.

As liquid bulk, dry bulk, and RoRo are the main cargo segments in the Europoort area; these are the initial cargo segments under consideration for some indicators. On the other hand, break bulk cargo segment is not considered within this analysis due to the relative small cargo share for Europoort.

The selected indicators are partially based on PoR Key Performance Indicators (KPI's) presented on the Annual Report 2012 (Port of Rotterdam, 2013a); though other indicators from PD-PP & EM teams and project MP7+(TGI et al., 2013) are specified for this analysis. Present values for these indicators are obtained; some of them are worked out for the purpose of this study. In contrast, it is only possible to identify a few envisioned future target values. The complete list is shown in Table 3-2.

At last, this is implemented to facilitate the analysis and obtain a comprehensive definition of success for Europoort. This approach can be also extended (and adapted) for other existing port areas in other harbour complexes. Each category is thoroughly treated in the following subsections.

### 3.4.1. Competitiveness

From all the reviewed sources, the following *indicators* are grouped within this category: *market share in HLH range* (in terms of throughput); *ship turnaround time*; *new participations in growing markets* (PoRInt); *quay or jetty productivity*; and *quay or jetty occupancy*. These are briefly discussed in the subsequent paragraphs.

PoR Annual Report 2012 (Port of Rotterdam, 2013a) and abridged Annual Report 2013 (Port of Rotterdam, 2014d) show that Rotterdam has a total market share of 37.5% in the HLH range. For 2030, the goal of Rotterdam is enhancing its leading position by reaching a total market share of 40% in the HLH range.

Although the focus is on Europoort, total market share values are included. This is justified because liquid bulk and dry bulk represent by far the largest throughputs. The situation is overemphasised when mentioning that PoR is the largest liquid bulk port in the world, and the twelfth largest in terms of dry bulk throughput in 2013 (Port of Rotterdam, 2013e). However, only a KPI for increasing containers'

market share is specified, but not specific values are thought for liquid and dry bulk cargo segments at PoR. So, to maintain its forefront position and achieve envisioned values, total market share in the HLH range may provide some insights. Nonetheless, this should be a managerial decision for the whole Harbour Industrial Complex.

To achieve competitive goals, PoRA is working at the moment with a nautical dynamic turnaround time (DTAT) of 4 hours and 27 minutes or less (excluding transshipment). DTAT is defined as the average time for every seagoing vessel larger than 150m, going from the sea (6-mile zone border) to a combine area of Europoort, Botlek & Waal-Eemhaven; and on the other way around (Port of Rotterdam, 2013a).

New participation on growing markets is mainly a KPI related to PoRInt. It is related to international Joint Venture Agreements, which can provide added value to key or new customers of PoRA. Specific goals for this KPI are not fixed yet for long-term; and short-term goals seems too broad (Port of Rotterdam, 2013a).

Port Planning is conducting preliminary studies towards obtaining more insights about efficient use of basic infrastructure at the moment of writing this report. Therefore, not much information is processed and analysed yet. Regarding quay or jetty productivity (ton/m per year) per each cargo segment some initial figures are specially prepared for this study. These are presented together with area productivity values in subsection 3.4.3 *Use of space* (more details in *Annex X*, section X.2). In contrary, information for quay or jetty occupancy factors is not available, because an extensive study is ongoing for determining berth occupancy at PoR.

### 3.4.2. Financial results

This category is mainly related with the shareholders, looking for return of investments and optimising profitability by pursuing sustainable financial growth.

Three *indicators* are identified: *Revenues from port dues; revenues from rent, ground lease and quay fees*; and the *IRR*. None of these figures are individually assessed for Europoort. *Payback time-horizons* are also considered relevant for analysis.

### 3.4.3. Use of space

The *indicators* grouped in this category are: *area productivity; revenue per ha* (per each cargo segment in average for whole port); *area contractual status*; and *segment share of rented land at Europoort*.

As shown in subsection 2.3.2 *Land use efficiency*, it is not simple to define representative area productivity & quay or jetty productivity (3.4.1) values for main cargo segments (e.g. liquid bulk, dry bulk and RoRo at Europoort), and not even for specific type of terminals within each cargo segment. Therefore, it is clear that only a complete benchmark would provide more insights. This can be carried out by clustering functional and commercial processes of the already grouped terminals by main operations. However, this is out of the scope of this study.

Consequently, aiming for a simpler approach than a full benchmark, representative terminals of each specific cargo segment are identified within Europoort. The selection is based in two main factors:

1. In-house benchmark of around two to three representative terminals assessed at Europoort within main type of terminals' operations. This is specifically developed for this research in close cooperation with PoRA Data Analysts (Port of Rotterdam, 2014o).
2. Professional judgment of well-functioning terminals at Europoort by the interviewed professionals at PoRA. A well-functioning terminal is understood as a terminal with significant commercial investments during the last 10 years to constantly update their facilities. This means front-runner terminals within each segment. Recommendations given by Data Analyst and "Gebiedsmanagers" are decisive for the selection process.

For the following categories within the liquid bulk cargo segment, these representative area productivity & jetty productivity values (average) are selected:

- Chemical & biomass storage and transfer: 160,000 ton/ha per year & 2,100 ton/m per year.
- Oil storage and transfer: 383,000 ton/ha per year & 13,000 ton/m per year.
- Crude oil storage and transfer: 293,000 ton/ha per year & 22,000 ton/m per year.
- Biofuels production: 55,000 ton/ha per year & 3,500 ton/m per year.

Refineries require a different approach therefore these are not considered as a major indicator of efficiency for this type of industry. Thus refineries should be treated separately.

Dry bulk cargo segment is also divided in categories. The following representative area productivity & quay productivity values for Europoort are:

- Coal storage and transfer: 335,000 ton/ha per year & 15,300 ton/m per year.
- Agribulk & Biomass: 281,000 ton/ha per year & 2,500 ton/m per year.

Concerning RoRo cargo, only two terminals are located in the "Beneluxhaven", and current representative area productivity is: 275,000 ton/ha per year & present quay productivity is: 11,000 ton/m per year. It is recommended to express these values in CEU (Car Equivalent Units).

As mentioned before, break bulk cargo segment is not considered in this analysis due to the small participation in Europoort's throughput.

For every presented value, representative goals are also set for 2030 only for the purpose of this thesis. The shared information is very appropriate to initiate the required internal discussions. Essentially, it is meant to be used as starting point for defining PoR goals for each port area.

In addition, throughput and area productivity evolutions (in years and for each terminal) are very interesting data to systematically consider. These give PoRA preliminary insightful tools to individually evaluate the efficiency of a terminal. However more efforts are needed to obtain generalized figures that would allow comparing terminal's efficiency. Hence, unless a complete benchmark is elaborated and some conclusions can be drawn from it; it is advised to independently evaluate productivity indicators terminal by terminal for planning purposes of existing port areas.

More details related to the In-house area productivity benchmark can be found in *Annex X*, section X.2.

### 3.4.4. Hinterland connections

The *indicators* set for this goal are: *modal split for each cargo segment*; and a *nautical reliability parameter*. Bulk cargo modal splits are shown in Figure 3-1, but there is not any modal shift goal set for these cargo segments; neither as a general vision, nor as specific planning policy of the port. Solely, current masterplans state that bottlenecks need to be prevented.

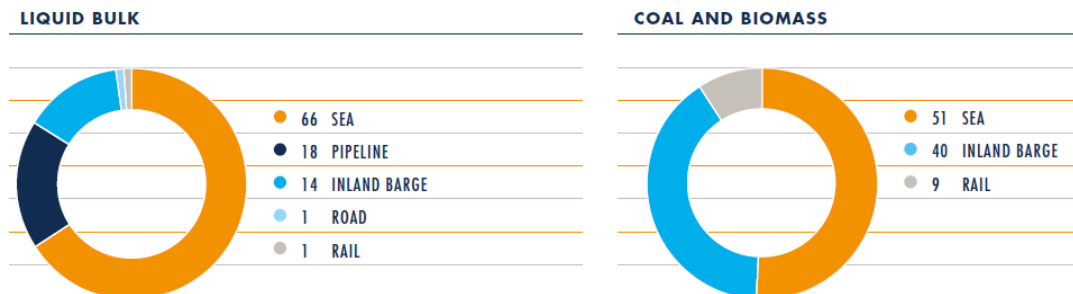


Figure 3-1 Incoming & outgoing flows in % in 2008 (Port of Rotterdam, 2010)

Terminals at Europort mainly deal with bulk cargo, therefore capacity on pipelines, railway and IWT (inland waterway transport) need to be carefully controlled, and in case needed enhanced. It is also important to note that changes on the cargo segments operating at Europort may imply variations in the modal shift which their possible consequences need to be reviewed. Possible increase of the road transport on the A15 highway may occur. Concerning RoRo cargo, there is not any available data referring to modal shift. However, it is expected that most of the cargo is reaching the “Beneluxhaven” by road. Thus, processing data of RoRo terminals is also considered important.

Supply chains play a key role in the hinterland connections efficiency; however processed data is not available at the moment of writing this report.

Transport efficiency for seagoing vessels at Europort is incorporated. Hence the Nautical Efficiency Index (NEI) is an important indicator of efficient handling of shipping. It represents to which degree a ship is handled in accordance to planning schedules (Port of Rotterdam, 2013a).

### 3.4.5. Economic & social impacts

As the activities developed at Europort are closely interrelated with other areas of the port; it is difficult to estimate their direct economic and social impacts. However, as the terminals at Europort are a vital part of Europe’s Industrial Complex vision, their influence is very large. Therefore, from every reviewed literature, these indicators are arranged in this category: cargo throughput; direct employment; indirect employment; contribution to Dutch GNP; and business investments from external parties.

The main *indicators* for this category are presented for the overall port. Firstly, PoR has been responsible in 2012 for 3.3% of the *Dutch GNP*. Secondly, PoR and its surroundings creates almost 90,000 of *direct employment*, with around 13,000 of employees connected to the industrial cluster, and therefore to a grand extent to Europort. Lastly, the *attraction of investments* is other essential indicator for this group.

### 3.4.6. Environmental implications

The Port Vision 2030 (Port of Rotterdam, 2011) sets important environmental objectives. In 2025, CO<sub>2</sub> emissions from the port must be reduced by 50%, and by 2030 sets a target for a 60% reduction (compared to 1990), as it is shown Figure 3-2. The decreasing CO<sub>2</sub> emissions per ton (bulk cargo) may start contributing to this.

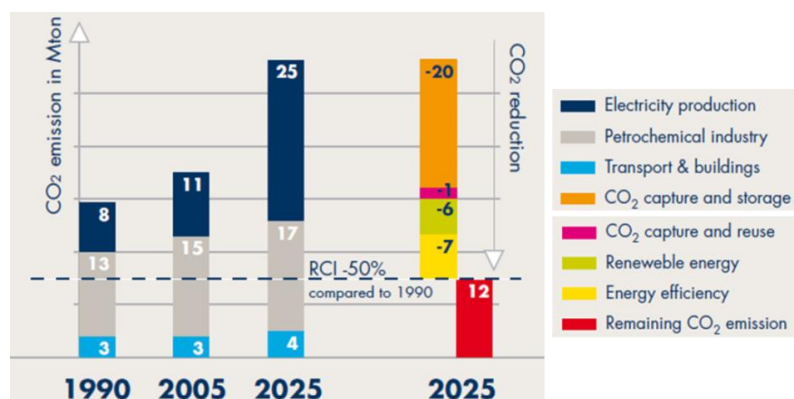


Figure 3-2 Target CO<sub>2</sub> reduction of the Rotterdam Climate Initiative (Port of Rotterdam, 2011)

In addition, general standards for air quality within the harbour were fixed for the development of MV2. This standard should be checked within Europort as well, the concentration of various substances in the air needs to have a maximum average year of: NO<sub>x</sub> < 40 g / m<sup>3</sup>, PM < 40 g / m<sup>3</sup>, SO<sub>x</sub> < 20 µg / m<sup>3</sup>, DPM < 25 g / m<sup>3</sup>. Lastly, the maximum noise level must not exceed 50 dB value day out in homes (TGI et al., 2013). The following **indicators** are obtained: CO<sub>2</sub> emissions in the harbour industrial complex, per cargo ton and/or cargo segment, and per industrial area; maximum noise levels at residential areas; annual emissions (DPM, NO<sub>x</sub>, SO<sub>x</sub>, PM); and (inter)national ecosystems, flora & fauna diversity (presence per unit).

### 3.4.7. Safety

Safety is high on the agenda and it comprises nautical safety, transport safety, environmental safety and port security. The (State) Harbour Master of Rotterdam is responsible for safe and efficient handling of shipping. Among others **indicators**, the amount of nautical accidents is closely controlled. In addition, the Nautical Safety Index (NSI) is also considered, because it measures the rate of accidents respect to the traffic density (Port of Rotterdam, 2013a). Both are computed for the whole port area.

Finally, Safety and Environmental Index (SEI), which is closely related to transport and environmental safety is considered as well, especially for checking the compliance level of prevailing rules on board. From 2012 onwards, inland vessels are also included on the SEI (Port of Rotterdam, 2013a).

### 3.4.8. Current detailed list of success indicators by category

The following table collects every discussed indicator, and it is intended as a guideline to check whether Europort is well-oriented or not to reach success. However, an initial scan evidences that currently there is not a comprehensive definition of success for Europort. Some of the overall values are functional to track the evolution of the complete Harbour Industrial Complex at management level, or for individual department's goals; but only a few are useful for planning specific PoR areas.

Table 3-2 Goals, indicators and definition of success for Europort, although several indicators are for the whole port area

Goals	Indicator	Definition of success	Source
<b>Competitiveness</b>	a. Total market share in HLH range	a. 2013: 37.5% 2015: 37.8% 2030: 40%	a. Port Vision 2030 Annual Report 2012
	b. Liquid bulk total market share in HLH range	b. 2012: 52.7%; 2015: N/A 2030: N/A	b. Annual Report 2012
	c. Dry bulk total market share in HLH range	c. 2012: 33.2%; 2015: N/A 2030: N/A	c. Annual Report 2012
	d. RoRo total market share in HLH range	d. 2012: 23.7%; 2015: N/A 2030: N/A	d. Annual Report 2012
	e. Ship turnaround time (DTAT)	e. 2012: 4:30 2015: ≤ 4:27	e. Annual Report 2012
	f. New participations in new industrial growing markets	f. 2015: 4 2030: N/A	f. Annual Report 2012 PoRInt department
	g. Quay or jetty productivity for each cargo segment at Europort	g. Chemical & biomass storage and transfer 2,100 ton/m	g. Area productivity, Port Planning, PD, PoRA
		Oil storage and transfer 13,000 ton/m	
	Crude oil storage and transfer 22,000 ton/m		
	Biofuels production 3,500 ton/m		
	Coal storage and transfer 15,300 ton/m		
	Agribulk & Biomass 2,500 ton/m		
	RoRo includes every vessel's draft	RoRo 11,000 ton/m	CEU figures needed
	h. Quay or jetty occupancy factor per each cargo segment	h. Liquid bulk: N/A Dry bulk: N/A RoRo: N/A	h. PoRA

<p><b>Financial results</b></p>	<p>a. Revenues from port dues (M: millions)</p> <p>b. Revenues from rent, ground lease and quay fees</p> <p>c. Internal Rate of Return</p>	<p>a. 2010: €305M 2012: €307M 2030: N/A</p> <p>b. 2010: €267M 2012: €292M 2030: N/A</p> <p>c. 8.5%</p>	<p>a. Annual Report 2012</p> <p>b. Annual Report 2012</p> <p>c. Business Plan</p>
<p><b>Use of space</b> Based on Global Economy (GE) Scenario and the figures are specifically for Europort</p>	<p>a. Chemical &amp; biomass storage and transfer terminal productivity (per ha &amp; per year)</p> <p>b. Oil storage &amp; transfer terminal productivity (per ha &amp; per year)</p> <p>c. Crude oil storage and transfer terminal productivity (per ha &amp; per year)</p> <p>d. Biofuels terminal productivity (per ha &amp; per year)</p> <p>e. Coal storage and transfer terminal productivity (per ha &amp; per year)</p> <p>f. Agribulk &amp; Biomass terminal productivity (per ha &amp; per year)</p> <p>g. RoRo terminal productivity (per ha &amp; per year)</p> <p>h. Revenue per hectare (per each cargo segment) in average for the whole port</p> <p>i. Status of the land at Europort Total area: 1,387.6 ha</p>	<p>a. 2013: 160,000 ton 2030: 150,000 ton</p> <p>b. 2013: 383,000 ton 2030: 400,000 ton</p> <p>c. 2013: 293,000 ton 2030: 250,000 ton</p> <p>d. 2013: 55,000 ton 2030: 70,000 ton</p> <p>e. 2013: 335,000 ton 2030: 275,000 ton</p> <p>f. 2013: 281,000 ton 2030: 275,000 ton</p> <p>g. 2013: 275,000 ton 2030: 500,000 ton</p> <p>h. 2012 Liquid bulk: €31.4k - €40.0k Dry Bulk: €55.0k RoRo: N/A 2030 N/A</p> <p>i. 2012 Leased: 89.3% Options: 2.3% Reserved: 5.6% Int. reserved: 0.2% Available: 2.7%</p>	<p>a. Area productivity, Port Planning, PD, PoR</p> <p>b. Area productivity, Port Planning, PD, PoR</p> <p>c. Area productivity, Port Planning, PD, PoR</p> <p>d. Area productivity, Port Planning, PD, PoR</p> <p>e. Area productivity, Port Planning, PD, PoR</p> <p>f. Area productivity, Port Planning, PD, PoR</p> <p>g. Area productivity, Port Planning, PD, PoRA</p> <p>h. Area Balance 2012, ("Ruimtebalans"), Port Planning, PD, PoRA</p> <p>i. Europort Masterplan 2013 &amp; Area Balance 2012 ("Ruimtebalans"), Port Planning, PD, PoRA</p>

	j. Segment share of rented land at Europort 89.3% of total area: 1,238.5ha	j. 2012 Liquid bulk: 77.3% Dry Bulk: 11.0% RoRo: 3.0% Other: 8.7%	j. Europort MP13 & Area Balance 2012 ("Ruimtebalans"), Port Planning, PD, PoRA
<b>Hinterland connections</b>	a. Modal split for liquid bulk cargo b. Modal split for dry bulk cargo c. Modal split for RoRo cargo d. Reliability	a. No bottlenecks b. No bottlenecks c. No bottlenecks N/A data d. Nautical Efficient Index (NEI) 2012 Norm: 7.0 2012: 9.5 2015: N/A	a. Europort MP13, Port Planning, PD, PoRA b. Europort MP13, Port Planning, PD, PoRA c. Europort MP 2013, Port Planning, PD, PoRA d. Annual Report 2012
<b>Economic &amp; social impacts</b> Figures related to the whole port area	a. Cargo throughput b. Direct employment c. Indirect employment d. Contribution to Dutch GNP (total PoR) e. Business investments (B: Billions)	a. 2013: 440.5Mton 2015: 500.0Mton 2030: 575.5Mton to 750Mton b. 2012: 87,111 jobs 2030: 97,500 to 115,000 jobs c. 2012: 50,160 jobs 2030: N/A d. 2012: 3.3% of GNP 2030: inaccurate estimations e. 2015-2030: €25.0B to €35.0B	a. Annual Report 2012 Port Vision 2030 b. Annual Report 2012 Port Vision 2030 c. Annual Report 2012 Port Vision 2030 d. Annual Report 2012 Port Vision 2030 e. Port Vision 2030
<b>Environmental implications</b>	a. CO <sub>2</sub> emissions in the port and industrial complex (Mton: millions of tons) b. CO <sub>2</sub> per cargo ton or per cargo segment c. CO <sub>2</sub> per industrial hectare d. Max noise levels residential areas e. Annual emissions (DPM, NO <sub>x</sub> , SO <sub>x</sub> , PM)	a. 2025: -50% 2030: -60% compared to 1990 (24Mton) b. N/A c. N/A d. 2030 Maximum daily load: 50dB e. 2030 concentration NO <sub>x</sub> < 40 µg/m <sup>3</sup>	a. Annual Report 2012 Port Vision 2030 b. Environmental Management? c. Environmental Management? d. Noise contours e. Environment department?



	f. (Inter)national ecosystems, flora and fauna diversity	$PM < 40 \mu\text{g}/\text{m}^3$ $SO_x < 20 \mu\text{g}/\text{m}^3$ $DPM < 25 \mu\text{g}/\text{m}^3$	f. No major changes in nature and different habitat types. Enhancing presence per unit.	f. Port Vision 2030
<b>Safety</b>	a. Nautical accidents	a. 2012 norm: 120 2012: 111 2030: N/A	a. 2012 norm: < 0.93 2012: 0.97 2030: N/A	a. Annual Report 2012
	b. Nautical Safety Index (NSI)	b. Port Safety Board for wet and dry areas. Creation of a vision.	c. PoRA	b. Annual Report 2012
	c. Criminality			c. PoRA

A workshop session with a multidisciplinary team of experts from PoRA was carried out in order to prioritise, validate and/or enhance the introduced indicators. Moreover, to facilitate this process for the participants, each indicator is translated into a statement on which they need to make a choice amongst five possible options: agree, agree a bit, neutral, disagree a bit and disagree. The proposed method allows ranking the presented indicators.

For the workshop session, individual online surveys for each goal category were created. Every professional independently completed the surveys one by one based on their professional expertise. When one of the seven surveys was completed by all the participants (only monitored by the moderator), the results were shared on a main screen. By implementing this procedure, insightful debates took place before proceeding with the next category survey. The workshop session was wholly recorded in order to track the details of the round-discussion table.



Figure 3-3 Workshop session, from left to right: Michel Bresser, Frank Wolkenfelt, Martijn Oosting & Ruud Melieste

Thereafter, to reach an even larger screening for the assessment, a “flexible workshop” was organised. This process allowed to increase the multidisciplinary audience evaluating the required parameters. Thus, the surveys used during the workshop session were also used afterwards.

The “flexible workshop” consisted on several individual meetings with various professionals from PoRA during the subsequent two weeks. At this point, it was a huge advantage to have online surveys available at the moment of extending the evaluations within the organisation. Throughout this process each interviewed professional independently provided their input and completed the online forms.

Then, after filling each working document, they individually gave their reflections and thoughts about each goal category. Moreover, most relevant ideas treated during the workshop session were also brought to the table for reaching deeper knowledge and pursuing a common understanding. The feedback gained through the “flexible workshop” allowed a larger screening of the debated topics without altering the initial methodology, and consequently the obtained outcomes.

Finally, ten professionals from diverse disciplines at PoRA participated of the workshop session and the “flexible workshop”. All of them are ranging on age, professional background and expertise. It is also important to point out that high management leaders are involved in this study. Their names and functions within the organisation are listed in *Annex B Workshop: Success & assumptions*.

### 3.4.9. Optimised list of success indicators for Europoort

All the collected information was carefully processed and analysed in *Annex B* section *B.1*. This resulted into an abridged list of indicators and recommendations to define and assess the success for Europoort, which noticeably represents a comprehensive answer for research SQ2. The followed process is fully described in the subsequent paragraphs.

Primarily, to rank the list of success indicators provided in Table 3-2, different scores from 0 to 100 are associated to each of the five possible answers given by the participants during the workshop session and the individual meetings of the “flexible workshop”. The assigned numeric values to each possible answer are as follows:

- Agree (100).
- Agree a bit (75).
- Neutral (50).
- Disagree a bit (25).
- Disagree (0).

Consequently, independent scores from each of the ten multidisciplinary participants of the surveys are calculated for every success indicator. Average values are used with the aim of removing any potential subjectivity in this study. Based on these averages, top one-third scores are acknowledged as the most relevant indicators. Roughly, this criterion matches with the success indicators scoring an average over 75/100. Besides, according to its significance, success indicators are also subdivided into:

- Intermediate importance (between 75/100 and 80/100)
- High importance (more than 80/100); and

Only those success indicators that received less than 20% of “Neutral” votes are considered as high importance. This approach seeks for sound recommendations based on high levels of agreement amongst the involved professionals.

Most of the indicated intermediate importance success indicators received less than 30% of “Neutral” votes. However, some of them can reach up to 50% of “Neutral” votes. These were thoroughly analysed case by case before being included in the optimised list of success indicators. It was decided to consider those with robust approval from the experts in each professional field of expertise.

As a consequence of the conducted research, a set of recommendations is also provided. These advices are associated with most relevant success indicators; of particular importance to provide a clear way of tracking success for an existing port area. At last, it is important to mention that almost every given recommendation is specific customised for Europort. Nonetheless, these recommendations can be easily adjusted for evaluating other port areas at PoR.

Table 3-3 Most relevant indicators for defining success of Europort & recommendations to properly address them

Goals	Indicator	Assessing success	Recommendations & comments
<b>Competitiveness</b>	<i>High priority:</i> Quay & jetty productivity (tons per metre).  Quay or jetty occupancy.	For each cargo segment, but zooming in for each specialised business or even at terminal level.	Setting goals for 2030 and beyond is highly important, more studies are needed. Thus starting with those well-known critical spots and/or terminals is suggested.
	<i>Intermediate priority:</i> Total market share in the HLH range (in terms of throughput for the overall PoR).  Dyn. Turn Around Time.	For the whole port area the goal seems a possible indicator, e.g. 40% of HLH in 2030.  Europort DTAT	Total throughput may be beneficial for EU level Added value to society seems to be a more convenient definition. Current values “questioned” to be too optimistic. Not too many insights for specific areas.
<b>Financial results</b>	<i>High priority:</i> Payback time-horizons for each business development.	Control lifetime serviceability over predicted payback time-horizon.	Distinguish different payback time-horizons in business cases for each type (clustered) of investments. Track compliance of main investments during their technical lifetime.
	<i>Intermediate priority:</i> Internal Rate of Return of PoRA investments.	Assess and control compliance with its associated risk for each terminal at Europort (prevent cash flow decrease).	Micro analysis for a pro-active approach from PoRA towards companies not fulfilling expectations in order to prevent decreasing cash flows. Macro analysis for cargo segments is another possibility, but insights are completely necessary.
<b>Use of space</b>	<i>High priority:</i> Terminal productivity (tons per ha).  Reduce area reserved and area options for existing companies (and not-leased land).	Define individual productivity goals for each terminal.  Reduce not-in-use areas [%]. Set goals for medium-term [~15%] & long-term [~5%].	Due to large dispersion on port operations, each terminal productivity should be closely monitored. Setting medium- and long-term goals for not-in-use area is required. Added value of each terminal may be studied too, including social and ecosystem services.
	<i>Intermediate priority:</i> Co-siting companies.	Evaluate terminal co-siting benefits &	Use co-siting as premise for every new company and business

	Revenues cargo segment & specialised business.	integrated process. Revenues per ha	development. Added value may be assessed throughout a MCA or ranking.
<b>Hinterland connections</b>	<i>High priority:</i> Sufficient capacity on inner waterways.	Measure waiting times to access the Caland canal or in the terminals	The Caland canal may become a possible bottleneck. Mainly it is related to its capacity (turning basins, vessel traffic, et cetera).
	<i>Intermediate priority:</i> Nautical Efficiency Index (NEI).	Europoort NEI	NEI is an interesting figure for PoR in general, but not useful for the Europoort planning
<b>Economic &amp; social impacts</b>	<i>High priority:</i> Indirect employment (can be extensive to the whole port area).  Business investments including also social valuation (to boost activities & well-being).	Employment (%) generated at Europoort in terms of regional/national employs. Relate to employees welfare.  Investments from the private sector over existing capital in each terminal, and in general, at Europoort.	Jobs generated and assessing the quality of these jobs would increase the license-to-operate. Expressing in terms of reducing inequality seems a convenient approach. Attracting business investments to maintain front-runner terminals, but also taking care of possible social needs may be promoted by including social valuation within standard PoRA processes and business cases
	<i>Intermediate priority:</i> Contribution to GNP.  Sharing or transferring companies' risks to PoRA for developing new potential business.	Assess Europoort share on Dutch GNP  # of innovative business developed in partnership.	For each port area the share on Dutch GNP can be weighed. Besides the amount of innovative business developed or attracted to Europoort and NL in partnership can be estimated.
	<i>High priority:</i> Limiting overall annual emissions of DPM, NO <sub>x</sub> , SO <sub>x</sub> and PM  Valuing ecosystem services, including them into PoRA business cases and monitoring afterwards	% of overall annual emissions at Europoort for the industrial areas and production type.  Value current ecosystem services within Europoort & monitor them (improvement).	Aside of the individual efforts carried on by PoRA, public goals should be set with agreements at regional or national level. Different internal goals may be set for medium- and long-term, at terminals level, but starting from each operation and/or production type.
<b>Environmental implications</b>	<i>Intermediate priority:</i> CO <sub>2</sub> emissions	Redefine goals at national and/or regional level. CO <sub>2</sub> emissions goals for industries.	If PoRA wants to stress its vision on reducing CO <sub>2</sub> emissions, should not constrain itself and define feasible targets always in accordance with national goals.
	<i>High priority:</i> Annual nautical accidents	# of accidents in access to, and into, the Caland canal or at Europoort harbours	Annual nautical accidents are an interesting figure for the whole port, but not for specific areas. Magnitude of the accidents should be categorised.
<b>Safety</b>	<i>Intermediate priority:</i> Nautical Safety Index (NSI)	Europoort NSI	NSI good for PoR in general, but not useful for Europoort planning

Details of this first part of the workshop, the used surveys, results and relevant outcomes gathered during the discussion sessions can be found in *Annex B*, section *B.1 Success for Europoort*.

As mentioned before, most of the existing indicators (KPIs) for PoR (Port of Rotterdam, 2013a) are thought to scrutinise the overall evolution of the port. Some of those indicators provides very good insights for this general picture, and are of special interest for the management, or individual goals for each PoRA department. Therefore, as a supplement to the optimised list of success indicators for Europoort; various general recommendations are suggested for improving the assessment of PoR general success.

### 3.4.10. Conclusions

The outcomes validate the need to review and redefine current indicators to properly appraise success for Europoort. The suggested indicators, in *3.4.9 Optimised list of success indicators for Europoort*, are meant to be the applied as the definition of success for existing industrial harbour complexes, in particular for Europoort. Of course, the list needs to be adapted for each specific area. The main used tools to apply this first step of APP framework are the literature review in *Chapter 2*, the workshop session and the individual discussion sessions (“flexible workshop”) in *Annex B*. This step is completely essential for a comprehensive application of APP framework and to gain insights about the area under study.

Although it is out of the scope of the thesis, a short review of current KPIs is briefly discussed. Firstly, a number of KPIs can be directly, and systematically, used for assessing the overall success of the harbour industrial complex. These highlights are: the Dynamic Turn Around Time (DTAT); PoR contribution to GNP; PoRA overall IRR & revenues; and PoR generated indirect employment. Secondly, some other KPIs that need adjustments and/or complements to track general PoR success are: market share in HLH range (for competitiveness positioning in NW Europe, but it is not useful for differentiating PoR at worldwide level); Nautical Safety Index (NSI) & Annual Nautical Accidents (interesting for the overall trend, but missing the magnitude of the accidents); and business investments (interesting for the whole picture, but it does not show relative distribution). Finally, certain KPIs need to be totally reconsidered, or at least, their goals need to be carefully redefined. Examples include: PoRA participation in new growing markets (the norm for 2015 seems to be unrealistic); CO<sub>2</sub> emissions (note that PoRA set its own goals too high -and isolated from other national policies-, thus now is disconnected from the national reality with targets almost not viable to achieve); maximum noise levels in residential areas (50 dB seems too low, and not frequency distinction is made for noises); and expected cargo throughputs (forecasts need to be adjusted); among others.

Moreover, applied practices allow classifying the evaluated indicators in three different levels of priority as it is shown in Table 3-3. Low priority indicators are not included due to their negligible influence for planning purposes, and due to time constraints for this study. It is also imperative to clarify that almost every elected indicator requires modifications from current versions, to comprehensively define and evaluate the success for Europoort. Moreover, expressly focused indicators for Europoort are also recommended to be introduced. These are specially developed for this report, or compiled from ongoing studies within Port Planning and other PoRA departments. As final point, most of the given recommendations are based on possible improvements attained from all the combined outcomes.

This approach is the initial step for establishing a common practice within Port Planning department (PD-PP) at PoRA. It is recommended to replicate the used methodology. However, for the five included options in the survey, it is advised to remove the neutral alternative to encourage further thinking. The proposed definition of success can be also used for Botlek and Maasvlakte due to prevailing similarities with Europoort. For port-city areas, it is suggested to reproduce the procedure from the beginning to attain distinctive indicators in order to specifically assess the success for this type of port zones.

To conclude, this section successfully addresses a comprehensive elucidation for research SQ2. The obtained conclusions and recommendations are in accordance with reviewed literature. Nonetheless, innovative proposals are provided as well, and possible research lines may emerge from this research. At last, PD-PP professionals are already implementing some of the recommendations and suggested guidance for achieving success. Besides, internal presentations already took place during the research.

### 3.5. Underlying assumptions

Topics extensively discussed in previous section 3.4 *Definition of success*, are partially the introduction for this ensuing analysis. Behind each introduced success category, and each indicator, there are several supportive hypotheses that are treated in detail in the coming paragraphs. Ergo, this part of the research is meant to exhaustively answer research SQ3:

**What are the basic underlying assumptions in current objectives, and in the definition of success, for Europoort?**

These basic assumptions are not only underlying in the definition of success. These are also interrelated with the port system, which is understood as every physical element of the port, the actors involved in it, their behaviour and all their relationships.

#### 3.5.1. Categorisation of the assumptions for port planning purposes

Underlying assumptions are constantly affected by external (and uncertain) evolutions as it is described in 2.4.1 *Future scenarios & external developments*. Hence in order to accomplish a correct scientific approach and research, many tools are used to identify and rank these assumptions. Special attention is given to those related with the future planning of Europoort. The main devices are the ones already applied: literature review, interviews with PoRA and external professionals (listed in *Annex A*), and workshop sessions. The information gathered from the literature review and during the individual meetings is used as input for the workshop session, and its subsequent continuation as “flexible workshop” (detailed scope and participants are listed in *Annex B*).

Additionally, many parameters need to be reviewed due to the fact that port planning and port design, are influenced by numerous of uncertain factors. Mostly, these values are determined based on organizational and/or personal preferences. Thus, are questionable and should be included into uncertainty analyses (e.g. planning horizon of a project; or discount rate & payback within commercial business cases; or ways of valuating environmental and social aspects; et cetera).

Uncertainty due to incomplete information or lack of knowledge can cause the failure of assumptions too. Such cases may also have a negative impact on the masterplans and must be considered during the planning (e.g. effectiveness of environmental compensation projects implemented; or benefit control of

a project once capitalised; or sustainability in projects as a whole and not as isolated approach; among others).

Further the assumptions on which are based the assessment indicators to define success cannot be known beforehand. This can either be due to insufficient knowledge about how the port system responds to external developments, or to unrealistic expectation. Therefore, these should be examined for underlying supposition theorems too (e.g. acceptable emissions in the harbour; or expected generated jobs; or suitable nautical waiting times; or development of future trends; et cetera).

Consequently, different groups are outlined to facilitate the task of identifying the statements from where the implicit assumptions are deducted. This proposed categorisation is derived from the literature review, and it is based on relevant publications dealing with possible developments influencing port planning. Besides, this approach is in line with the one followed for developing MP7+ (TGI et al., 2013). Some minor modifications are introduced based on the literature review. Nevertheless, this allows an integration and adaptation of the outcomes presented within MP7+ and the ones carried on within this report. Without any doubt, this practice helps to structure the work and to systematically recognise most substantial uncertainties in each suggested category. Thus every underlying assumption is incorporated within one of the following categories:

1. PoRA internal organization
2. Government
3. Port competitiveness
4. Cargo flows
5. Fleet mix and evolution
6. Dry & wet infrastructure
7. Hinterland connections
8. Business development (terminals)
9. Expertise and know-how

The process for identifying assumptions underlying on different statements is done for each category. In total forty one (41) statements are elucidated within this study. At least, for every provided statement, one assumption is recognized. However in some cases, other assumptions for the same statement are also deducted.

From those forty one statements, in total eighty two (82) assumptions are recognised. These are linked with each of the defined time-horizons in *3.2 Planning strategies and its related time horizons* (short-term, medium-term, and long-term).

Due to time constraints, the list of assumptions is pragmatically reduced throughout a simple voting process. Based on their professional judgement, Martijn Oosting, Peter Vervoorn and Pablo Arecco independently assessed each assumption according to their degree of relevance for the research. This prioritisation procedure is based on a three-colours voting technique:

- Green      —————→      High relevance
- Yellow     —————→      Medium relevance
- Red        —————→      Low relevance

The premise for assigning weights was to uniformly try to distribute the votes amongst the eighty two underlying assumptions. Only assumptions resulting with at least two yellow votes and one green were considered to be further explored. Hence, a condensed record with twenty nine (29) assumptions is initially selected. However, after reviewing the distribution per category, it was decided to include five (5) additional assumptions (subsequent most relevant from the voting process within the less balanced categories). The intention was to equalise the list of postulations for some categories.

At the end, thirty four (34) underlying assumptions are selected to be classified in the following step as vulnerabilities or opportunities.

The complete list of statements including their sources with their respective underlying assumptions is clearly presented in *Annex B* section *B.2 Identified underlying assumptions by category*. A summary table with given votes is also shown in the last part of that section. Moreover, within the same section the abridged underlying assumptions are evidently indicated with their reference number as are included in the vulnerabilities and opportunities survey presented at the beginning of *Annex B*.

### 3.5.2. Findings & recommendations

This process is developed for identifying the basic assumptions on current masterplan, port vision and definition of success. This represents the second step of APP framework. Consequently, this is the answer to research SQ3. Initially, it was necessary to identify every presented statement with all the related underlying assumptions. All these are the consequence of an extensive research that included previous studies, congresses proceedings, technical papers, possible future scenarios, and numerous individual meetings with PoRA and external professionals. Main research sources are included in *Chapter 2 Literature review*.

The research is also enlightened by the participation in many international conferences, seminars and special dedicated lectures during the elaboration of the report. Most relevant attended events during the thesis preparation period were: PIANC Congress 2014 in San Francisco, USA; WRR lecture: The future of globalization in The Hague, The Netherlands; and 1<sup>st</sup> PIANC YP-Com Asian Seminar in Yokohama, Japan.

Although thirty four (34) underlying assumptions are evaluated from the total list of eighty two (82), all of them are carefully considered to provide final recommendations and actions to be incorporated within the planning of Europoort. As mentioned before, the complete list is included within *Annex B* section *B.2 Identified underlying assumptions by category*.

These are the assumptions that afterwards are classified into vulnerabilities and opportunities based on experts' judgement by the same professionals whom were involved during the workshop session, and the "flexible workshop" described also in *Annex B*.

Finally, it is recommended to regularly review and update all the assumptions, at least by repeating the described process every three to five years. However, yearly updates may be considered in case of rapid changes on global trends or major variations in current paradigms (e.g. economic crisis).



## 3.6. Vulnerabilities and opportunities for each planning-horizon

Main vulnerabilities and opportunities influencing the planning of Europoort are acknowledged. These directly results from the evaluation of the underlying assumptions presented in previous section 3.5. The objective of this section is to address research SQ4:

**What are the main vulnerabilities and opportunities that can be identified for Europoort in the medium- and long-term?**

As the identified assumptions are linked with the defined time-horizons; the identified vulnerabilities and opportunities also result clustered into different planning horizons. This is a straightforward procedure to detect if these are circumscribed to: project planning (short-term), strategic planning (medium-term), and/or the masterplan (long-term) & port vision (PIANC, 2014).

### 3.6.1. Evaluation criteria

The multidisciplinary team of experts involved during the workshop session and the “flexible workshop” (*Annex B*), is also asked to give their qualified professional opinions for each of the selected assumptions via an online survey in two aspects: likeliness of occurrence and conceivable effects for the port, as it is shown in Figure 3-4.

Basically, assumptions are classified as vulnerabilities or opportunities based on their possible influence for future development of Europoort.

In addition, the likeliness of occurrence is mainly connected towards the efforts PoRA should accomplish, either to boost those opportunities, or to reduce potential vulnerabilities. This, combined with conceivable effects for the port, generates a suitable background to prepare robust plans for embracing uncertainties.



Figure 3-4 Survey used to measure the likeliness of occurrence (left) and to classify conceivable effects for the port (right)

Details of the vulnerabilities and opportunities part of the workshop can be also found in *Annex B*. In this online survey, comments' fields for each of the thirty four (34) assumptions are implemented to allow participants to write down their reflections. This is very important because in contrast with the success part of the workshop, it is separately completed by each professional before November 18<sup>th</sup>, 2014. This approach provides sufficient time to complete this part (more than one month after the workshop session took place on October 6<sup>th</sup>, 2014). Besides, it gives the participants the tools to fully share their thoughts while assessing each underlying assumption.

To evaluate every given answer in the survey, scores from 0 to 5 are assigned to each possible answer in both aspects (likeliness of occurrence and conceivable effects for the port). Starting with a score of 0.5 for both, the less feasible (very unlikely) and the less favourable (very negative) marks, to then

progress on unitary values until reaching a score of 4.5 for the most feasible (very likely) and most favourable (very positive) marks.

This means that if one assumption, named “A”, is classified as: “positive”, but “unlikely” to happen; the following scores are respectively associated: “3.5” and “1.5”. In the same way, if other assumption, labelled “B”, is assessed as: “very negative” and “likely” to occur, the subsequent values are correlated: “0.5” and “3.5”.

Then these values can be represented in a graph where the vertical axis is coupled with the likeliness of occurrence, and the horizontal axis represents the conceivable effects for the port. Therefore vulnerabilities and opportunities, and the efforts that PoRA should do to enhance the situation, can be simply elucidated from a graph. These examples visibly symbolize an unlikely “Opportunity” (positive & unlikely to happen, “A” in blue), and a certain “Vulnerability” (very negative & likely to occur, “B” in orange). Moreover, this approach can be also assimilated as a kind of SWOT analysis. All previous discussed issues are summarised in a single chart shown in Figure 3-5.

The magnitude  $\Delta$  needed to bring either “A” or “B” to the “Strengths” quadrant (upper right) of the chart is quite significant ( $\Delta > 0.5$ ). Hence, both given cases require rather large efforts to transform them into future strengths (maximising opportunities and minimising vulnerabilities). It is important to note that  $\Delta < 0.5$  can be either opportunities or vulnerabilities because are mainly related to neutral values. In case of averaged values, this can also represent large deviations on the given answers.

With no need to stress it any more, PoRA should always try to enhance the chances of occurrence for the opportunities, and to transform vulnerabilities into certain opportunities and/or strengths.

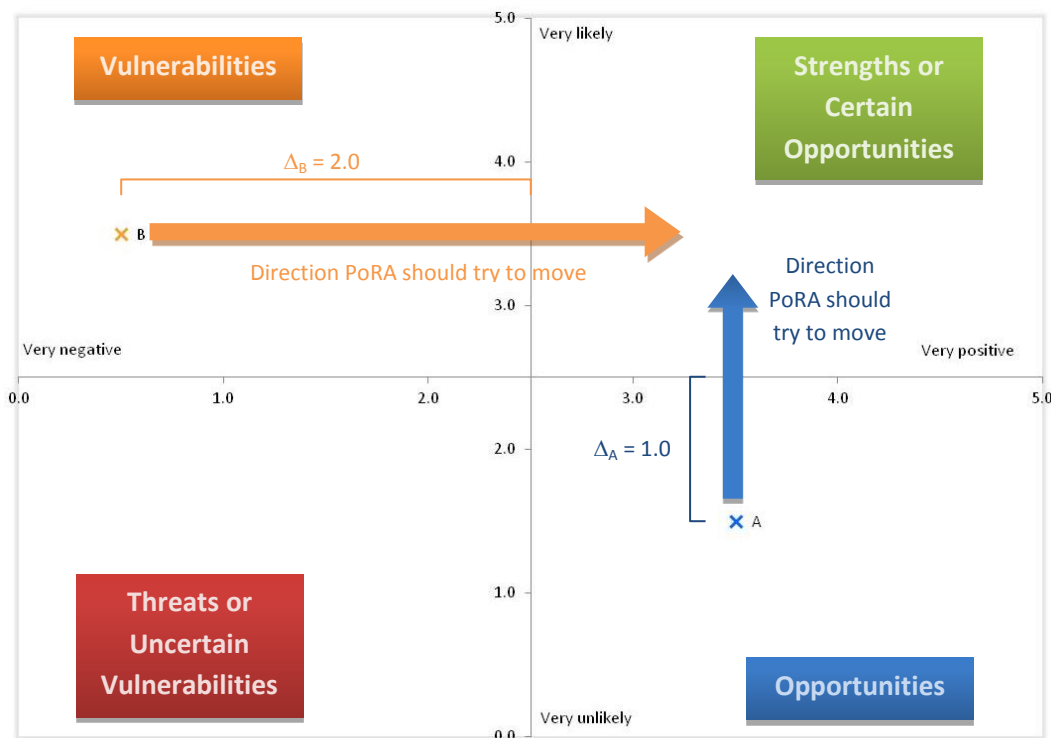


Figure 3-5 Example for visualising given answers for two assumptions' examples “A” & “B”

Special attention should be given to assumptions categorised within the “Threats” quadrant. This is related with those receiving both, “negative or very negative” and “unlikely or very unlikely” votes. Two

possibilities arise, either these threats are instigated to not occur or intensive actions are taken to convert them into opportunities and/or strengths. Anyways, threats require special attention and will be mainly relying on management decisions and envisioned future of the port area. Assumption “C”, rated as “negative” (“1.5”) and “unlikely” (“1.5”) is presented as an example in Figure 3-6.

Once all the thirty four (34) underlying assumptions are fully assessed by PoRA professionals, a neutrally weighed outcome is pursued. Therefore, to attain unbiased classifications for all of the assumptions into vulnerabilities and opportunities, every PoRA professional’s answer is equally considered. PoRA management and professionals assessments are similarly weighed for this step. Consequently, final results are directly the average of every received answer, translated into scores.

Comments given from the participants are used only for the following step when associating actions to the identified vulnerabilities and opportunities. Management remarks are critically reviewed to associate actions that may persuade them to implement long-term views towards robust planning.

In case of large variance on the answers received for an assumption, special discussions were held with the participants to achieve a complete understanding of their thoughts and use their input to elaborate the actions. Only less than 20% of the evaluated assumptions suffered about this special situation.

Additionally, the outcomes obtained during the workshop for each category introduced in 3.5 *Underlying assumptions*, are presented in Annex B section B.3 *From underlying assumptions to opportunities & vulnerabilities*. For each category, a summary graph with the average valuation of the assessed assumptions is obtained (as the example shown in Figure 3-5 and Figure 3-6). From those graphs, each underlying assumption is easily labelled as vulnerability or opportunity for the planning of Europoort.



Figure 3-6 Example for assumption “C” categorised as a threat

Finally, as previously stated in this section, every single result is easily combined with the time horizon formulated in its underlying assumption. Thus all the vulnerabilities and opportunities are catalogued for each specific planning horizon: project planning (short-term), strategic planning (medium-term) and masterplan (long-term).

### 3.6.2. Major outcomes

This is one of the most crucial procedures of the third step of APP framework. Basically, it is essential for understanding how robustness can be increased in current Europoort masterplan.

Of the thirty four (34) assessed underlying assumptions, twenty three (23) are opportunities (eleven certain and twelve uncertain), eleven (11) are vulnerabilities.

The top three most relevant opportunities identified within this study are:

- Development of bio-based port areas;
- Compliance within acceptable limits for environmental emissions and safety risk contours;
- Sharing quay or jetty facilities as a premise for any new infrastructure commercial development.

It is important to understand the reasoning behind APP framework to fully visualise the underlying strengths behind each opportunity. Just for further clarification, the first one is foreseen as the reuse and regrouping of existing plots for the creation of a new cluster in the Europoort (in essence an Energy Port cluster), basically it is related with flexible planning; the second opportunity is related with the enormous potential the Europoort has to enhance the surrounding environment towards a sustainable growth; and finally, the third opportunity deals about the multi-user and multi-purpose character of the basic infrastructure to be developed at Port of Rotterdam.

In contrast the weakest recognised points for the Europoort are:

- Non-consideration of opportunities for “temporary” use of unallocated plots;
- The debate “food for fuel” may challenge bio-based developments;
- LNG may be regarded only as transition fuel, and finally trade in Europe is impacted by global power shifting.

Once again, every statement need to be carefully analysed for fully acknowledging the underlying reasoning. The first threat or unlikely vulnerability is related with the level of flexibility the port can achieve on pop-up port related businesses; the second weakness is related with maturity level the bio-based segment can achieve at worldwide level, consequently in the long-term at PoR (alternatives need to be thought); and finally, the third threat is related with fossil fuels (all of them) as main energy source in the long run.

To conclude, it is possible to state that research SQ4 is comprehensively addressed within this section. Basically, summary tables are presented in *Annex B* section *B.4 Overview of the vulnerabilities and opportunities*. These tables clearly recognise vulnerabilities and opportunities related to PoRA internal organisation, and to Europoort planning. Identified vulnerabilities and opportunities linked with Europoort planning are also shown with their related actions to increase robustness in the following subsections 3.7.1, 3.7.2 and 3.7.3.

### 3.7. Actions to increase robustness & flexibility during planning phases

Based on the recognised vulnerabilities and opportunities, actions are defined to achieve a more robust and flexible planning for Europoort. These actions are also clustered according to each planning horizon (short-, medium- and long-term). Therefore, this section aims answering research SQ5:

**What are the main actions to increase robustness of the basic masterplan for Europoort?**

The defined actions are grouped in four different types accordingly to APP framework: shaping, mitigation, hedging and seizing actions. A shaping action (SH) is envisioned to influence the vulnerability of an assumption; however it is not always possible to implement this kind of solutions. Therefore, reducing adverse effects of a plan becomes crucial. This can be implemented within current planning cycle through mitigating actions (M) on almost certain vulnerabilities. Complementary, hedging actions (H) are defined as those that may reduce the risk of highly uncertain negative effects (uncertain vulnerabilities, which are also called threats in this study). And finally, seizing actions (SZ) are those boosting opportunities (Taneja, 2013).

Actions dealing with vulnerabilities and opportunities related to *PoRA internal organization* are not treated in this section, but specially addressed in *Chapter 6 Implementation of APP at PoRA*.

In the following subsections, actions are associated to each vulnerability and opportunity. The actions are elaborated based on long-term perspectives and on several sources of inspiration like, literature review, conferences; interviews with experts; brain storming sessions; and creative way of thinking.

All these proposed actions are either directly related with the planning of Europoort (and the Harbour Industrial Complex), or with actions that need to be initialised by “Gebiedsmanagers” in close cooperation with other professionals and departments at PoRA.

#### 3.7.1. Increasing the flexibility and robustness for short-term planning (Project planning)

As previously stated short-term planning actions result from this analysis. These are soft measure that can be easily initiated. Table 3-4 and Table 3-5 summarise promising paths to follow.

Table 3-4 List of vulnerabilities with their correlated actions

Vulnerabilities (uncertain)	Actions (SH: Shaping; M: Mitigation; H: Hedging; SZ: Seizing)
Seizing opportunities for "temporary" use of the unallocated plots is not considered as an option.	SH: look for temporary port-related business for unallocated plots (new companies).  M: Proactively PoRA may stimulate existing clients for temporary use of neighbouring not-in-use plots.

For presented actions, implementing flexible contracts with well-defined terms is highly important. This would allow reassigning port areas in case it is needed for long-term developments. A parallel with real-state pop-up business can be set. However, PoRA may only look for port-related pop-up businesses (up to a maximum of around 10 years); unless really short-term contracts are agreed (e.g. around one year is a common understanding among “Gebiedsmanager”). It is also advised to consider the possibility of interconnecting not-in-use plots, and linking these areas with existing supply chains.

Table 3-5 List of opportunities with their correlated actions

Opportunities (uncertain)	Actions (SH: Shaping; M: Mitigation; H: Hedging; SZ: Seizing)
Terminals related with the vision of Europe's Industrial complex are interested in developing their business in the Europoort. The port's motto is "The right company in the right place", & the statement "a missed opportunity is greatest risk!" is totally left aside.	SH: Use price strategies to attract planned and intended cargo segments for Europoort. SZ: Increase PoR marketing campaigns within envisioned cargo segments and companies. SZ: Implement Port area branding.

Price strategies may be controversial; however these may also be interesting for further investigation. Port area branding might also enhance PoR public engagement, meanwhile strengthening Harbour Industrial Complex and Europoort's commercial image (Dalmeijer, 2014).

### 3.7.2. Increasing the flexibility and robustness for medium-term planning (Strategic planning)

Medium-term planning actions are discussed in Table 3-6, Table 3-7, Table 3-8 and Table 3-9. Most of these actions can be directly included within the current masterplan cycle within PD-PP briefly described in subsection 1.2.3 *Current planning process* of Chapter 1. Even though are medium-term actions, these resulted from the process to increase robustness of the masterplan in the long-term.

Table 3-6 List of certain vulnerabilities with their correlated actions

Vulnerabilities (certain)	Actions (SH: Shaping; M: Mitigation; H: Hedging; SZ: Seizing)
Minimum distance from chemical clusters to the residential areas are demanded to be increased.	M: Increase PoR public image linked to pollution control. SH: Look always for win-win solutions during the business decision-making process, for both, the environment and for PoR. SH: Invest on monitoring existing clients' emissions, and include their effects within the planning process. M: Pro-actively negotiate with existing terminals to reduce emissions rates. M: Prepare joint agenda with SSM for future discussions with surrounding municipalities. M: Prepare an Environmental Masterplan for Europoort.
Second- and/or third-generation products (break-bulk) replace raw materials cargo (liquid and dry bulk).	H: Define a clear vision for integrating break-bulk at PoR. SH: Prepare adaptable plans proposing flexible basic infrastructure within each concept cargo segment (e.g. Energy Port, Fuel Hub and Standardised Cargo). M: Invest on marketing campaigns positioning PoR as major break-bulk port at EU level (advertise and approach main break-bulk companies).
More trade disputes between China and third countries take place, creating a major impact on trade with Europe.	M: Reinforce commercial bonds with raw material producer's countries and companies. Focus on increasing the served foreland with its supply chains. H: Increase cooperation agreements with Chinese ports.

<p>“Hartelkanaal” capacity is challenged due to restrictions on emission. Inland barges speed limit is reduced (difficult overtaking).</p>	<p>SH: Lobby campaign to promote cleaner engines (and quieter) for the inland navigation vessels. PoRA → Government → IWT.</p> <p>SH: Enforcement of incentives and agreements for cleaner inland barges. PoRA → Terminals → IWT.</p> <p>SH: Promote renowned Environmental Shipping Index, ESI (IAPH, 2014) and Green Award (Green Award Foundation, 2000) for inland barges. PoRA → IWT.</p> <p>M: Stimulate the renovation of the fleet in order to increase the average size of the barges sailing on the Hartelkanaal.</p> <p>M: Implement regular and scheduled lines to enhance capacity and reduce emissions. Supply chains improvements.</p>
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Actions towards sustainable growth by reducing odour, noise and light pollution need to be pursued. Enhance social, companies & PoRA joint awareness to improve surroundings areas of the port. In other words, proactively include every stakeholder during the planning of existing port areas. At Europort for example expand the project “we-nose” with more sensors and by engaging more companies (Port of Rotterdam, 2015b). Dynamically implement continuous SSM programs for every existing port area. Moreover, when repeating the yearly masterplan cycle, constantly think about implementing environmental projects to enhance the license-to-grow (in cooperation with surrounding communities). Generate more possibilities for new industries to be accommodated by reducing current emissions. This is also in line with the transition for cleaner IWT (Port of Rotterdam, 2013g, 2013j).

Table 3-7 List of uncertain vulnerabilities with their correlated actions

Vulnerabilities (uncertain)	Actions (SH: Shaping; M: Mitigation; H: Hedging; SZ: Seizing)
<p>Seizing opportunities for "temporary" use of the unallocated plots is not considered as an option.</p>	<p>SH: Invest on long-term flexible infrastructure connected to unallocated plots.</p>

Table 3-8 List of uncertain opportunities with their correlated actions

Opportunities (uncertain)	Actions (SH: Shaping; M: Mitigation; H: Hedging; SZ: Seizing)
<p>Company’s merging has not a large impact for the cargo flows at Europort.</p>	<p>SH: Offer integrated supply chains systems and worldwide solutions for this type of corporations.</p> <p>SZ: Develop flexible contracts.</p>
<p>Terminals related with the vision of Europe’s Industrial complex are interested in starting their business at Europort. The port’s motto is “The right company in the right place”, and “a missed opportunity is greatest risk!” is totally left aside.</p>	<p>SZ: Lobby and support exclusive partnership agreements.</p> <p>SZ: Widen the spectrum of companies that can settle at Europort, but only through enlarging envisioned concept cargo segments.</p> <p>SH: Introduce flexible designs and establish a regular cycle (3 to 5 years) for updating long-term masterplan.</p>
<p>The companies and terminals emerging in new market segments like synthesis gas (or syngas), carbon capture, and bio-based can find enough local professionals with the right expertise.</p>	<p>SH: Work together with companies and universities for high-level educations and training programs.</p> <p>SZ: Promote researching lines into innovation fields for envisioned industries.</p> <p>SZ: Arrange national campaigns to stimulate studies on related fields, and to attract young generations</p>

Table 3-9 List of certain opportunities with their correlated actions

Opportunities (certain)	Actions (SH: Shaping; M: Mitigation; H: Hedging; SZ: Seizing)
PoRA becomes part of a national public limited company (N.V.) in charge of every Dutch port.	SH: Teaming-up with other Dutch ports, so PoRA can focus on most relevant planned cargo segments. Coordinate ports' masterplans. SZ: Stimulate transshipment. Prepare infrastructure for receiving more coaster vessels traffic.
Estimated environmental emissions and risks at Europoort are complying acceptable limits.	SZ: Brand Europoort as PoR core industrial area with sufficient environmental space to allocate more companies. SH: Introduce flexible contracts to achieve a more dynamic renegotiation of the contracts.
Long-lasting contracts are a common practice to attract companies.	SH: Implement flexible contracts and translate PoRA risks to the contracts.
World-class industrial companies are willing to settle in Rotterdam with the same spirit of PoRA (efficiency and sustainability) and do not prefer other ports with different requirements.	SH: Prepare plans for attracting and accommodating worldwide sustainable companies (contact existing major players at PoR too). SZ: Explore new markets niches, especially those markets that involve materials that are not expected to decrease in the long-term or which its substitution is almost inhibited.
PoRA will also pursue every optimization opportunities (not-in-use land, productivity and efficiency) to anticipate uncertain developments. <b>High consensus &amp; key for long-term!</b> Ranked #4!	<b>SH: Cluster unallocated plots by retrieving not-in-use plots (for more than 5-10 years) from existing terminals.</b> <b>SH: Claim back in-use plots that are not intensively in use by terminals for more than 15 years. Benchmark area productivity.</b> SZ: Monitor terminal's facilities. Contrast them with global state-of-the-art developments to achieve an efficient world-class port. SZ: Monitor amount of private investments in each terminal. <b>SH: Implement terminal's performance, investments &amp; efficiency as key drivers for planning purposes of existing port areas. Assess them for each terminal with risk-based methods.</b>
Sharing quay or jetty facilities is a premise for any new infrastructure commercial development. <b>TOP 1!</b>	<b>SH: Develop flexible multi-user facilities.</b> <b>SH: Develop different type of multi-purpose jetties (for different liquid bulk cargo and vessels).</b> <b>SH: Encourage company's co-siting. Provide incentives.</b> SZ: Include this as a premise for every new business at PoR. SZ: Clear differentiation and identification between supply chain vessels (functioning within a process and tight on schedules), and trader vessels (volatile schedules). SZ: Benchmark available industrial areas in combination with surrounding municipalities.
PoRA takes the lead in promoting and supporting the development of bio-based companies by several means (e.g. facilitating and providing access to first or second generation feeder stock, good logistical access, et cetera). <b>TOP 2!</b>	SZ: Team-up with large worldwide companies that are already operating at PoR, but not producing second- and/or third-generation products at PoR. SZ: Explore business opportunities with other large global biodiesel companies. <b>SH: Prepare flexible masterplan</b> to accommodate bio-based cargo.



Recommended goods and activities for Europoort are: waste recycling, neodymium or lithium (Club of Rome, 2013). To cite some benefits, lithium would encourage cooperation with large high-tech battery producers. The production chain can be concluded by elaborating components for any industry requiring those batteries (it can include recovering used batteries). Other thought-provoking markets for Europoort are related with hydrogen fuels (LNG only as transition fuel), and materials that originate circular economies. At last, it is important to explore more business opportunities for Europoort with large global biodiesel companies already operating in Rotterdam, but without carrying out this type of activities at PoR; and with those that are not running businesses in Rotterdam yet.

Finally, special attention should be given to the actions related to high ranked opportunities. These are distinctively noted in Table 3-9, and can be summarised as:

- Develop **multi-purpose** (flexible) and **multi-user** facilities.
- Promote **co-siting**.
- Increase **land use efficiency** throughout **assessing current terminal’s facilities**.
- Prepare **flexible masterplans** to accommodate **bio-based cargo** among other segments.

On the one hand, enhancing the efficient use of the land needs to be absolutely considered for Europoort; either by claiming back not-in-use plots from existing terminals (for more than 5-10 years), or by retrieving not intensively used port areas for longer periods. On the other hand, concerning the efficient use of infrastructure, multi-user facilities are a priority, even areas to put into operation fast-track projects needs to be considered (for ship-to-ship transhipments, & ship-to-ship-to-shore configurations). From this research, it also results mandatory the monitoring of Europoort terminal’s facilities, and its assessment throughout a risk-based methods.

### 3.7.3. Increasing the flexibility and robustness for long-term planning (Masterplanning)

In Table 3-10, Table 3-11, Table 3-12, and Table 3-13 long-term actions are proposed for each of the identified vulnerabilities and opportunities. Some of them are linked with medium-term strategic planning steps. Therefore, a number of long-term points are relying on the execution of previous actions (e.g. medium-term development of flexible designs for jetties/quay walls to then be accomplished). In summary, every action should be methodically monitored, either for checking its possible implementation at Europoort, or for adapting it in case external conditions vary.

Table 3-10 List of certain vulnerabilities with their correlated actions

Vulnerabilities (certain)	Actions (SH: Shaping; M: Mitigation; H: Hedging; SZ: Seizing)
Minimum distance from chemical clusters to the residential areas are demanded to be increased.	SH: Constantly promote innovation amongst the terminals at PoR. SH: Improve living quality in surrounding residential areas. SH: Include planning actions for surrounding communities. SH: Develop working possibilities for surrounding towns; find common goals to accommodate new businesses.
Second- and/or third-generation products (break-bulk) replace raw materials cargo (liquid and dry bulk).	SH: Build adaptable and flexible basic infrastructure within each concept cargo segment (e.g. Energy Port, Fuel Hub & Standardised Cargo).

<p>“Calandkanaal” capacity is challenged by other large vessels with greater air draft and low manoeuvrability (e.g. large containerships or LNG carriers) or for too much traffic (two-way req.).</p>	<p>SH: Adapt nautical rules for LNG vessels.</p> <p>SH: Increase manoeuvring areas (semi-waiting areas) in the “Calandkanaal”.</p> <p>M: Increase the amount of available tug boats (and service harbours) in order to avoid shortage during high wind conditions.</p> <p>SH: Cluster service companies operating at PoR.</p> <p>SH: Optimise the use of the waterfront when developing available not-in-use areas. Partially retreat the waterfront landwards; either by displacing the bank slope or by building quay walls (this can be done at both banks of the “Calandkanaal”).</p>
<p>Rail and road transport does not play a major role for cargo handled.</p>	<p>SH: Pro-actively promote clustering existing terminals to strengthen Europoort’s industrial complex.</p> <p>M: On the planning side, look always for clustering possibilities for new terminals.</p> <p>SH: Invest on railway hinterland connections. Co-share railways companies.</p> <p>SH: Introduce flexibility on railway developments to increase their capacity in the future (e.g. double stack of containers)</p>

Table 3-11 List of uncertain vulnerabilities with their correlated actions

<p><b>Vulnerabilities</b> (uncertain)</p>	<p><b>Actions</b> (SH: Shaping; M: Mitigation; H: Hedging; SZ: Seizing)</p>
<p>Partial emissions from sea-going ships and inland barges are accepted in the long-term; therefore LNG does not become the main fuel in Rotterdam.</p>	<p>SH: Invest on multi-purpose jetties.</p> <p>H: Plan areas for fast-track deployment of regasification vessels (FSRUs). Flexibility on LNG handling (LNG transition fuel for peaks).</p>
<p>Unmanned vessels are implemented at worldwide scale and current manoeuvring areas are sufficiently large to accommodate these vessels</p>	<p>SH: Research to enhance, &amp; to gradually implement automated navigation systems. Check plans for E-Navigation.</p> <p>H: Monitor worldwide developments within planning cycle.</p>
<p>First-generation of bio-based production (using soy, rape, palm, sugarcane, wheat, corn, et cetera) is fully accepted and the “food for fuel” debate is totally overcome.</p>	<p>H: Promote fair trade bio-based fuel generation.</p> <p>SH: Invest on alternative fuel sources.</p> <p>H: Monitor evolving global trends and food demand in relation to population growth within the planning &amp; strategy cycles.</p>

In summary, one of the main identified actions for Europoort is related with executing the needed investments on those adaptable designs proposed within the strategic planning actions.

In addition, the masterplan should not be only constrained to the port area. This can become one of the major vulnerabilities for PoR and Europoort. Thus, “Gebiedsmanagers” may include actions for PoR surrounding communities. The range of actions could be quite spread, from isolated activities, up to developing permanent activities (schools & institutes for educate & train professionals for port related activities), enhancing quality of life (museums, cultural activities, et cetera), or increasing jobs opportunities by location of new companies in surrounding communities, et cetera. Fluent face-to-face contact with every stakeholder plays a major role when planning existing port areas. Maassluis, Rozenburg, Brielle, Oostvoorne & Hoek van Holland become day-to-day partners of PoRA.

Masterplans may also influence the introduction of flexibility in every hinterland connection and supply chain with a constant monitoring of possible developments. Besides, connecting existing plots and waterfront areas with new multi-core pipelines, or multi-user conveyor belts is advised. Implement multi-user and co-siting concepts as negotiation tools for business contract's renegotiations, and as a premise for new terminals and/or business in the area.

Table 3-12 List of uncertain opportunities with their correlated actions

Opportunities (uncertain)	Actions (SH: Shaping; M: Mitigation; H: Hedging; SZ: Seizing)
Policy-making bodies at local, regional, provincial, national and EU level facilitate achieve Europe's Industrial Cluster vision at PoR (less bureaucracy, less req. time for consult. and less regulations).	SZ: Invest on lobbying groups at EU level. SH: Invest on developing trustful relations at every level by improving sustainability & safety confidence on port development. Sustainable growth is the new paradigm.
Dutch corporate tax environment keeps facilitating the development of business with better conditions than other NW EU countries	M: Set-up campaigns to support open free-market economies in every European country. SZ: Lobby at EU level to equalise corporate tax environment.
PoR houses strong players in all market sectors.	SH: Invest in flexible infrastructure. SZ: On the one hand, keep sufficient diversification to withstand possible market volatile changes, but intensify high-end port cargo segments.
Company's merging has not a large impact for the cargo flows at Europort.	SH: Invest on co-sharing part of these large corporations.
To achieve a more efficient transport chain the number of actors interacting from the port to the hinterland is strongly reduced by the creation of corporations (e.g. for inland barges transport).	SH: Major investments on IWT distribution centres, and its transport chain to enhance hinterland connections. Develop inland port hubs. Improve supply chains. SZ: Translate economies of scale to the hinterland without hampering local economies and skippers' benefits/independency. M: Determine current IWT berth capacity and occupancy factors. M: Determine current IWT quay or jetty productivity.

Table 3-13 List of certain opportunities with their correlated actions

Opportunities (certain)	Actions (SH: Shaping; M: Mitigation; H: Hedging; SZ: Seizing)
PoRA becomes part of an International public limited company (with shares from different countries like Brazil, Oman, Romania, et cetera).	SH: Invest on developing global port businesses. M: Execute and invest on flexible long-term infrastructure not only in Rotterdam, but also abroad.
Estimated environmental emissions and risks at Europort are complying acceptable limits. <b>TOP 3!</b>	SH: Invest on emission capturing/reducing equipment and devices. Integrate them with other activities, not only within the port. SH: Execute win-win solutions selected during the business decision-making process, for both the environment and for PoR. <b>SH: Implement specific projects for environmental enhancement detected within the Environmental Masterplan for Europort.</b>

Long-lasting contracts are a common practice to attract companies.	SH: Prioritise long-lasting contracts with companies that complement, extend, or even complete existing industrial production cycles through innovations or businesses not-established in the area yet.
World-class industrial companies are willing to settle in Rotterdam with the same spirit of PoRA (efficiency and sustainability) and do not prefer other ports with different requirements.	H: Provide incentives and facilitate settlement of those world-class companies fitting within Europoort vision (from developed and developing countries too).
Rotterdam and Antwerp team-up as a single port and develop new industrial business together using its integration as main driver for competing with other industrial complexes in the world.	SH: Increase clustering between Antwerp and Rotterdam companies. M: Partnering on EU lobbying for EU policies. SH: Invest on inland port hubs together.
The opening of the Arctic North route between Asia and Europe is not challenging the Europoort's position due to the limited available depth.	H: Accommodate first companies sailing on the Arctic North route. H: Provide incentives for companies supporting fair navigation through the Arctic.

To sum up, and once again, improving the license-to-grow is a high priority on the agenda for port planning. Sustainable growth with flexible solutions should be pursued by all means. Aside of implementing this in Rotterdam, the same model should be followed to expand PoR global activities.

Execute those specific projects to improve the environment and sustainability within Europoort. These result from the expansion of current masterplan with particular environmental driven actions (medium-term action).

In the long-term the consolidation of these actions should take place in Rotterdam, and other PoRInt development at global level. In conclusion this sustainable growth needs to be complemented with the expansion of **multi-purpose** (flexible) and **multi-user** facilities to more than 50% of the infrastructure and terminals' facilities at Europoort.

In *Annex X* section *X.6 Europoort Masterplan 2030+*, a practical list with every resulted action towards a robust masterplan is presented. These actions represent the last procedure of the third step of APP framework. Each action is correlated with main responsible departments and possible time frames. This section in junction with the mentioned annex successfully addresses the set of actions to answer research SQ5; thus, increase the robustness of current Europoort masterplan.

### 3.8. Conclusions

*Chapter 3 Europoort Adaptive Port Planning* represents the core of the research. Firstly, a comprehensive definition of success for existing port areas, particularly for Europoort is provided after analysing current goals (research SQ2). Secondly, main underlying assumptions within current Europoort masterplan are attained from the worked out definition of success, the literature review, and several meetings held with professionals at PoRA (research SQ3). Then again, these underlying assumptions are critically analysed to be classified as vulnerabilities or opportunities in the medium- and long-term for Europoort and in a broader way for Port of Rotterdam in general (research SQ4).

Finally, actions to increase the robustness of current Europoort masterplan are provided; some of given the actions are explicitly for this port area, meanwhile others are recommended for a positive implementation of future-proof plans for the Harbour Industrial Complex as a whole (research SQ5). Moreover, input from research SQ1 is extremely needed to properly address the others. Therefore, within previous sections most of the research SQs are essentially answered.

In summary, Europoort problem and strategy are defined, the basic assumptions are identified, and the actions to increase robustness of current masterplan are devised. These are the first three steps of APP framework which are effectively presented within this chapter.

Moreover, and as previously mentioned in the report, it is clear that current port development processes do not consider long-term planning related actions. Thus, as starting point a practical differentiation for each planning time-horizon is provided, where 2030 is used as break point between medium- and long-term. Then, existing goals for Europoort success are recognised for the seven categories identified within the literature review to assess success of existing port areas. However it is notorious that clear indicators are not available for setting objectives and following those possible intentions at Europoort. Most precise indicators are specifically developed within this study for setting targets, and as useful tools for evaluating and monitoring success. Others are collected from different sources, but are meant for the overall port. A summary of every proposed indicator and recommendations to properly implement them for Europoort are indicated in subsection 3.4.9 *Optimised list of success indicators for Europoort*. This abridged list is partially the outcome of the first part of the workshop sessions described in *Annex B Workshop: Success & assumptions*, section *B.1 Success for Europoort*.

Once a consistent definition of success for Europoort is achieved, its underlying assumptions are obtained. For accomplishing this, existing visions are expanded throughout a comprehensive scenario analysis. The scenario analysis is discussed in *Chapter 2 section 2.4 Possible future developments challenging Europoort success*. Eighty two assumptions are reduced to thirty three thru an internally carried out port planning voting process. All this information is also presented in *Annex B Workshop: Success & assumptions*, section *B.2 Identified underlying assumptions by category*.

Those underlying assumptions are categorised as opportunities and vulnerabilities for Europoort, and Port of Rotterdam, during the second part of the workshop sessions. This process is extensively discussed in this chapter. Moreover, detailed results are available in *Annex B Workshop: Success & assumptions* too, expressly within sections *B.3 From underlying assumptions to opportunities & vulnerabilities* and *B.4 Overview of the vulnerabilities and opportunities*.

Finally, the last section of the chapter deals with actions proposed towards increasing the robustness of current Europoort masterplan. These outcomes represent core modifications to be introduced in existing planning practices at Port of Rotterdam Authority. Some of them are in connection with certain present lines of innovation within the organisation; most of them are completely matching with foremost of the reviewed literature; and at last, a few innovative proposals are introduced as well.

Main key concepts related to the proposed actions after applying Adaptive Port Planning for Europoort are graphically summarised in Figure 3-7.

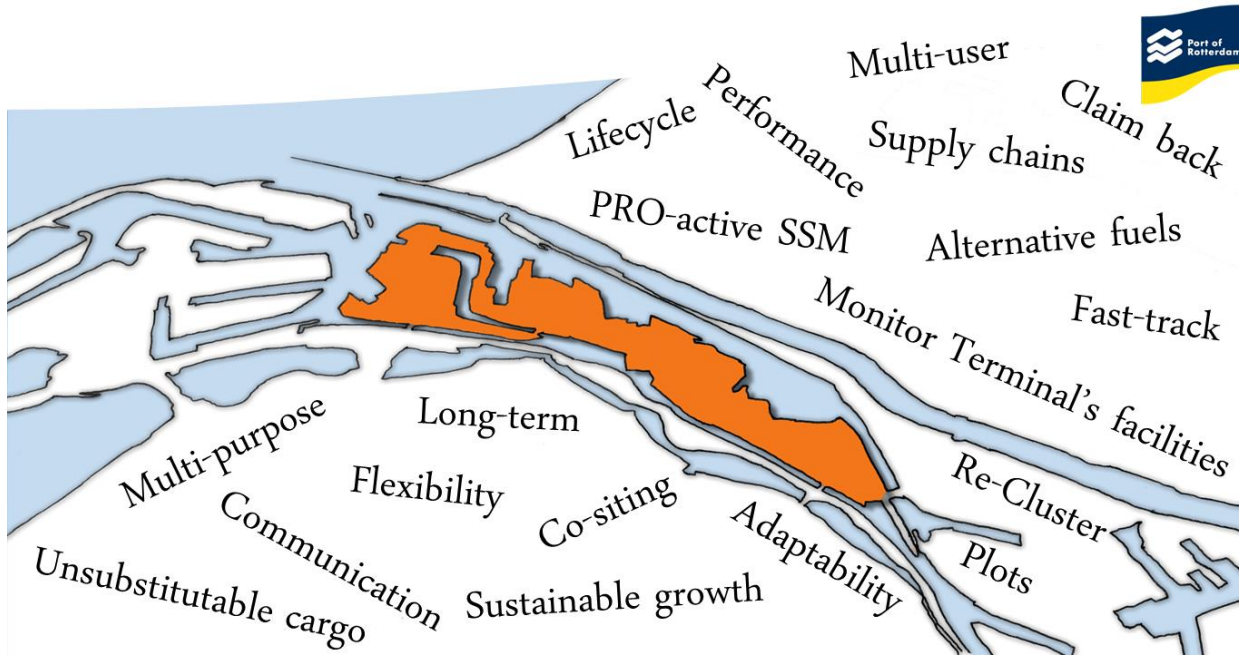


Figure 3-7 Main key concepts related to included actions throughout Adaptive Port Planning process

All these concepts are mainly related to long-term planning course of action. Their concrete application is further elaborated in the following chapter.

# Chapter 4. Europoort Masterplan 2030+

Having developed every step of the APP framework allows achieving a better understanding of the uncertainties in the planning process. This also enables defining actions to cope with those uncertainties in order to increase the robustness of the masterplan. Consequently, this chapter imparts a practical synthesis of every finding acquired in *Chapter 3 Europoort Adaptive Port Planning*. Thus, a full long-term masterplan based on APP framework is presented. Moreover, as it is mentioned in 3.2 *Planning strategies and its related time horizons*, it is proposed to develop a three layered masterplan, where each layer is correlated with a planning horizon. Hereafter, this proposed masterplan, is referred as **Europoort Masterplan 2030+**.

Section 4.1 treats the proposed planning process with its updating cycle. Section 4.2 discusses about the strategic cargo concepts (group of cargo segments) related to long-term planning. Finally, section 4.3 abridges Europoort Masterplan 2030+ outcomes in the form of a Europoort map and key actions.

## 4.1. Proposed planning process

Firstly, it is needed to build up a practical way of incorporating flexibility with simple techniques into the Europoort Masterplan 2030+. As it thoroughly elucidated in previous chapters, long-term evolution of each cargo segment involves the largest amount of uncertainties. Hence, as practical resolution, it is proposed to base long-term plans only on strategic cargo concepts. Particularly for Europoort these are:

- Energy Port
- Fuel Hub
- Standardised Cargo Port

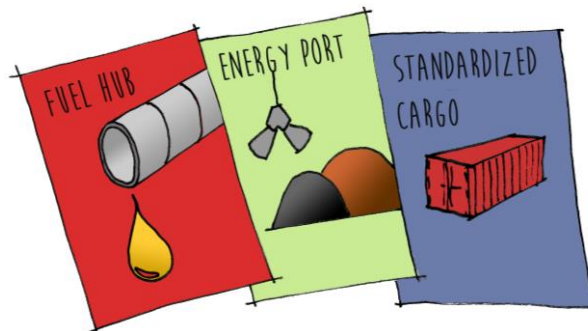


Figure 4-1 Strategic cargo concepts for Europoort long-term planning

Each of these strategic cargo concepts are the ones linked with flexible basic infrastructure. Besides, as it is common practice for any other planning process, regular updates are essential. Thus, it is advised to perform in-depth updates every 3 to 5 years, but always depending on the evolution of global developments. Thus yearly monitoring of global trends is crucial. The monitoring procedure should include a Contingency Plan (Taneja, 2013).

Secondly, the medium-term plan or “Strategic Planning” (PIANC, 2014a) layer is elaborated by dividing the strategic cargo concepts into different cargo segments. For this stage, it is imperative to explicitly associate tentative planning dates. This means assigning conceivable starting dates and duration required for executing each action (and/or possible projects) included in the masterplan. This is

extremely important to attain a planned reaction, allowing PoR to be sufficient prepared in case some planned future actions are required to be implemented sooner than anticipated. It is clear that changes on initial plans will always appear due to the reduction of initial uncertainties. Thus, this will be an outcome when periodically executing the monitoring processes set in the Contingency Plan. For “Strategic Planning”, it is recommended to realise yearly quick scans to identify possible fluctuations of the original plans, and in-depth updates when integrally reviewing the Europoort Masterplan 2030+.

Thirdly, the short-term plan or “Project Planning” (PIANC, 2014a) phase is derived from the long- and medium-term plans with their related actions. It mainly focusses on the initialisation of projects, its follow-up and those concrete “day-to-day” actions. This requires continuous tracking, and it also involves the most intense interaction phase amongst different disciplines to implement the proposed actions. Reaction time should be reduced to a minimum in order to serve clients in the best possible manner. Nevertheless, it is not the main topic of this study; thus it is not considered as a relevant part of the thesis; however some recommendations are given.

Finally, the proposed planning process is summarised in Table 4-1. It is advised to implement this methodology as a regular practice of Port Planning at Port of Rotterdam.

**Table 4-1 Planning levels and recommended updating cycle**

Year	Europoort map	Document	Associated actions	To be shared with...	Review & update
2015	Current situation	Project Planning	Upcoming two years only	Every PoRA department	Every year This is quite similar to current practice, but long-term possible effects may require actions now!
2030	Cargo segments	Strategic Planning	Actions & projects with its linked explicit durations (starting until 2030 & finishing date)	Business Intelligence & Commercial developers	Quick scan every year but checking defined triggers & monitoring plan. In depth w/Masterplan+
2030+	Strategic cargo concepts	Masterplan +	Possible actions & long-term projects	Financial Corporate strategy	Every 3 to 5 years, but depending on defined monitoring plan & global trends
		Port Vision			

## 4.2. Planning beyond 2030

As it is already introduced in the preceding section, to introduce maximum flexibility within long-term planning processes, it is considered essential to associate flexible basic infrastructure for each strategic cargo concept envisioned for Europoort. This approach is found as the most practical implementation of flexibility during long-term planning phases. Moreover, it is a core part of the Europoort Masterplan 2030+. Consequently, in the following subsections flexible basic infrastructure with its general considerations related to each strategic cargo concept are presented.

### 4.2.1. Energy Port

This strategic cargo concept is mainly related with dry bulk cargo (e.g. biomass, coal, agribulk, mineral products, et cetera). For several operations it is strongly integrated with the Fuel Hub strategic cargo



concept. Nonetheless, this interconnection is further examined in 4.2.3 *Interdependence between Energy Port & Fuel Hub*. So to put it simple, the main goal is to achieve the standardisation of the waterfront from the planning perspective. It is possible to accomplish this throughout normalising the basic infrastructure designs. A good summary can be found on *Quay wall designs for uncertain futures* (Zwakhals, Taneja, & Ligteringen, 2012), where there are elucidated four different design approaches:

1. Traditional designs + later Ad-hoc adaptations.
2. Designs for short-time and demolition or possible reuse.
3. Robust designs for any possible future situations.
4. Adaptable designs for future scenarios.

Some of these design approaches seems not be suitable enough for being implemented within the Europoort Masterplan 2030+. Hence, the selection of most convenient design approach is carried on within the following subsections. To achieve a general picture some cases, either at Port of Rotterdam or at other port complexes in the world, are presented and discussed.

#### 4.2.1.1. Traditional designs + later ad-hoc adaptations

Initially, Port of Buenos Aires in Argentina is zoomed in. It is a perfect case study where the first and third mentioned design approaches are found. Over there, existing quay walls were designed almost a century ago. But due to changes on the service requirements, it was needed to implement ad-hoc adaptations in 2009. Initially, this example represents a robust quay wall design from early 20<sup>th</sup> century (third design approach, but due to past state-of-the-art design conditions using large safety coefficients) with later ad-hoc adaptations.

In 2009 works were carried on to extend its economic lifetime by strengthening existing gravity walls with a line of post-tensioned anchorages. Afterwards new post-panamax gantry cranes were installed to serve the new generation of vessels calling at this South American port (Arecco, Fernández Bugna, Cucci, & Sendra, 2015). The construction works for reinforcing the quay wall can be partially appreciated in Figure 4-2.



Figure 4-2 Active post-tensioned anchors to reinforce existing quay walls at Port of Buenos Aires

Another significant example of traditional port design with ad-hoc adaptations can be found at Port of Valencia in Spain. Some years ago, it appeared the necessity to increase the water depth at the toe of

the Levante caisson quay wall from -14.0m MSL to -15.2m MSL. Accordingly ad-hoc measures were thought to adapt the quay wall representing a clear example of the first stated design approach.



Figure 4-3 Super-jet grouting equipment operating at Port of Valencia (Fernández Vincent, 2008)

To solve the problem super-jet grouting techniques were used. This implied perforating the bottom slab of the caisson from the top of the quay to inject concrete (Fernández Vincent, 2008). Photos of these works are shown in Figure 4-3. This method allowed building an extension in depth of the toe along the whole waterfront.

#### 4.2.1.2. Designs for short-time and demolition or possible reuse

Complementary to already discussed cases, several examples can be found of pilot designs for short-time and demolition or possible reuse (second proposed design approach). Among them, Containerland (Exalto, 2002) and Maxisteck (IGWR, 2000) are two well-known systems. However, until now every study dealing with them or even treating the reuse of caissons, shows that at least it is needed to reuse the structures from 3 to 5 times during their lifecycle to attain a competitive cost with a traditional quay wall construction (Zwakhals et al., 2012).

In addition, floating solutions are very interesting flexible solutions for possible future reuse. A case study at Europoort is presented in The Flexible Port (Taneja, 2013), however it needs further development to move forward in that direction. These design approaches promises to become inflection points for port design. There are examples that are already employed for dry bulk cargo handling, especially with floating cranes (EBS, 2014a, 2014b; Port of Rotterdam, 2012a). Furthermore several conceptual studies were carried on (Ligteringen, 2011; Pielage, 2008; Samsung Heavy Industries, 2014). Some have been applied, but most of them were not even advanced into pilot phases. Consequently further developments on this line of research are needed. There is a special need for introducing different ways of producing current business models (dedicated & custom-made business models) to evaluate the economic feasibility of these high added value products. Besides, it is also vital to break down economic opportunities that were not considered until now.

#### 4.2.1.3. Robust designs for any possible future situations

Some extra ways for introducing flexibility in the design approach, it is through the implementation of robust designs which correspond to the third mentioned design approach. Related to this, some future proof examples can be already found at Port of Rotterdam.



Figure 4-4 Rhenus terminal at Maasvlakte, Port of Rotterdam (Port of Rotterdam, 2012b)

In 2001, the quay wall at the North bank of the “Europahaven” in Maasvlakte was built to be adapted in the future for a maximum depth of -16.65m MSL (requiring bottom scour protection for this depth). However at that time the contractual required depth by DFDS Seaways, former company operating there, was only -11.65m MSL. For around 10 years the quay wall was operating with this depth and without bottom scour protection. Though, this situation changed in 2012 when Rhenus Logistics B.V. supplanted DFDS terminal operations at this site. This new company necessitates an operational depth of -12.65m MSL; for that reason the quay wall depth was increased one extra metre (again the bottom was left without scour protection). An overall view is shown in Figure 4-4.

As it can be easily deduced, the associated downtimes for this adaptation were minimised. Besides this simple works for increasing the depth were only possible due to robust designs constructed more than 10 years before. Likewise this solution is prepared for being deepened four extra metres. This robust design approach was established on future plans for deepening the “Europahaven”, and for increasing the width of the navigation access channel when deepening the basin. Nonetheless, it has already shown to be a prudent decision, because in around 10 years, the “Europahaven” has been deepened from -11.65m MSL to -12.65m MSL. Besides, it also enables a gradually enlargement of the harbour access channel due to ship size increase, thus maintaining or even enhancing ship’s manoeuvrability.

United Waalhaven Terminals (UWT) at Port of Rotterdam is an additional example of constructing robust designs to introduce flexibility. Especially the quay wall dealing with the storage and transhipment of empty containers was prepared for future deepening.

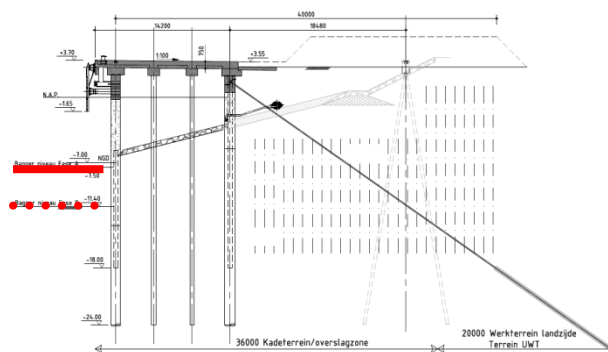


Figure 4-5 UWT quay wall cross section (Port of Rotterdam, Witteven+Bos, & De Klerk, 2014)

During a first phase the constructed depth is -7.0m MSL, however it can be deepened to -11.4m MSL in the future. Details of the proposed design and an artist impression are shown in Figure 4-5.

#### 4.2.1.4. Adaptable designs for future scenarios

Both presented examples in 4.2.1.1 *Traditional designs + later ad-hoc adaptations*, either at Port of Buenos Aires or at Port of Valencia, would shift into an adaptable quay wall design for future scenarios, if the applied adaptability can be planned beforehand. Hence, this type of solutions would match with the fourth proposed design approach.

Following the same way of thinking, quay walls can also be prepared for future adaptations e.g. by implementing the use of pneumatic caissons or by evaluating alternative technical solutions that would allow future adaptability without too high capital expenditures (Toorn & Gijt, 2013; Voorendt, Molenaar, & Bezuyen, 2011) as it is shown in Figure 4-6.

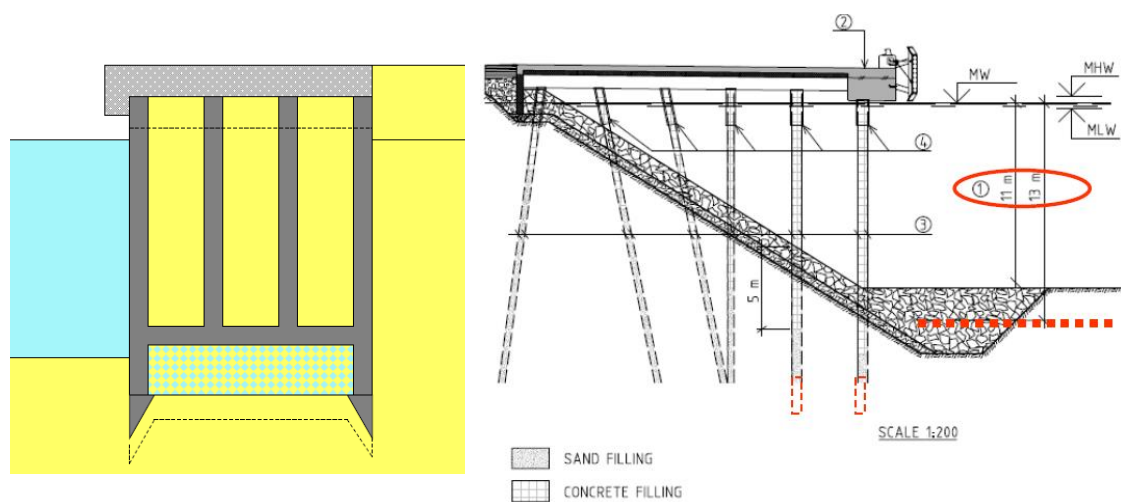


Figure 4-6 L-R: Pneumatic caisson quay wall & Adaptable open quay wall already prepared for future deepening by extending the foundation piles at low cost (Toorn & Gijt, 2013)

In the case of pneumatic caissons it is crucial to unify ongoing research from at least the last 20 years, starting with initial automation techniques to avoid difficult working conditions for the workers (Kodaki, Nakano, Nanasawa, Maeda, & Miyazawa, 1996) to technical solutions already implemented in other fields of civil engineering, like tunnelling engineering (de Wit, Dorreman, & van der Ploeg, 2011), or bridge foundations (PARI, 1997), among other fields.

The selection of adaptable designs should be specifically studied case by case. Of course, applied research is mandatory to mature options for Port of Rotterdam. Therefore, this is a crucial task for PoRA project engineers in order to develop the most suitable solution at convenient costs.

#### 4.2.1.5. Recommended quay wall approach design

According current state-of-the-art and based on previously presented design approaches, it is recommended to implement adaptable designs and robust solutions for implementing flexibility at Europort in the long-term. These two design approaches are greatly in line with the desired way of planning for the Europort Masterplan 2030+.

Although the dispersion of structural requirements for a quay wall can be quite large, it is also possible to cluster cargo segments based on the planning and similar type of strength requirements. This allows the standardization of the water front. There are several initiatives on going within PoRA, but it is also something that needs further research to materialise comprehensive solutions. To sum up, to achieve the already mentioned standardisation of the water front for the Energy Port, two types of flexible basic infrastructure are proposed for the Europoort Masterplan 2030+:

- Robust quay walls
- Adaptable quay walls (floating solutions are included too)

A robust quay wall can accommodate in the long-term, all Energy Port related type of cargo and ships; every possible variation of service loads on the nearby storage yard is also taken into account. Quay walls with margins in design for future deepening are also circumscribed within robust quay walls.

On the other hand, an adaptable quay wall is referred to those designed for predicted future variation. This is possible by several means, e.g. either by extending its depth, or by modifying the structural system, or by introducing planned reinforcements in case larger service loads are achieved, among other possibilities. There several techniques to adapt quay walls for future conditions; more alternatives needs to be analysed and studied case by case, and finally there are still some limitations. Therefore continuous innovations are needed to gradually overcome current boundaries.

To conclude, it is advised to properly group the envisioned cargo segments during the planning process for the Energy Port. Consequently, it is also likely to provide sufficient information to PoRA project engineers that would allow them to mature either an adaptable or a robust quay wall. Multidisciplinary work at early stages plays a key role during the planning phases.

#### 4.2.2. Fuel Hub

This strategic cargo concept is related with liquid bulk cargo (petroleum oil, bio-based oil, LNG, syngas, hydrogen fuel, et cetera). As it was mentioned, for some processes it is deeply combined with the Energy Port strategic cargo concept. This is dealt in 4.2.3 *Interdependence between Energy Port & Fuel Hub*. The basic infrastructure associated with the Fuel Hub is fundamentally multi-purpose & multi-user jetties that can be used and/or adapted for any of the comprised cargo segments.

Again, according to specific needs of the terminals related to the liquid bulk cargo segment, different type of cargos should be clustered to achieve a few standard variants of multi-purpose jetties. These standard alternatives could cover the whole range of possible related activities. Besides linked to each of those standard variants, typical dolphin designs and systematic dolphin's mooring configurations should be defined for current and future possible cargo vessels calling at the port. Implement multi-user options and co-siting when planning the construction of a new jetty, and even when a new terminal is willing to start operations at the port. It means including this premise for every new business at PoR. Furthermore, sharing basic infrastructure and storage facilities must be encouraged for example by providing incentives. Some examples of multi-user and multi-purpose jetties can be found in ports around the world. Some of these were a direct response for urgent needs to serve new type of vessels and cargo; while others were planned.



Figure 4-7 Multi-user jetty, MEGA terminal at Port of Bahía Blanca

In 2007 Argentina went over a severe gas supply crisis, consequently the need for importing gas rapidly increased. The most convenient, cheapest and flexible solution was importing gas through the port system with LNG vessels. However the country did not have any importing LNG port facilities at that time. Therefore an innovative solution was implemented. A multi-user jetty was adapted at Port of Bahía Blanca for receiving floating storage and regasification units (FSRU) plus LNG vessels mooring attached to the FSRU. Currently MEGA terminal is used by three companies: YPF, Petrobras & Dow (Puerto Bahía Blanca, 2012). The aim of implementing this technology was a “fast-track” adaptation to convert LNG from the carriers back into natural gas to send to the internal market, and solve Argentina’s gas supply crisis. This presented several challenges, but it was possible to apply due to innovative solutions and a strong decision-making process (Groenveld et al., 2014; Iribarren et al., 2010). An aerial photo is shown in Figure 4-7.

Other examples of multi-user and multi-purpose jetties can be found in Japan. An interesting design of a detached multi-user and multi-purpose can be found at Port of Yokohama (Yokohama Port Corporation, 2014), some general images can be appreciated in Figure 4-8.



Figure 4-8 Detached multi-user & multi-purpose jetty at Port of Yokohama

There are some conceptual designs at Port of Rotterdam for developing shared utilities. These initiatives are either for green fields like the proposed Bio Port at Maasvlakte 2 (Port of Rotterdam, 2014m), or even at Europoort with the multi-user jetty proposed at the “Calandkanaal” in front of the “7e Petroleum haven” (Port of Rotterdam, 2015a). Nonetheless further development is needed, but even more important is establishing these criteria as standard process for port development.

### 4.2.3. Interdependence between Energy Port & Fuel Hub

According to the definition of Energy Port and Fuel Hub, both strategic cargo concepts are intrinsically interconnected. However, within the Europoort Masterplan 2030+ these are also differentiated based on its basic infrastructure as it was explained in the two previous subsections. In this approach is also assumed that both concept cargo segments contain the commercially envisioned chemical cluster.

Energy Port is associated with dry bulk cargo and its related industries. Consequently for the Europoort Masterplan 2030+, it is only related to basic infrastructure for dry bulk cargo. Nevertheless the name can lead to possible misunderstandings. As it is known, energy can be also generated from liquid bulk cargo such as LNG, oil, et cetera. However in this point is where the interdependence among both strategic cargo concepts becomes clear. So if liquid bulk cargo is needed to fuel the Energy Port, it would reach the port through the Fuel Hub basic infrastructure, and then internally that liquid bulk cargo is transferred to the Energy Port industries, mainly through pipelines.

To provide a clear explanation, electric power generation with combined cycle turbines is chosen as example. Undoubtedly these are part of the Energy Port. However if these combined cycle plants are powered by liquid bulk cargo (natural gas, fuel oil, et cetera) needs connections with the Fuel Hub strategic cargo concept. On contrary, if powered by coal, or biogas produced at PoR but derived from agricultural and forestry waste, the whole process remains within Energy Port strategic cargo concept. In this case the cargo is arriving to the port through dry bulk basic infrastructure, this means through the Energy Port.



Figure 4-9 Port of Rotterdam Energy Port & Fuel Hub (Port of Rotterdam, 2011, 2013c)

A similar situation exists for the Fuel Hub. This strategic cargo concept is associated with liquid bulk cargo and its related industries. This means that a petroleum refinery is fully contained within the Fuel Hub strategic cargo concept, but it can also fuel part of the Energy Port. In opposition a biofuel refinery is clearly part of the Fuel Hub, because its final products are fuels. However, to operate it may require to be connected to the Energy Port strategic cargo segment. It may be fed by dry bulk cargo reaching the port through the Energy Port basic infrastructure.

Although both strategic cargo concepts are interlinked, the proposed divisions are necessary to easily structure and follow a flexible long-term planning process with its derived actions and projects.

#### 4.2.4. Standardised Cargo Port

Even standardised cargo at Europoort is not a large segment for the moment; there are some possibilities aside current activities at the “Beneluxhaven”. This strategic cargo concept is related with containers and RoRo cargo. Also it could also include break bulk cargo, but it is not considered now as an envisioned segment at Europoort.

Possibilities are potentially foreseen at Europoort, mainly to replace the container short sea hub in the Waal- Eemhaven in the long-term. Taking into account that short-sea vessels will increase their size as well.

In addition, RoRo may develop as a potential growing cargo segment. Therefore fostering a RoRo cluster is also interesting. However it will present some drawbacks, mainly related with the deep sea available depths and the low draft required by RoRo vessels. On the other hand, with a conceivable realisation of the “Oranjetunnel”, the Europoort area can represent a very favourable location (for break bulk cargo too).

For the Standardised Cargo Port, a similar approach as the one recommended in subsection 4.2.1 for the Energy Port is proposed. Thus implementing multi-purpose quay walls for accommodating containers, RoRo and possible break bulk cargo is the goal for the associated basic infrastructure.

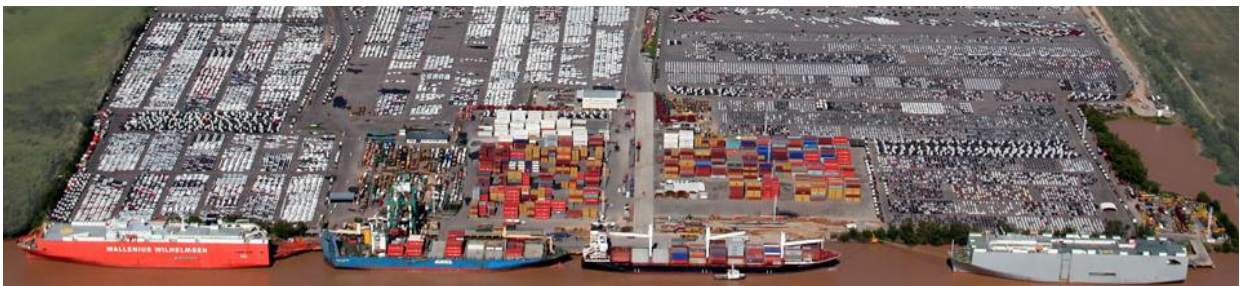


Figure 4-10 Terminal Zarate (TZ) on the Paraná waterway, around 100 Km inland country in Argentina (Terminal Zarate, 2013)

The design approach may be either to implement robust and/or adaptable quay walls. There are some examples of Standardise Cargo Ports in the world, an interesting example is shown in Figure 4-10 , where a flexible quay wall allows operations of short sea containerships and RoRo carriers.

### 4.3. Results

Extensive and more elaborated details are presented in *Annex X* section *X.6 Europoort Masterplan 2030+*. Fundamentally, the main outcome is a more robust masterplan for the Europoort. This is the direct result of applying Adaptive Port Planning framework. It combines all the findings of *Chapter 3* with the proposed approach in this chapter. This combination is possible after developing the first three steps of APP framework and thoroughly analysing possible alternative plans for the Europoort as part of the fourth step of APP framework (related with the selection of alternatives). Besides the fifth and sixth step of APP framework are included in practical way within the proposed long-term masterplan.

**Europoort Masterplan 2030+** presents specific actions with the same style as current HIC masterplan (map & list) for the Europoort area. Accordingly, it can be directly included in the next official masterplan version. A conceptual visualisation (artist impression) is presented in Figure 4-11.



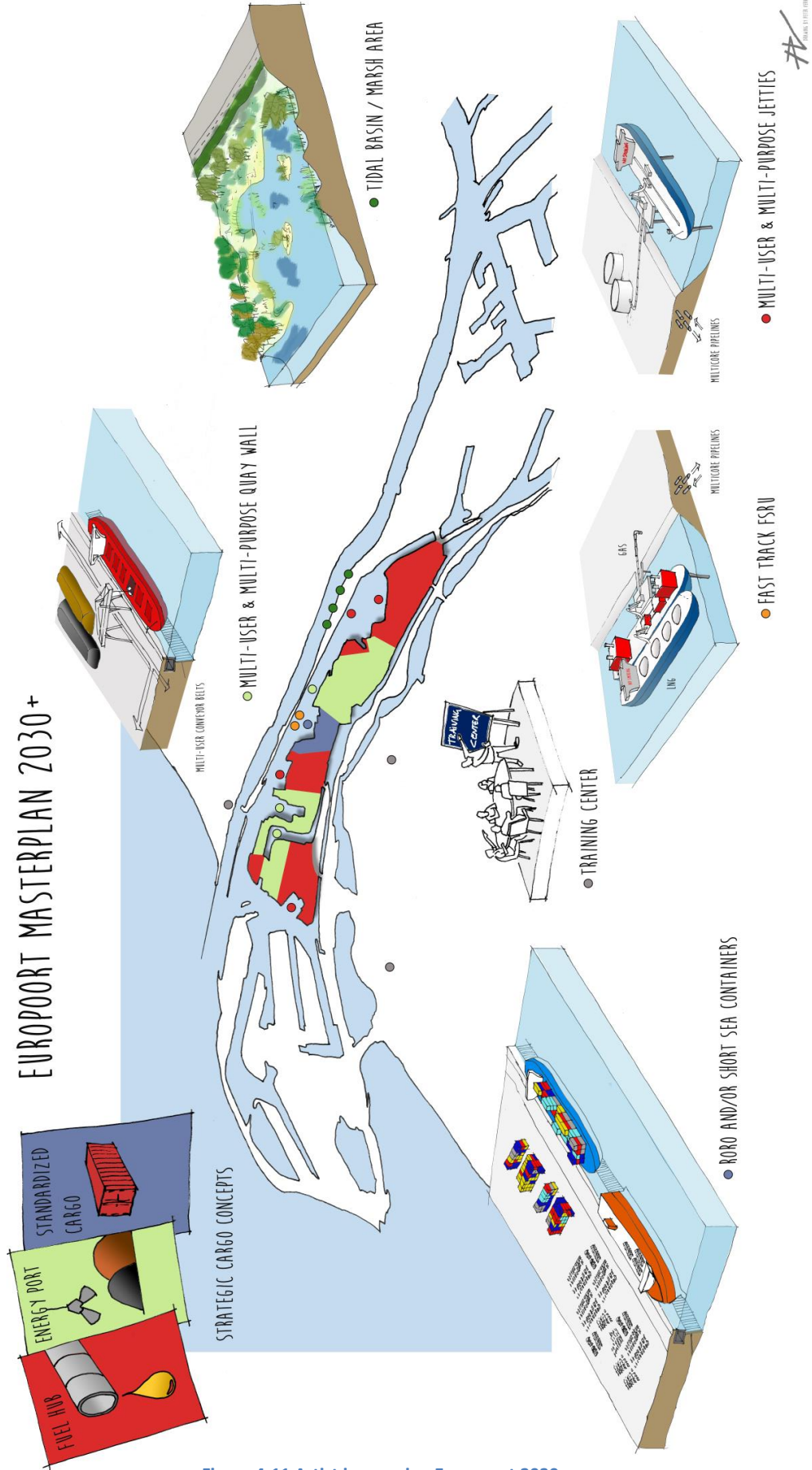


Figure 4-11 Artist impression Europort 2030+

## 4.4. Conclusions

Although, *Chapter 3* presents the entire procedure for reaching up a robust masterplan throughout answering research SQ1 to SQ5; it is in this chapter where the complete APP framework is thoroughly materialised as a long-term masterplan for the Europoort area.

Summarising, this chapter is the final step to achieve a robust Europoort masterplan. It is important to note that every action and the whole procedure are the direct consequence of applying APP framework. Even though at a first look, some of the proposed actions may appear as disconnected points; all of them are methodically obtained in a structured way through critical thinking.

This study can be further extended using the already developed work as starting point. For achieving this, it would be needed to reproduce the applied methodology in a prolonged version, but without any minor efforts. Therefore, although this extension may bring some extra insights; first, it is advised to extent this practice to other existing port areas at PoR. This recommendation is based on the attained simplicity to identify possible vulnerabilities or boost existing opportunities, which is considered one of the distinctive features of this suggested approach.

In conclusion, this proposal is found as a practical and systematic combination for collecting all the attained outcomes towards long-term sustainable growth with a very straightforward technique. This is clearly outlined in the **Europoort Masterplan 2030+** in *Annex X* section *X.6*.

# Chapter 5. General guidance for a case study

This chapter aims to bring one step further the practical application of APP at Europoort. For this purpose “Europoort Midden”, shown in Figure 5-1, is designated as specific case study.

An evaluation practice to recognise most critical areas from the planning perspective is briefly discussed. To thoroughly materialising this, an Adaptive Port Planning tool is proposed to fulfil every goal to successfully plan port existing areas. This is only developed into an initial stage due to time constraints of this research. However, it is anticipated as a core tool towards a more efficient and robust use of the land from a flexible port planning perspective.

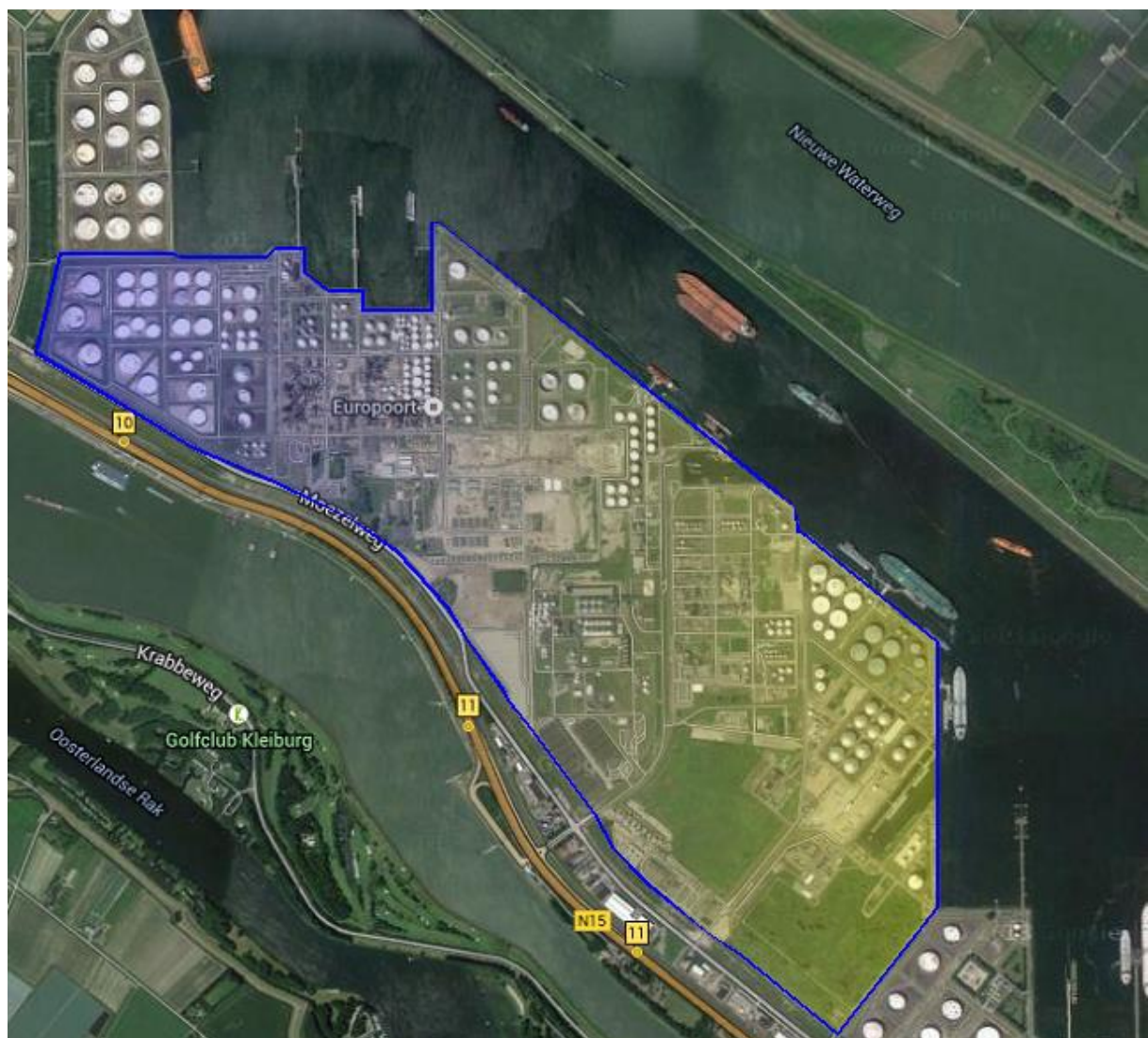


Figure 5-1 Aerial image of the “Europoort Midden” (Google Maps)

Clearly, this approach enables the prioritisation of actions to be carried out within the “Europoort Midden”, and if extended it would allow a proper assessment of the whole port industrial complex. With no need to stress it again, this is based on all previous worked out information and obtained outcomes. Furthermore, possible valuation approaches to support the decision-making process for comprehensively selecting alternatives within a project and/or a port area are also discussed.

## 5.1. Why “Europoort Midden”?

As it is described in *Chapter 2 Literature review* within subsection *2.1.8 Europoort current spatial distribution & contractual situation*, significant parts of this core area are not-in-use for several reasons. While this is a common parameter for every sector within Europoort, the zone where these circumstances are maximised is the “Europoort Midden”. More acquired facts are shared in *Annex X* sections *X.4* and *X.5*. Ironically, “Europoort Midden” is one of the most valuable areas at Port of Rotterdam due to its large available water depth, its low environmental restrictions for the industry when comparing with other areas like Botlek, and the huge potential for increasing the capacity of its hinterland connections.

Undoubtedly other sectors in the Europoort area also present several challenges and some similar favourable circumstances. However, due to current status, a closer analysis is carried out for the “Europoort Midden” to attain better insights, and to further develop some of the planning actions.

## 5.2. Towards front-runners facilities

All the processed information through previous chapters, and main outcomes from the individual meetings with professionals working at PoRA (*Annex A*) and the workshop sessions (*Annex B*), showed that monitoring the state of superstructures and terminal’s facilities performance is crucial for PoR. In other words, Port of Rotterdam performance is highly dependent on each terminal operating within Harbour Industrial Complex. Basically, if every terminal has foremost state-of-the-art facilities that efficiently operate with high productivity rates, PoR will achieve a maximum performance too.

Nowadays, despite the fact that PoR currently has world-class basic infrastructure and services with very favourable conditions for businesses, some companies and global corporations may not pursue the same objectives for their terminals operating at the port. This may happen due to various circumstances, and it is not within the scope of the research to determine them. But, hereafter it is patent that terminal’s investments may flow in different directions leading to outdated facilities and superstructures in Rotterdam, which clearly influences PoR performance.

Moreover, strategic decisions taken by some companies may result in keeping reserve areas for more than 10 or 15 years, and not investing on them. Again this may happen for several reasons, like preserving key areas for very uncertain future expansions, or failures on predicted commercial growth, or low prices associated with these reserve areas in their contracts, or hindering the possibility for competitors to settle at the port (hampering natural terminal’s facilities evolution), among many other issues. Whereas the causes need to be checked case by case, all of them lead to non-existent or low efficient use of some port areas, and the related terminal’s facilities.

In summary, all these may result in low productivity rates with high berth occupancy factors due to inefficient ship-to-shore equipment, culminating in market share decrease for some cargo segments. Thus, PoR success is directly affected, and in this particular case Europoort’s competitiveness as it is described in *Chapter 3* section *3.4.9 Optimised list of success indicators for Europoort*. Of special interest is the liquid bulk cargo segment, which slowly decreased 5.2% during the first half-year in 2014 (Port of Rotterdam, 2014d). This cargo segment has a large incidence at Europoort and PoR. Hence, it is unquestionable that a closer look at each terminal with its facilities is needed to keep and promote front-runners facilities and operations.

### 5.3. A risk-based tool leading to success

Adaptive Port Planning tool is thought as a cross-cutting risk-based method for assessing terminals' performance based on some of the recognised success indicators and current state of terminal's facilities. Thus, it is meant for monitoring and tracking every terminal's evolution.

This technique is only developed up to a conceptual stage. However, it is already foreseen as a simple and useful tool for planning existing port areas. Main parameters included to assess risk of each plot and/or terminal for long-term planning are:

- State of the facilities
- Investment at the terminal
- Business performance
- Jetty/Quay productivity
- Jetty/Quay occupancy
- Terminal productivity
- Not-in-use areas
- Co-siting integration & available connections (supply chain)
- Environmental performance
- Safety performance

For each one of these parameters a certain risk mean value can be defined based on professional judgement and measured figures. Then, a probabilistic distribution can be also associated to each one, including a standard deviation. Finally, a formulae to combine all these parameters needs to be defined to identify the total risk each terminal implies for PoR from the planning perspective of existing port areas.

An initial figurative exercise to implement flexible alternatives is applied for the "Europoort Midden". This exercise was done during an extensive brain storming session with Martijn Oosting based on all the research and figures acknowledged within this study. PoRA is now able to extend this practice to the rest of the port to stimulate the optimisation of any terminal's facilities and superstructures. As this is sensitive information, it is presented in *Annex X section X.5 Planning flexible solutions for the "Europoort Midden"*

### 5.4. Other valuation tools for comparing project's alternatives

Once the actions are prioritised to efficiently assess each plot, most critical circumstances are initially considered for further analysis.

Then, possible alternatives are studied for this port sector. All of them need to be weighed and critically compared. Consequently, to fulfil these requirements research SQ6 is addressed within this section:

**How can flexibility, social and ecosystem services be valued to compare different alternatives in current Port Planning processes at Port of Rotterdam Authority?**

To compare possible alternatives that include adaptable or robust solutions, the execution of purely financial business cases can be extended by implementing SCBA techniques with the valuation of flexible designs too, as it is proposed in Figure 5-2.

Real Options Analysis (ROA) can be adopted as the main approach for valuing flexibility as it was already executed in “The option to value investment opportunities” (Turnhout, 2011).

Both techniques are presented as promising lines to advance for PoRA. Furthermore, it is possible that the combination of SCBA and ROA can maximise the results of the envisioned policy at PoRA.

According to current state-of-the-art, this approach is understood as one of the most tangible ways to directly unify current financial business cases with other valuation methods into a single method. Certainly, this proposed approach would become the ultimate evolution for analysing commercial investment with an all-embracing method.

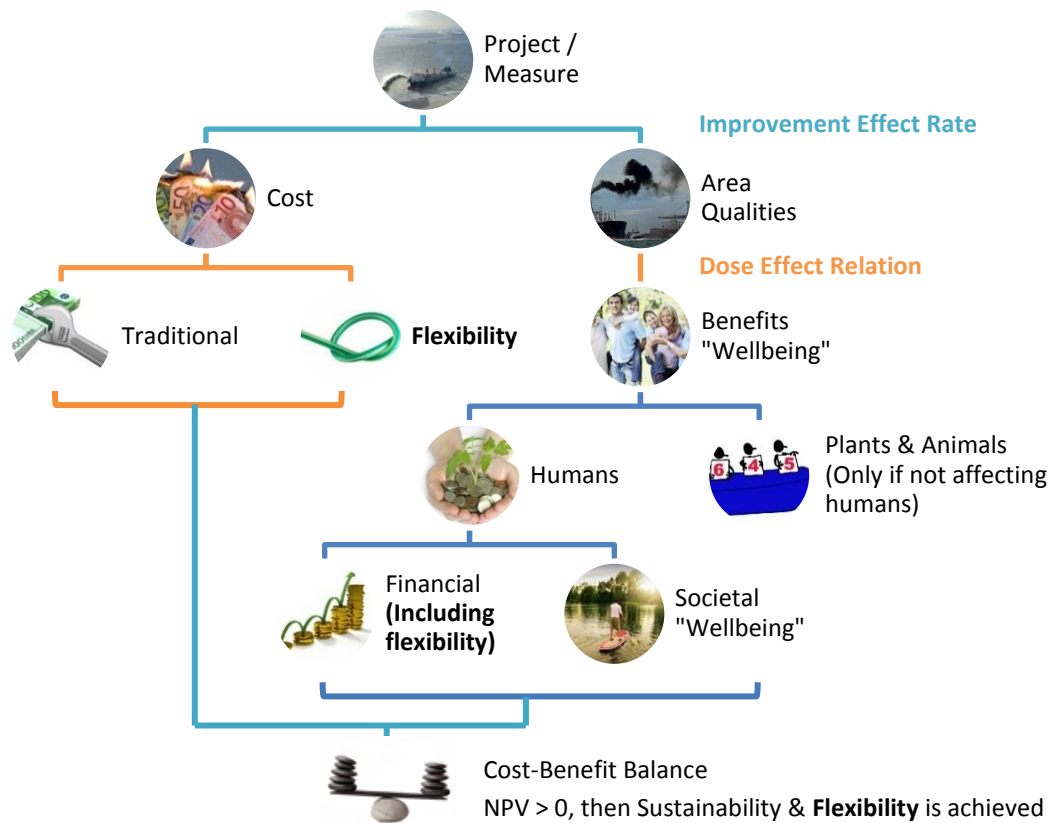


Figure 5-2 Social Cost-Benefit Analysis (SCBA) based on Elisabeth Ruijgrok approach (Ruijgrok, 1999, 2004) including ecosystem services and adopted by Rijkswaterstaat (Centraal Planbureau, 2013; Rijkswaterstaat, 2014b), but with a modification related to Flexibility, proposed in this study (in bold font).

On the benefits side, it is important to note two phases specifically referred to SCBA. These are the Improvement Effect Rate and Dose Effect Rate (Ruijgrok, 1999, 2004).

The Improvement Effect Rate (IER) refers to variations of the qualities (changes on ecosystem services “ΔQ”) of an area due to the implementation of a project or a measure (e.g. variations on air quality, water quality, et cetera).

The Dose Effect Rate (DER) denotes specific amount of benefits per unit. These are related to those variations for the “wellbeing” of humans. Hence, DER allows to establish trade-offs for ecosystem services (monetize or trade-off rate “P”) that are affected (Centraal Planbureau, 2013; Rijkswaterstaat, 2014b).

Then in a later stage,  $\Delta Q \times P$  is calculated. This comprises the complete benefits for the societal “wellbeing”. In other words, this figure represents the valuation of ecosystem services for everybody impacted by the project or measure.

The financial analysis is carried out at the same stage of societal “wellbeing” benefits. This can be understood as the financial business cases. However, in the proposed approach shown in Figure 5-2, the financial benefits are not only thought as current business cases. Whereas, these financial benefits may also include the benefits of introducing flexibility in the development of any project and/or measure at PoRA.

In addition, the introduction of flexibility may generate some extra costs, these might be considered as well as shown in Figure 5-2.

Summing up preceding stages results in the balance of a project and/or measure. Therefore, when all these parameters are properly included and assessed, both at the cost and benefits side, a positive balance of them might directly represent sustainable and flexible projects.

Definitely, there is clear the need to check the outcomes in detail. However, once this process becomes a common practice at PoRA, it is expected to become a comprehensive and useful way for enriching the decision-making process to develop new projects at PoR. Otherwise, all these steps can also be individually assessed and used as additional techniques for enhancing current decision-making process. Therefore, current business cases can be complemented with the estimation of ecosystem services benefits and the resulting balance of introducing flexibility in a project. Indistinctly the preferred methodology, it is highly recommended to review current practices for performing business cases.

Aside of reviewing current financial business cases towards a complete valuation approach; the used payback period for business cases may also be examined. Particularly, it would be interesting to employ as payback period the lifetime horizon of the basic infrastructure under development. A different possibility may be assigning a residual value within current financial business cases to the assets after present financial horizon of 25 years. So, discussing diverse payback and depreciation periods within the financial analysis related to each infrastructure development is also recommended. Categorically, this stresses once again the need for reviewing current approach of performing business cases.

As a result, it is recommended to perform comprehensive (not only financial) and individual business cases for a project, and for a whole port area under development.

Business cases also need to be continuously followed and updated during the whole lifespan of any implemented solution. Certainly, it is recommended to include it within regular update cycles, because flexibility may also imply the implementation of flexible budgeting techniques.

At last, a close control of the benefits is also very important for impairment indications, and for checking whether the basic assumptions of a business case are valid or not after a certain period of time. This is currently done for MV2, and it might result interesting to extend this practice to other port areas within the Harbour Industrial Complex.

## 5.5. Conclusions

This concise chapter briefly provides a general guidance to further implement Adaptive Port Planning based on the outcomes of the research. Furthermore, basic concepts for developing a risk-based tool are briefly introduced in section 5.3. These are attained through the application of Adaptive Port Planning framework for Europoort. Furthermore, this can be easily extended to whole Harbour Industrial Complex. Certainly, it is a powerful tool for every “Gebiedsmanager” at Port of Rotterdam Authority.

In addition to the success indicators identified in *Chapter 3* subsection 3.4.9 *Optimised list of success indicators for Europoort*, it is also important to mention the notorious need for PoRA to monitor terminal’s facilities to pursue a continuous enhancement of PoR performance.

The “Europoort Midden” is initially analysed in more detail, because after an extensive study, it is identified as a critical area from the planning perspective within Europoort.

Moreover to compare project’s alternatives, it is clear the need for reviewing current appraisal for performing (and monitoring) business cases used for the decision-making process.

Consequently, a theoretical combined approach for valuating flexibility, social and ecosystem services is provided. This answers research SQ6; however practical applications need to be further investigated. This chapter thus contributes an extra step towards achieving an all-inclusive method for valuating port development projects (incorporating flexibility, social and ecosystem services).



# Chapter 6. Implementation of APP at PoRA

Providing a set of guidelines to implement “The Flexible Port” (Taneja, 2013) philosophy within the organisation is as important as providing the technical steps to successfully adopt it as common practice at PoRA.

As extensively described in previous chapters, AAP framework also requires flexible organisations and management, and the inclusion of flexible contracts (described in subsection 2.2.9) amongst other instruments, are essential to be put into practice. Hence, in this chapter research SQ7 is systematically answered:

## **How can APP framework be incorporated in a comprehensive way into existing planning organisational processes at Port of Rotterdam Authority?**

Some other techniques and approaches relevant to this study are recommended to offer additional guidance for PoRA. These are: Strategic Stakeholder Management (subsection 2.1.6); Opportunity Framing (subsection 2.2.6); Value Engineering (subsection 2.2.7); and Lifecycle Management (subsection 2.3.7).

Additionally, several assumptions related with PoRA internal organisation are identified as direct outcome of carrying out the second step of APP framework. Those assumptions are also treated during the workshop sessions described in *Annex B Workshop: Success & assumptions*. Thus, are classified as vulnerabilities and opportunities. Finally, these are clearly summarised and distinguished in section B.4 Overview of the vulnerabilities and opportunities of *Annex B*. Accordingly, actions related to them are also listed in this chapter, specifically in the following section.

### **6.1. Some recommended actions**

Table 6-1 and Table 6-2 summarise main identified opportunities and vulnerabilities. Correlated actions are easily deduced from each of the statements.

Basically, direct efforts to realize most of the opportunities are needed. In addition, measures to reduce acknowledged vulnerabilities have to be identified, before executing them.

**Table 6-1 Certain opportunities and vulnerabilities related to PoRA internal organisation**

<b>Vulnerabilities</b> (certain)	<b>Opportunities</b> (certain)
* The only link between clients (potential and existing) and PoRA are the commercial managers.	<p>* Conceptual designs (phase 0) for new or existing clients are always performed with a full multidisciplinary team of professionals (including asset manager, environmental professional, “Gebiedsmanager”, financial expert, project engineer and possible future project manager).</p> <p>* PoRA has strong technical professionals. It is a worldwide front-runner company in the field of technical innovation, leading international best practices. PoRA is not only a management company; it also develops first-class technical know-how in the medium- and long-term.</p>

Table 6-2 Uncertain opportunities and vulnerabilities related with PoRAs' internal organisation

Vulnerabilities (uncertain)	Opportunities (uncertain)
<p>* There is a shortage of (skilled) labour in the region in the long-term.</p>	<p>* Excellent communication &amp; cooperation amongst PoRA internal departments is fully achieved.</p> <p>* <i>Predicted IRR (in a business case) is achieved during the commercial lifecycle of a project and internally controlled (also stated) for each terminal.</i></p> <p>* Once the construction of a project is finished (capitalised), PoRA assigns a multidisciplinary team ("Gebiedsmanager", financial controller, environmental controller and asset manager) to control the estimated asset performance during the lifecycle.</p>

### 6.1.1. Creating synergy to better serve clients and PoR development

Currently at PoRA, Business Developers (BD) in close cooperation with Business Analysis & Intelligence (BAI) department are constantly looking for new business opportunities to be developed at PoR. Thus, if opportunities arise, these are transferred to the Business Managers (BM), whom share the necessities of new or existing clients with each area related "Gebiedsmanager" to initiate potential projects requested by a company. Certainly, this is the case if projects are not directly initiated by the BM to be further analysed by the Consultation Board ("Driehoeksoverleg"), as it is explained in subsection 2.3.3 *Project development process*.

After several months of shared time with every "Gebiedsmanager" at PoRA, it is noticeable that present communications between "Gebiedsmanagers" and Business Managers are not as fluent as needed to reach the envisioned synergy for a worldwide front-runner company leading international best practices. This is a certain vulnerability for Port of Rotterdam, and it might remain like this unless something is adjusted at PoRA internal organisation. Consequently, more efforts are needed to improve "Gebiedsmanagers" and Business Managers cooperation. On top of current annual meetings included in the annual masterplan cycle (Figure 2-11), and the spontaneous meetings held during the year, some actions might be taken. Perhaps, this can be done by regular and frequent meetings, or even more by physically sharing the same working space (floor and sector) within the World Port Centre.

This research proposes that Business Managers cannot be the only professional link between PoRA and the different companies operating at the Harbour Industrial Complex for port development purposes. Others and more fluent channels of communications between terminal's needs and professionals dealing with the improvement and growth of the port require to be enforced. Of course, Business Managers may remain as core commercial contact professionals. However, it is advised to include pertinent "Gebiedsmanagers" within some of the regular meetings between Business Managers and terminal's professionals when treating possible new developments. However, of special interest is the organisation of meetings among Business Managers, "Gebiedsmanagers" and those professionals dealing with the strategic planning of the companies operating at PoR. Although this may appear as a difficult step to accomplish, it is advised to include these multidisciplinary strategic planning meetings in the agenda, especially when reviewing medium- and long-term prospects. Furthermore, including some professionals from Corporate Strategy and Business Analysis Intelligence departments during the strategic planning meetings may be fruitful as well.

### 6.1.2. Enhancing internal communication

In line with precedent subsection appears one of the greatest opportunities found within PoRA organisation: “Excellent communication & cooperation amongst PoRA internal departments is fully achieved in the short- and medium-term”. It still emerges as an uncertain opportunity because the potential for a larger integration is rather high. Currently, each department holds weekly meetings, usually with presentations from other departments. However, increasing the actions towards more fluent internal communications is recommended.

Intensifying cooperation and communication amongst every PoRA internal department should be taken as a key driver for attaining the goal of becoming “The” global model for Port Authorities. Certainly, this is simple to write, but it is not easy to achieve it. Thus, management and professionals should be continuously encouraged to cross interdepartmental borders. For example, setting rotating monthly meetings or workshops between two departments is something that may enhance internal communication; This can also be done at team level within each department. Nonetheless, this topic is out of the scope of the research, but it is important to address the need for additional actions.

Finally, it is interesting to point out that for this research some actions are expressly taken to spread the voice about Adaptive Port Planning and the ongoing work for Europort within many departments at PoRA, TU Delft and international events. Some remarkable actions were the round table discussion sessions carried out during the Port Management Program with more than twenty participants from seven different countries in September 2014 as part of the cooperation of “Jong HbR” with PoRInt; and a daily international PIANC YP-Com meeting held at Port of Rotterdam with professionals from PoRA and participants from Singapore, Brazil and The Netherlands.

### 6.1.3. Initiating projects with multidisciplinary teams

Currently, a project is primarily initiated on Phase 0 according to the project development process. This is done either by Business Managers or “Gebiedsmanagers” as it is shown in *Figure 2-16* and *Figure 2-17*, section 2.3.3 of *Chapter 2*. Thereafter, if the proposal is approved by the Consultation Board (“Driehoeksoverleg”), a complete team is set to build up the project under the coordination of a Project Manager, but without the participation of the “Gebiedsmanager” or Area Manager. Nonetheless, the involvement of “Gebiedsmanagers” is still possible, though subjective to the Project Manager who can always consult them in case is considered necessary.

Based on these discussed facts, starting every conceptual project with full a multidisciplinary team is identified as the second foremost opportunity within PoRA internal organisation.

It is noticeable that described practices may hinder the sufficient maturity to implement long-term planning solutions which can efficiently serve both PoR and the clients during the whole infrastructure lifecycle.

Thereafter, it is at this stage where it is highly recommended to put into practice *Opportunity framing* and *Value Engineering (VE)*. Both methodologies introduced in *Chapter 2 Literature review* can be implemented either in Phase 0 and/or Phase I of the project development process within PoRA. These definitely would help to systematically structure the starting of a project to materialise a flexible port development.

Consequently, it is suggested setting a Phase 0 multidisciplinary team for starting each project (conceptual design) and for defining its design basis in a very expedite way (e.g. two or three brain storming team meetings).

This group of professionals may be organised by each pertinent “Gebiedsmanager”, including specialists from Port Development (Project Engineer, Designer and Project Control) and advisors from Asset Management, Environmental Management, Harbour Masters and Investments & Risk Management. The inclusion of a Project Engineer and a Project Controller is supported by the idea of starting and keeping the fundamentals of project during the whole project development process. In other words, both professionals might start the conceptual design in phase 0 and remain as core members of the project team until the end of phase IV (closing a project) as showed in Figure 2-17 and Figure 2-18.

This advised multidisciplinary team structure for Phase 0 is shown in Figure 6-1. The proposed team structure includes mentors and/or peer review from the innovation teams, because this may increase the possibilities of introducing flexible solution and creating more value in every project. Nonetheless, before initiating the proposed Phase 0 team an approval from the “Driehoeksoverleg” would be needed to allocate the required professional resources to develop the conceptual design and to set the design basis.

In addition, the proposed objective for this team is intrinsically related with Opportunity Framing; thus it is reduced to the outline of projects’ scope; the identification of the project success; and setting up the essential values for it with a possible SWOT. This can be directly structured throughout the first three steps of *Value Engineering (VE)*: Preparation, Information and Function Analysis.

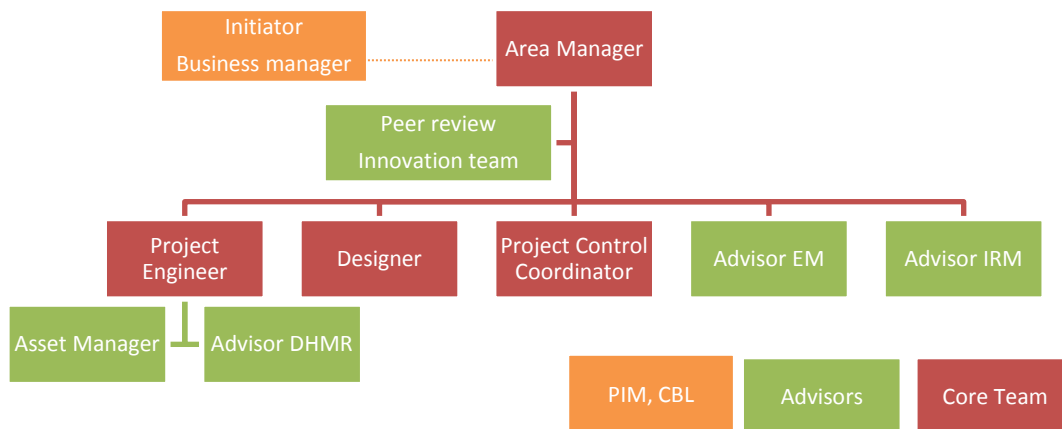


Figure 6-1 Proposed project team composition for Phase 0 to draft a conceptual design and set the design basis

At last, the conceptual project is proposed by the Phase 0 team to the “Driehoeksoverleg”, and if approved, then the project moves forward to Phase Ia. Furthermore, it is recommended to include the “Gebiedsmanager” as part of the advisors of the Phase I project team shown in Figure 2-17.

Moreover, it is advised to keep following the methodologies proposed within Opportunity Framing and VE. Predominantly, these are the remaining phases to be executed: Creativity (with an Opportunity framing workshop), Evaluation, Development, Presentation (stakeholders’ engagement), and Report & Implementation.

Singular awareness should be given to the Development phase, which is related with the selection and elaboration of those project alternatives maximising value thru the inclusion of flexible designs, social benefits and ecosystem services considerations.

To conclude, a re-evaluation of current alternatives' selection process needs to take place, and reviewing the business case approach is mandatory.

#### 6.1.4. Are present business cases leading to a long-term sustainable growth?

As mentioned before in subsection 2.3.4 *Business decision-making throughout business cases* of Chapter 2, business cases are only financial analyses for 25 years and pursuing to achieve a fixed IRR. Furthermore, business cases are only prepared for the selected alternative.

Consequently, it is advised to at least financially appraise with individual business cases each different alternative developed within the selection process approach. Although, robust or lifecycle adaptable proposals may not result selected due to adopted payback horizons, or due to the lack of including other valuation parameters (e.g. flexibility, social and/or ecosystem services); this would be the first step to enhance current practices.

For example, current financial business cases can be easily combined with a MCA, or directly with Portfolio Management matrixes (subsection 2.3.6) to attain a more objective selection of alternatives. Of course, combining business cases, either with a MCA or a Portfolio Management matrix, imply the need to perform them at the same time of thinking alternatives, and not when once is decided. This is graphically shown in Figure 6-2.

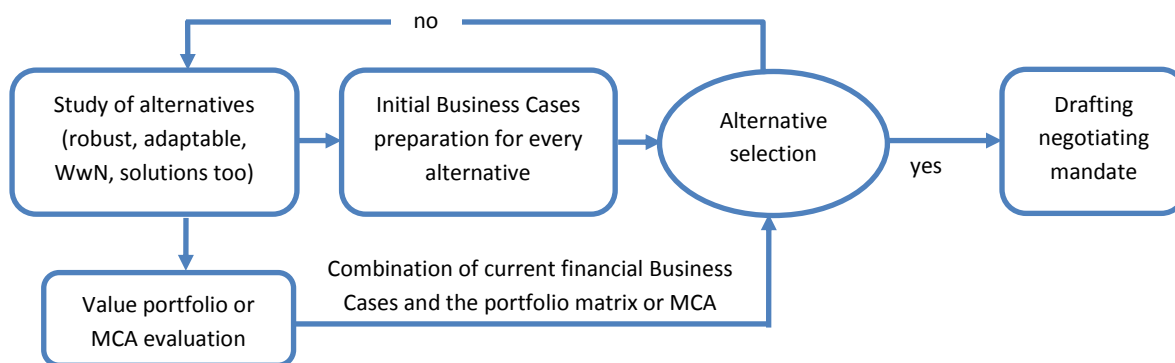


Figure 6-2 First steps towards including flexibility and ecosystem services in current alternative selection process

A review of present business case process is advised in Chapter 5 section 5.4 *Other valuation tools for comparing project's alternatives*. Nonetheless, the approach presented in this section is foreseen as a transition step in the organisation. These given reflections in allusion to decision-making process have the intention of creating awareness to improve present practices for long-term sustainable growth.

Furthermore, all the presented recommendations in this subsection and in section 5.4 can be provided in the form of a simple decision-making support chart that clearly states every obtained value and scores (e.g.  $\epsilon_{\text{Financial}}$ ;  $\epsilon_{\text{MKBA}}$ ; MCA; Portfolio, et cetera) together with a brief explanation of the choices and most relevant adopted decisions to help the management to make a choice.

### 6.1.5. A closer look to monitor facility performance

This subsection aims to communicate the need to have a closer look at every facility performance during the whole lifecycle. Monitoring their technical conditions is highly important as explained along the report, and particularly in *Chapter 5*. Equally significant is controlling the financial performance of every investment during the entire lifecycle; whereupon there is a prominent necessity to strongly control business cases and their expected results. Business cases (financial, or including SCBA with ecosystem considerations and/or ROA) should be a dynamic tool tracing terminals' or areas' performance during the complete service life of any asset at PoR, and not a static financial exercise. These needs are already evidenced and agreed during the individual meetings held with several of the professionals listed in *Annex A Interviews: PoRA & external experts*. Main of those findings are summarised in subsection 2.3.5 *Control of investments of Chapter 2*.

This is closely correlated with one of the uncertain opportunities associated with the internal organisation of PoRA. Therefore, once the construction of a project is finished (and capitalised), it is recommended assigning a multidisciplinary team from PoRA to control the estimated asset performance during its lifecycle. The proposed team includes the following professionals: Business Manager, "Gebiedsmanager", Financial Controller, Environmental Controller, and Asset Manager.

To sum up, business case predictions, terminal's and facilities' performance also require to be closely controlled by an expert team after a project is capitalised. This is named as Performance Management.

### 6.1.6. Keeping world-class skills in Rotterdam

At last, in order to avoid a shortage of regional (skilled) labour and to remain as world-class company with strong technical professionals in the medium- and long-term, several actions may be proposed. However, investing in education at regional level, and teaming up with top level universities is foreseen as a primordial goal. Thereafter, from the planning perspective this can be encouraged by involving neighbouring municipalities and every professional related stakeholder to develop regional training centres within the surrounding communities.

With no need to elaborate more in this topic because it is out of the scope of the research, it is the aim of the subsection addressing its importance for medium- and long-term planning of Port of Rotterdam as a whole.

## 6.2. The role of the "Gebiedsmanager"

Every discussed item generates the questioning of current functions of the "Gebiedsmanagers" or Area Managers at PoRA. From the name, it is understood as a purely operational role as shown in subsections 2.3.3 and 6.1.3. Nevertheless, as "Gebiedsmanagers" are circumscribed within Port Planning (PD-PP), they are also expected to deal with the planning of the Harbour Industrial Complex. Consequently, their role is also related with the development of an area, mainly through the translation of present medium-term strategic vision of the port into each area, as discussed in subsection 2.3.1.

It is also important to note that current role of "Gebiedsmanagers" relies on each individual character and professional attitude. Some are more advocated to daily tasks on the operational side, thus on short-term actions (Area Manager). While others are more devoted to strategic planning, hence medium-term planning (Area Developer). Yet, they try to combine both functions.

In one way or another, existing “Gebiedsmanager” role does not consider the required workload to incorporate APP framework in a comprehensive way into existing planning organisational processes at PoRA. Hence, provisions need to be taken to integrate the procedure carried out within this research, either for repeating the approach in other port areas, or for monitoring and updating Europort Masterplan 2030+. Apprising MP7+ (TGI et al., 2013) developed for MV2 some years ago is also foreseen. Consequently, it is anticipated that the responsibility of incorporating and following the proposed approach in this research might rely within Port Planning. Additionally, to attain a better understanding of every described role, a summary chart is presented in Figure 6-3.

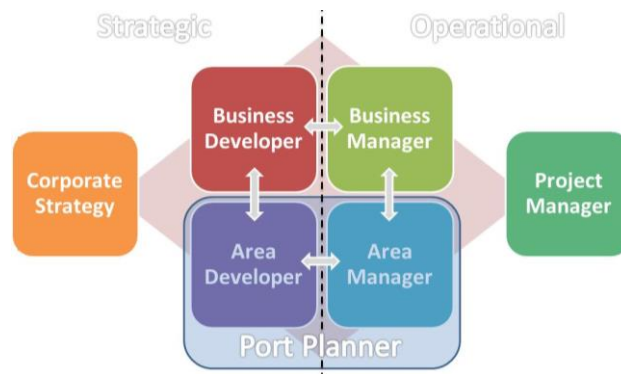


Figure 6-3 Area Manager (“Gebiedsmanager”) + Area Developer = Port Planner at PoRA

Finally, it is possible to conclude that “Gebiedsmanager” or Area Manager function nowadays is much more than the one indicated by its name. Moreover, the given name tends to misconceive the role. Thus, this research intends to propose re-naming this function as Port Planner, and to include within their umbrella the incorporation of APP framework in a comprehensive way for each port area at PoR, as done throughout this report for Europort.

### 6.3. Proposed actions for enhancing decision-making process at PoRA

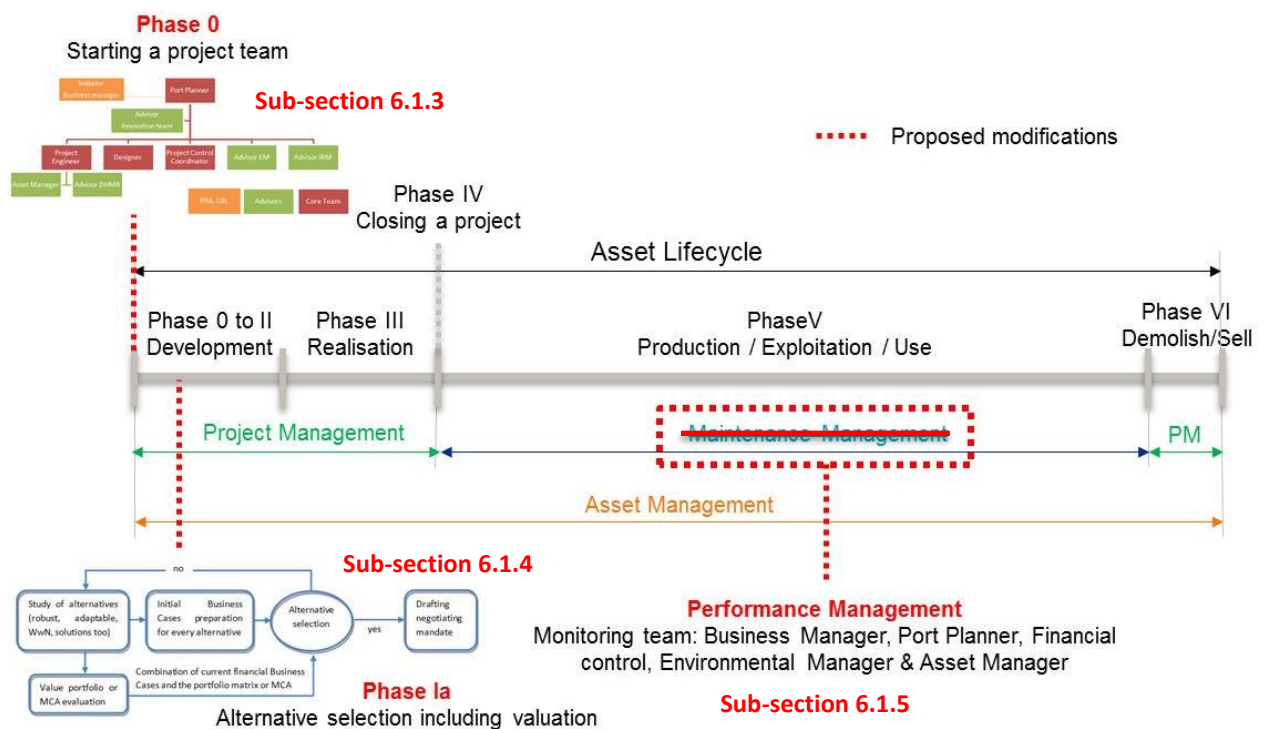


Figure 6-4 Some of the proposed modifications within the decision-making process at PoRA

The set of provided actions and proposals of this chapter is outlined in Figure 6-4. It is noteworthy that this summary totally matches with lifecycle management approach discussed in subsection 2.3.7 of *Chapter 2*.

Finally, it is also important to point out that the distribution of each proposed task depends on internal decisions within Port Planning, to then pursue greater agreements within PoRA.

## 6.4. Conclusions

Concise actions to implement APP at PoRA are given throughout the whole report. Particularly, steps to implement APP in the masterplan are given in *Chapter 3*, *Chapter 4* and *Chapter 5*.

In this chapter, precise recommendations to adapt current internal organisation and project development process are presented. Some general guidance is also provided to pursue this goal.

Of importance is the review of current procedures for initiating any project and the decision-making methodology based on purely financial business cases. Additionally, recommendations are given to attain insights in the investments, and not only the overall picture.

As conclusion, guidelines are provided in this chapter to successfully implement APP framework at PoRA. This process started with the implementation of APP steps for the Europoort area within Port Planning (PD-PP) in *Chapter 3* and *Chapter 4*. Then, it continued with some guidance for a specific case study that includes valuation tools in *Chapter 5*. And with the final suggestions, this chapter answers research SQ7.



# Chapter 7. Conclusions & recommendations

This study was not always a simple and straightforward enterprise due to the ambitions set in the research proposal. One of the main challenges was to narrow down such a broad topic, and converge into specific actions.

Nonetheless, it is possible to assure that every initial objective is exhaustively accomplished. The main research question is methodically answered throughout successfully addressing each of the seven research sub-questions (SQ). This is visualised in Figure 7-1.



Figure 7-1 MSc structure with main research question, every correlated sub-questions and chapters

Most of the conclusions are easily found within the report at the end of each chapter; hence, it is not the intention to fully repeat all of them here. Consequently, only a summary of the followed process, main findings and final remarks regarding the carried out research are shared in this last chapter.

*Chapter 2* summarises the wide-ranging literature review performed. This was primarily focused on understanding the frameworks for improving the Europoort planning process, current internal organisation at Port of Rotterdam Authority (PoRA), core decision-making procedures to develop the port, and possible long-term external challenges for the Europoort area.

Some of the studied documents within the *Literature review* state that 2030 is very close. Meanwhile, some others consider that is too far ahead. Naturally, this is related with the different functions in the organisation. Nevertheless, the point is that for port planning strategies no longer time-horizons are contemplated at PoRA, although it already states *flexibility* as a key component for future development of the Harbour Industrial Complex. Therefore, it is clear the need for maturing an even more robust and long-term vision beyond 2030. Consequently, it is relevant for PoRA to re-adapt its strategy without considering only one-path approach for a medium-term horizon. Start maximising long-term opportunities for the port complex now, is a must to build on PoR future strengths.

This initial part of the study also describes present state of Europoort, consequently it comprehensively addresses research SQ1. From this study, it is important to point out the necessity of adapting present course of action towards a more dynamic, sustainable, and pro-active corporate attitude as well. In addition, a comprehensive scenario analysis was carried on to identify main challenges for Europoort.

Current objectives are identified from the multiple information sources, especially for enhancing even more Port of Rotterdam character as Europe's Industrial Cluster, it is needed to keep strengthening the Fuel Hub and Energy Port (including the Chemical Cluster). In order to achieve this, it is mandatory to pursue an optimum use of the land and the infrastructure (co-siting and supply chain enhancement too). In summary, it is already clear from the beginning that sustainable growth (license-to-grow + license-to-operate) is the only possible way to succeed.

*Chapter 3* provides all the insights for systematically applying APP framework for the Europoort area. This chapter represents the core of the research. Firstly, a comprehensive definition of success for existing port areas, particularly for Europoort is provided after analysing current goals (research SQ2). Secondly, main underlying assumptions within current Europoort masterplan are attained from the worked out definition of success, the literature review, and several meetings held with professionals at PoRA (research SQ3). Then again, these underlying assumptions are critically analysed to be classified as vulnerabilities or opportunities in the medium- and long-term for Europoort and in a broader way for Port of Rotterdam in general (research SQ4). Finally, actions to increase the robustness of current Europoort masterplan are provided; some of given the actions are explicitly for this port area, meanwhile others are recommended for a positive implementation of future-proof plans for the Harbour Industrial Complex as a whole (research SQ5).

In section 3.4, a complete *Definition of success* for existing industrial harbour complexes is given. This is done in particular for Europoort answering in this way research SQ2. It is imperative to clarify that almost every existing indicator requires modifications from current versions, to carefully define and evaluate the success. Moreover, expressly focused indicators for Europoort are recommended to be introduced. These are specially developed for this report, or compiled from ongoing studies within Port Planning and other PoRA departments. As final point, most of the given recommendations are based on possible improvements attained from all the combined outcomes (literature review, interviews, workshop sessions at PoRA, congresses, et cetera). This approach is the initial step for establishing a common practice within Port Planning department (PD-PP) at PoRA. The proposed definition of success can be also used for Botlek and Maasvlakte due to prevailing similarities with Europoort. For port-city areas, it is suggested to reproduce the procedure from the beginning to attain distinctive indicators in order to specifically assess the success for this type of port zones.

The optimised list of indicators for defining success in Europoort consists of 11 high-priority and 10 medium-priority success indicators. Some noteworthy and distinct indicators are:

- Quay & jetty productivity per cargo segment and by specialised activity [tons per m]
- Serviceability lifetime over predicted payback time-horizon for investments
- Terminal productivity [tons per Ha]
- Relate employments generated at PoR with employees welfare (reducer of inequality)

The attempt to define success of an existing port area is considered as one of the core parts of the research due to its uniqueness, and the obtained outcomes.

Thereafter, for accurately answering research SQ3, which is also discussed in *Chapter 3*, it was necessary identifying every presented statement in the definition of success and current masterplan to recognise their *Underlying assumptions*. In total eighty two (82) underlying assumptions are summarised in section 3.5. These are the direct consequence of an extensive research and mainly long-term scenario analysis for Europoort that included previous studies from PoR (Maasvlakte 2 MP7+ & PoR Energy Scenarios) and several external sources (RWS, US Coast Guard, OECD, OPEN, Club of Rome, NIC, among others), congresses proceedings, technical papers, and numerous individual meetings with PoRA and external professionals. These are the assumptions that afterwards are classified into vulnerabilities and opportunities based on experts' judgement by the same professionals whom were involved during the workshop session, and the "flexible workshop" described also in *Annex B*.

Then, *Vulnerabilities and opportunities for each planning-horizon* related to PoRA internal organisation, and Europoort planning are recognised. Therefore, it is possible to state that research SQ4 is comprehensively addressed in section 3.6. Of the already mentioned initial eighty two (82) underlying assumptions, thirty four (34) are fully assessed due to time constraints. This resulted in twenty three (23) opportunities (eleven -11- certain and twelve -12- uncertain) and eleven (11) vulnerabilities. Furthermore, every underlying assumption is carefully considered to provide final recommendations and actions to be incorporated within the planning of Europoort.

On the one hand, top three most relevant opportunities for Europoort are:

- Development Energy Port cluster (reuse and regrouping of existing plots thru flexible planning)
- Enormous potential of Europoort for enhancing the surrounding environment towards a sustainable growth. Integral planning goes beyond port boundaries.
- Development of flexible basic infrastructure at PoR (multi-user and multi-purpose character of the basic infrastructure).

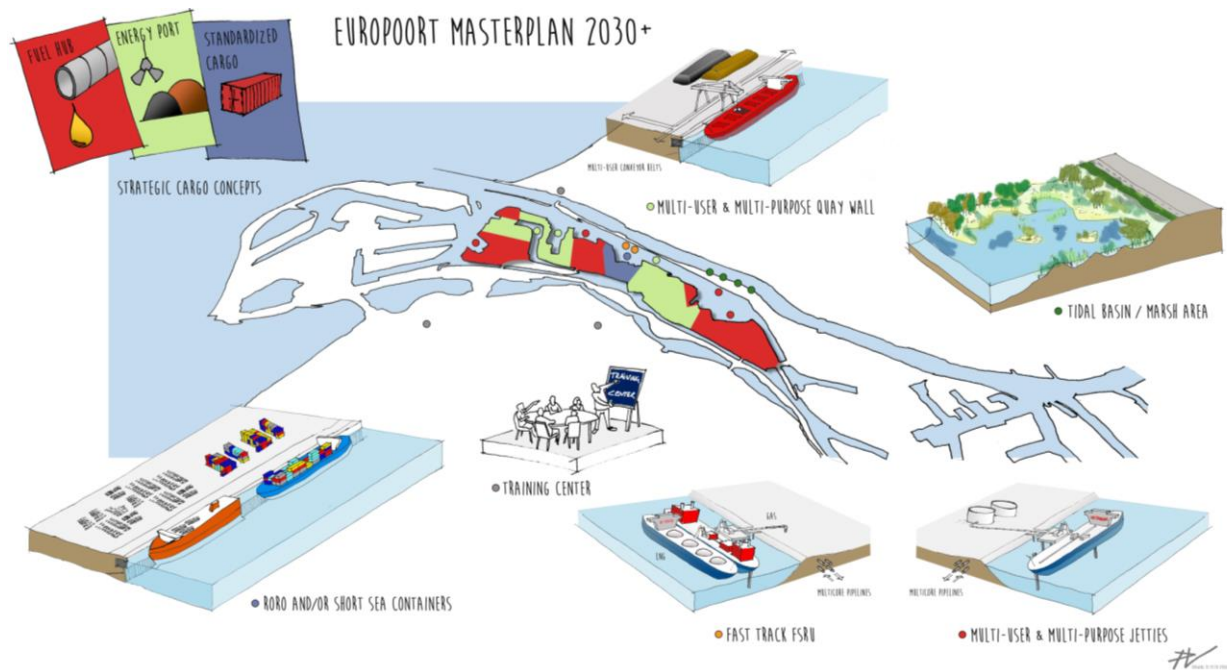
On the other hand, the weakest points are:

- Non-consideration of opportunities for "temporary" use of unallocated plots. In other words, maintaining a low level of flexibility for starting port related activities within the Harbour Industrial Complex.
- The debate "food for fuel" may challenge bio-based developments; this is related with future bio-based maturity level at global scale.
- LNG may be regarded only as transition fuel, and finally trade in Europe is impacted by global power shifting. Related with the role of fossil fuels as main energy source in the long run.

Afterwards, section 3.7 deals with *Actions to increase robustness & flexibility during planning phases* of current Europoort masterplan. These outcomes represent the answer to research SQ5 and introduce core modifications in existing planning practices at PoRA. Some of them are in connection with certain present lines of innovation within the organisation; most of them are completely matching with foremost of the reviewed literature; and at last, a few innovative proposals are introduced as well. One of those innovative suggestions, is mainly related to long-term planning course of action. Although, Chapter 3 presents the entire procedure for reaching up a robust masterplan throughout answering research SQ1 to SQ5; it is in Chapter 4 where APP framework is thoroughly materialised as a long-term masterplan for the Europoort area. This is named **Europoort Masterplan 2030+**.

Chapter 4 *Europoort Masterplan 2030+* is the final step to achieve a robust long-term planning for Europoort. It is important to note that every action and the whole procedure are the direct consequence of applying APP framework. Even though at a first look, some of the proposed actions may appear as disconnected points; all of them are methodically obtained in a structured way through critical thinking. In conclusion, this proposal is found as a practical and systematic combination for collecting all the attained outcomes with a very straightforward technique.

Instead of focusing in specific cargo segments (e.g. coal & iron ore, refineries, oil storage, biomass, et cetera). **Europoort Masterplan 2030+** proposes to cluster them under strategic cargo concepts for long-term planning. This is easily appreciated, with some other actions, in the following artist impression.



These strategic cargo concepts are something already familiar for Port of Rotterdam, but not used for planning purposes before. Particularly for Europoort these are the ones considered:

- Energy Port
  - biomass, coal, agribulk, mineral products, et cetera
- Fuel Hub
  - oil, bio-based oil, LNG, syngas, hydrogen, et cetera
- Standardised Cargo Port
  - short sea containers, RoRo, Feeders, et cetera

The aim of this way of planning is to link each strategic cargo concept with flexible basic infrastructure that can accommodate every cargo segment contained within each strategic cargo concept during the service lifetime. This is idealised for reaching a maximum matching level between the design, economic, commercial and compliance lifetime to maximise the service lifetime of the basic infrastructure.

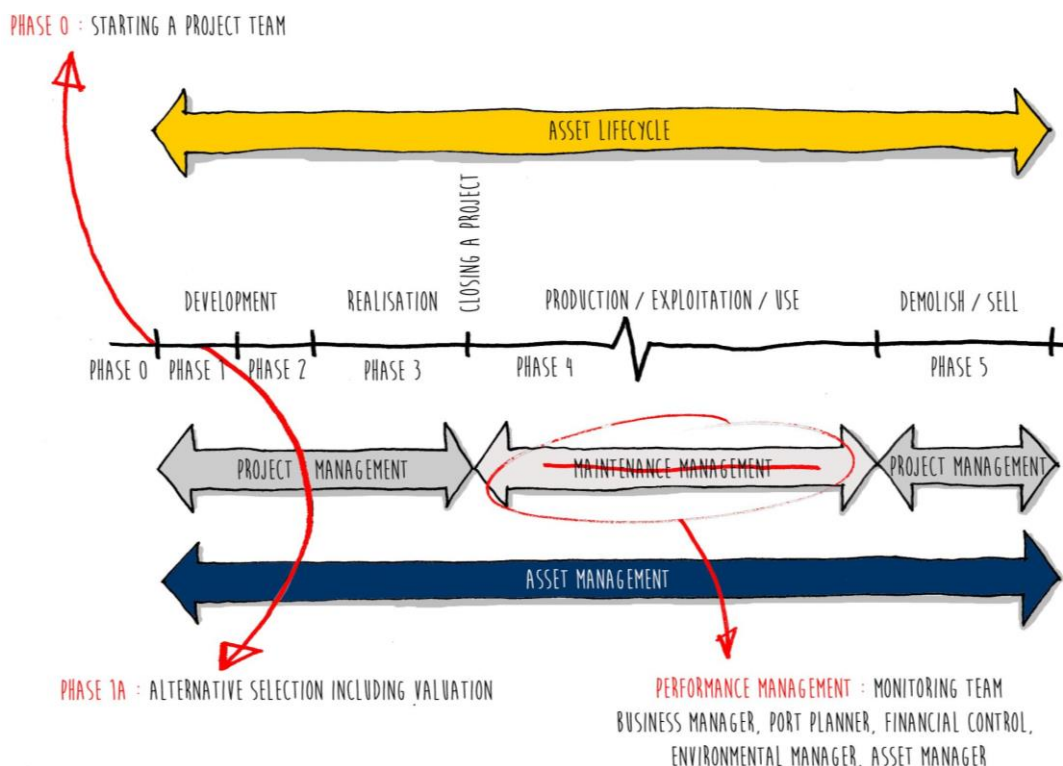
*Energy Port* is associated with multi-user and multi-purpose quay walls. This can be either robust or flexible. A robust quay wall is designed considering all possible loads during the service life of the basic infrastructure and also on the nearby storage yard; it can accommodate all these type of cargo and ships related with Energy port. Meanwhile, a flexible quay wall allows predicted future reinforcement in

case maximum cargo loads are achieved in the area (e.g. additional line of anchorages or pneumatic caissons, et cetera). *Fuel Hub* is related with multi-purpose and multi-user jetty. These proposed type of jetties can be used and/or adapted for any of the included cargo segments within this strategic cargo concept (or some smaller range or cargo type). This includes standard dolphin designs and configurations prepared for many possible cargo vessels affected to this strategic cargo concept. *Standardised Cargo Port* is linked with multi-purpose quay wall for containers and RoRo (lower loads than Energy Port quay walls). For Europoort, it is thought either to replace the container short sea hub in the Waal- Eemhaven (expecting also an increase on the size of the vessels), and/or to develop a RoRo cluster.

Furthermore, it is clear that port planning cannot stay constricted to the port area itself. Therefore, including the surroundings into a more comprehensive masterplan is totally advisable.

*Chapter 5* gives a general guidance to further implement Adaptive Port Planning based on the outcomes of the research. Vasic concepts for developing a risk-based tool are briefly introduced in section 5.3. These are attained through the application of Adaptive Port Planning framework for Europoort. This chapter also stresses the notorious need for PoRA to monitor terminal's facilities to pursue a continuous enhancement of PoR performance. Moreover, a theoretical combined approach for valuating flexibility, social and ecosystem services is provided. This answers research SQ6 and contributes an extra step towards achieving an all-inclusive method for valuating port development projects (with the incorporation of flexibility, social and ecosystem services).

*Chapter 6* offers precise recommendations to adapt current internal organisation and project development process. Of importance is the review of current procedures for initiating any project and the decision-making methodology based on purely financial business cases. Additionally, recommendations are given to attain insights in the investments, and not only the overall picture. These final suggestions answer research SQ7, and are summarised in the following chart.



To conclude, it is clear that Port of Rotterdam is one of the global front-runners port authorities that make the management feel confident. But, on the other hand it is obvious that huge efforts are needed to keep its place by rapidly adapting in a fast changing world. This situation becomes particularly prominent with the reluctance to shift current decision-making and planning practices because these are working out until now, or just simply due to the lack of momentum for exploring different alternatives. Recurrently, it appears that day-to-day tasks hamper the opportunity for launching systematic improvements. Thus, all this is foreseen as a critical barrier, which is mostly relying on managerial decisions. Of special interest is the final abridged list of actions for short-, medium- and long-term. All of these actions are the direct consequence of applying APP framework in combination with all the worked information. Executing each one of those proposed is clearly strengthening Europort's and PoRs' long-term development through the inclusion of flexibility pursuing a sustainable growth.

At last, but not least, these are some identified topics for further research:

- Develop floating solutions for quay walls and jetties.
- Elaborate proposals for multi-purpose jetties & multi-user jetties.
- Realise a comprehensive benchmark to assess area productivity for each type of cargo & each specific operation.
- Prepare a comprehensive benchmark to assess quay and jetty productivity for each type of cargo & each specific operation (also dividing between sea going vessels -analysing type of vessels & business- and inland barges).
- Research different ways of ranking world ports instead of using total throughput. (e.g. added value for society created by a port, port activities as reducers of regional inequality, sustainability indexes related to social well-being).
- Look for improvements on current business cases, and execute practical business cases using the proposed approach (with different valuation techniques). Consider financial situation of already depreciated assets, but generating income.
- Implement flexibility within standard contracting and procurement methodologies.
- Extend the scenario analysis with some other perspectives, especially from major Asian countries that may influence global developments (e.g. India, China, et cetera).
- Propose different business options for reusing flexible solutions for quay walls not considered until now, for example temporary uses during expansion works of terminals to avoid downtimes, or for global business terminal's operators in order to try first the market before materialising even larger investment on infrastructure.
- Look for possible measures to enhance current internal communication within PoRA departments.

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# Annex A. Interviews: PoRA & external experts

Several discussion sessions were arranged with different professionals from PoRA and external parties in order to have better understanding of the functioning of the port and to consider possible methodologies that may be useful to implement within the port

## A.1. Professionals from PoRA

Insightful discussions were organised with the professionals from PoRA listed in the following table.

Name	Department	When?
Frank van Rhee	Port Development - Contract & Real Estate advisor	20-May
Michel Bresser	Port Development - Area Manager MV1 & MV2	22-May
Jelle Peddemors	Port Development - Area Development Analyst	26-Jun
Giel Jurgens	Asset Management - Asset Owner	09-Jul
Wouter Demenint	Strategic Finance Management - Advisor	09-Jul
Ruud Melieste	Corporate Strategy – Advisor	18-Jul
Joop Verdoorn	Capacity Management - Valuing alternatives	18-Jul
Maurits van Schuylenburg	Containers, Breakbulk & Logistics - Project Manager	21-Jul
Arnoud Willeumier	Business Intelligence & Commercial Strategy	22-Jul
Albert Spencer	Strategic Finance Management - Head of Financial Control	25-Jul
Egbert van der Wal	Port Development - Project Engineers Manager	28-Jul
Marielle van Dijk	Environmental Management - Sustainable Development	05-Aug
Kees Kleinhout	Port Development - Area Manager	14-Aug
Linda Wagemans	Port Development - Area Development Analyst	29-Aug
Isabelle Vries	Corporate Strategy – Advisor	04-Sep
Victor Schoenmakers	Head of European & International Affairs	24-Sep
Joop Smits	Manager of Environmental Advising & Consulting	26-Sep
Bas Henissen	Vice President Industry & Bulk Cargo Business	07-Oct
Monique de Moel	Energy & Process industry - Business Manager	
Alfred Roubos	Port Development - Project Engineer	31-Oct
Jasper Hoes	Port Development - Project Control	03-Dec
Pieter Nordbeck	Harbour Master Division – Advisor	04-Dec
Rob Sibbes	Harbour Master Division - Sector coordinator	04-Dec
Wim Hoebee	Harbour Master Division - Unit Manager & advisor	18-Dec
Sjoerd Figdor	Port Development - Project Management	23-Dec
Mark Franken	Project Management and Realization	24-Dec

## A.2. Professionals from external organisations

External experts from different companies, governmental agencies and universities highly contributed with their knowledge and experience in this research throughout meetings and/or e-mails exchange.

<b>Name</b>	<b>Department</b>	<b>When?</b>
Elisabeth Ruijgrok	Witteven + Bos	29-Jul
Milou Wolters	Rijkswaterstaat	25-Sep
Anne Cann	United States Army Corps of Engineers – USACE	10-Oct
Ricardo Schwarz	Academia Nacional de Ingeniería - Argentina	05-Nov
Jan Willem Koeman	Port Consultants Rotterdam	19-Dec



# Annex B. Workshop: Success & assumptions

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A two hours' in-house workshop session was organised on October 6<sup>th</sup>, 2014. The title for this activity was: "Europoort success, vulnerabilities & opportunities".

It was meant for discussing the identified definition of success and for evaluating possible indicators to achieve it. The vision and planning underlying assumptions for Europoort were extensively debated.

The program of the event was as follows:

15:00 – 15:50 Success for Europoort

- Short presentation introducing the different categories for success and what is currently defined as success for PoR, and specifically for Europoort.
- Individual digital surveys to analyse and weigh the identified indicators (and KPI's) affecting each category (possible vulnerabilities). Online review of the given answers for each category. Discussions and reflections.
  - Competitiveness survey: <http://goo.gl/forms/clkX2mvbfM>
  - Financial survey: <http://goo.gl/forms/6V3Q6znEzy>
  - Use of space survey: <http://goo.gl/forms/7hDJyoa96r>

16:00 – 16:10 Coffee break

16:10 – 16:45 Success for Europoort (continuation)

- Hinterland Connections survey: <http://goo.gl/forms/GBj0wABuvn>
- Economic & social survey: <http://goo.gl/forms/9weoFXpL9c>
- Environmental implications survey: <http://goo.gl/forms/1ou4kwPTJo>
- Safety survey: <http://goo.gl/forms/XihqA4mSAs>

16:45 – 17:00 Analysis of underlying assumptions

- Brief presentation of the already identified assumptions underlying the definition of success. These are related to possible port developments from the literature review, interviews with professionals at PoRA listed in *Annex A*, and similar initiatives carried out for other areas of the port (e.g. MV2). Definitions of proposed planning time-horizons and categorisation of the recognized assumptions are also discussed.
- Explanation of the digital survey to evaluate the abridged list of the underlying assumptions (presented in section 3.5 *Underlying assumptions*) in two aspects: likeliness of occurrence and conceivable effects for Port of Rotterdam (likely-not likely & negative-positive). The aim is to classify them as vulnerabilities or opportunities based on this appraisal.
  - Vulnerabilities & opportunities survey: <http://goo.gl/forms/w7bONxvr4o>
- Wrap-up and final discussions.

The participants involved in the workshop session on October 6<sup>th</sup>, 2014 are listed in the following table:

Name	Department
Martijn Oosting	Port Development - Area Manager Europoort
Michel Bresser	Port Development - Area Manager MV1 & MV2
Ruud Melieste	Corporate Strategy - Program Manager
Frank Wolkenfelt	Environmental Department - Environmental Manager
Pablo Arecco (Moderator)	Port Development - Port Planning

The professionals involved in the “flexible workshop” stage were:

Name	Department
Kees Kleinhout	Port Development - Area Manager Waal-Eemhaven
Albert Spencer	Financial Accounting & Control - Head of Financial Control
Tiedo Vellinga	Environmental Department - Environmental Manager
Jeroen Steens	Port Development - Head of Port Development
Marielle van Dijk	Sustainable Development - Project Manager
Alfred Roubos	Port Development – Project Engineer

The working documents of this session (also available in the provided links) can be found in the following sections.

## B.1. Success for Europoort

In this section the working documents and results of the first part of the workshop are presented.

### Surveys, summary of results & general findings

How far do you agree with the listed statements defining current **COMPETITIVENESS** success for Europoort? <http://goo.gl/forms/clkX2mvbfM>

Select one of the following five alternatives by doing a cross in the selected answer (if possible try to prioritise the most important): Agree, Agree a bit, Neutral, Disagree a bit & Disagree.

Statement	Agree	Agree a bit	Neutral	Disagree a bit	Disagree	Score [0-100]
It is very important that PoR reaches 40% of the <b>total market share</b> (in terms of throughput) in HLH range for 2030 (market share in 2013 37.5%)	7	-	2	2	-	<b>77</b>
Increasing <b>liquid bulk market share</b> (% in terms of throughput) in HLH range is important for the success of Europoort in 2030	4	4	2	1	-	<b>75</b>
Increasing <b>dry bulk market share</b> (in terms of throughput) in HLH range is important for the success of Europoort in 2030	2	5	4	-	-	<b>71</b>
Increasing <b>RoRo market share</b> (% in terms of throughput) in HLH range is important for the success of Europoort in 2030	1	3	5	1	1	<b>55</b>
Assessing and reducing <b>ship DTAT</b> (Dynamic Turn Around Time) is essential for measuring the competitiveness of Europoort	5	2	2	2	-	<b>73</b>
Recognising and improving <b>quay and jetty productivity</b> at Europoort for each cargo segment (and specialised business in each one) is vital for achieving competitiveness success	8	1	2	-	-	<b>89</b>
Identifying current <b>quay or jetty occupancy</b> for each terminal and defining associated goals for 2030 is highly important for success related to competitiveness	4	6	1	-	-	<b>82</b>

*Note: some statements are done considering the whole port area. DTAT is defined as the average time for every seagoing vessel larger than 150m, going from the sea (6-mile zone border) to the combine areas of Europoort, Botlek and Wal-Eemhaven and vice versa.*

Firstly, most of the participants agreed that **total market share** (in terms of throughput) in HLH range is a good indicator for the competitiveness success. However some of them do not feel very confident about this KPI because it reflects PoR performance in general, but it does not provide insights for any specific area like Europoort. Besides during the discussions some other important concerns appeared. Some participants think that current goals are too optimistic, mainly because they are based in one or two cargo forecasts which are not matching with current results. Finally, almost everybody agreed that total throughput does not seem to be a very comprehensive parameter for tracking competitiveness success. Although it is very easy to measure, it is not recommended to continue its use as main parameter for ranking worldwide ports. PoRA can use this as a differentiator for EU standards (or even western hemisphere standards), but for international comparisons, mainly when comparing with the largest growing ports in Asia, this is not an adequate enough indicator to recognise which are the major ports in the world. Generated added value for the society by the port, or the reduction of inequality (Stiglitz, 2014), seems a superior KPIs for addressing port competitiveness. In the meantime, it results an *intermediate priority indicator* for assessing PoR and Europoort competitiveness success.

Secondly, majority of the participants considers that **liquid bulk market share** (in terms of throughput) in HLH range is relatively important for the Europoort area due to the amount of companies from this cargo segment currently operating at Europoort. But some others mentioned that this indicator is not that relevant, because regardless the type of cargo, PoR has to improve its competitiveness. Moreover as PoR is still the largest liquid bulk port in the world, increasing its market share within this cargo segment, seems rather difficult. In contrary if one or more terminals are not performing well this will immediately affect overall PoR performance; currently this is the case with some liquid bulk terminals that are losing market share against some other terminals with newer facilities in some other NW European ports.

Then, **dry bulk market share** (in terms of throughput) in HLH range is weighed in a quite similar way as liquid bulk market share indicator was evaluated. It resulted moderately important for addressing the competitiveness success of Europoort. However it may present some important figures, due to the fact that dry bulk cargo can take full advantage of the available deep water access to Europoort. Considering **RoRo market share** (in terms of throughput) the results are little bit different, mainly because some of the participants consider that RoRo is a strange cargo segment to be handled at Europoort. Nevertheless everybody agreed that keeping the companies in the port and increasing its market share is important for the entire port, but not specifically for the Europoort area.

Subsequently, **ship DTAT** presents a large dispersion of results, after some discussions the reasoning behind this appeared. Mainly this KPI it is useful for a general overview of the ship handling time performance in the whole port, but it does not provide any insights for any of the specific areas. Therefore it is concluded that an Europoort ship DTAT is needed for enhancing the planning of the area.

Finally, concerning **quay & jetty productivity and occupancy factors**, almost everybody agreed on their importance as *high priority indicators*. Both of them are clearly connected with the efficiency of each terminal, and the ship handling capacity. Nonetheless there are still some clashes between the amount of data needed to process in order to obtain a fully detailed analysis of each terminal (even it is an already started process), and expected response time to materialise concrete planning actions. Thus it is recommended to first focus on the already well-known critical spots within the port area, and then keep extending this approach to every terminal.

How far do you agree with the listed statements defining **FINANCIAL** success for Europoort?  
<http://goo.gl/forms/6V3Q6znEzy>

Select one of the following five alternatives by doing a cross in the selected answer (if possible try to prioritise the most important): Agree, Agree a bit, Neutral, Disagree a bit & Disagree.

Statement	Agree	Agree a bit	Neutral	Disagree a bit	Disagree	Score [0-100]
It is relevant that PoRA increases the <b>revenues from port dues</b> from the companies operating at Europoort for the year 2030	1	2	6	2	-	55
It is a priority to increase the <b>revenues from rent, and ground lease</b> for the year 2030 at Europoort	4	2	4	1	-	71
It is important to assess the <b>Internal Rate of Return</b> of the investments done by PoRA in each terminal at Europoort	5	1	2	2	1	66
Distinguishing different <b>payback time-horizons</b> (in business cases) for each type of new commercial basic infrastructure investments is highly important	6	3	1	-	1	80
Assigning <b>residual value</b> for PoR assets after the estimated depreciation period is essential	5	2	3	-	1	73

*Note: some statements are for the whole port area.*

Referring to increase the **revenues from port dues** the results were mostly neutral. Most of the participants do not consider this relevant due to the fact that charging more fees to the vessels does not seem to provide additional benefits in the long-term. In contrary, increasing **revenues from rent, and ground lease**, is an indicator that achieved a higher score, although there is a large dispersion of the scores given by the participants. Those in fully agreement with this statement based their answers on the premise that increasing efficiency on the use of the land, would generate more revenues for the terminals, and consequently for PoRA as well. Additionally, if higher lease fees are asked and obtained, companies would try to achieve a more intensive use of their parcels.

Assessing different **Internal Rate of Return (IRR)** for each investment to develop a terminal received a large dispersion of scores. Large part of the participants, among them every professional from the financial department, fully agreed on assessing and controlling the IRR for each investment in each terminal referred to the original business case. This process would let PoRA to have a closer control of the investments and their associated risks. These risks can be combined for specific zones to define area success indicators. Thus, this KPI is included as an *intermediate priority indicator* for financial success. On the other hand some of the negative scores are based on the predilection of having general business cases for each cargo segments with their associated IRR, instead for each terminal. However it

is important to point out that is not convenient to take into consideration, within the business balance, already depreciated infrastructures and assets, at least when dealing with port planning and increasing efficiency. For PoR general financial performance this can cover some underlying difficulties, though to obtain an overall financial performance picture, it is useful.

Almost everybody fully agreed, or agreed up to a certain degree, that even if current business cases are performed for payback time-horizon of 25 years, it is important to discriminate **different payback time-horizons** for each type of new commercial investments. Extending business cases for basic infrastructure up to their technical lifetime (e.g. 50 years) would allow PoRA to mature higher investments for basic infrastructure in a transparent way. Besides it would also lead to larger investments from the clients at PoR (i.e. currently business cases with payback time-horizons of 25 years, approximately generates private investment for the first 15 years). Therefore infrastructure lifetime serviceability over predicted payback time-horizon is set as *high priority indicator*.

For last the last two indicators there was a common agreement almost among every participant: business cases cannot be static anymore, they need to shift into dynamic business cases with regular updates.

Several discussions raised around assigning **residual value** for PoR assets after the estimated depreciation period. With no need to stress its importance for asset management procedures, the discussion was focused on their financial perspective. Those were mainly related to their tax treatment. There was not a common agreement on this topic, and no financial success indicators can be obtained at this moment.

How far do you agree with the listed statements defining **USE OF SPACE** success for Europoort?  
<http://goo.gl/forms/7hDJyoa96r>

Select one of the following five alternatives by doing a cross in the selected answer (if possible try to prioritise the most important): Agree, Agree a bit, Neutral, Disagree a bit & Disagree.

Statement	Agree	Agree a bit	Neutral	Disagree a bit	Disagree	Score [0-100]
Recognising <b>terminal productivity</b> (tons per ha) and defining <b>individual goals for each terminal</b> in 2030 is vital for reaching a more efficient use of the land	6	4	-	1	-	<b>84</b>
It is a priority to increase the <b>revenues per ha</b> in each cargo segment (and for each specialised business) at Europoort	4	4	3	-	-	<b>77</b>
Reducing <b>area reserved</b> and <b>area options</b> for existing companies at Europoort for the year 2030 is vital for optimizing the use of the land	6	3	2	-	-	<b>84</b>
Defining a goal for <b>cargo segment share (%) of rented land</b> at Europoort in 2030 is extremely important	-	2	5	2	2	<b>41</b>
Quantifying the amount of <b>co-siting</b> companies within each terminal at Europoort is essential for tracking a successful use of the space	4	2	5	-	-	<b>73</b>

Note: some statements are for the whole port area.

**Terminal productivity** (tons per ha) sometimes seems to be not well understood. Most of the participants, not embedded in the production of this information, think that standard values can be easily obtained in order to set terminal productivity goals for each cargo segment. However when the details of the ongoing studies are presented, everybody agrees to zoom into the details of each terminal. Therefore, for the Europoort area the approach presented in subsection 3.4.3 *Use of space* is a good indicator for planning purposes and to address use of space success. Thus it is set as *high priority indicator*. Conversely a possible drawback is the amount of work required to process all the information, nevertheless large part of these tasks are already done or ongoing at PP within PoRA.

In close relation to terminal productivity (tons per ha), **revenues per ha** in each cargo segment (and for each specialised business) resulted an *intermediate priority indicator*. It is an indicator that is clearly connected to the use intensity of the land for each cargo segment and each specialised business.

**Area reserved** and **area options** are needed to allow the expansion of companies and terminals operations that are already settled or are settling at the port. Thus the reduction of these areas should be almost a natural process, after a company is operating. But only if private investments take place in

Rotterdam, and sometimes this is not the case. Hence based on current situation at Europoort, reducing not-in-use areas resulted in a *high priority indicator* to address the use of space success.

The obtained results proved that defining goals related to **land use (%) for specific cargo segments** is almost irrelevant, and not useful to apply as a success indicator for existing port areas (i.e. for green fields this may be an important success indicator, e.g. MV2).

Even the recorded results show that companies **co-siting** in the Europoort area does not seem to be very important. During the discussions this idea totally shifted. Hence the elaboration of an indicator to estimate the benefits of co-siting and the amount of integrated processes for a terminal was consider relatively important to obtain of more efficient use of space, and consequently it is included as *intermediate priority indicator* for denoting use of space success.



How far do you agree with the listed statements defining **HINTERLAND CONNECTIONS** success for Europoort? <http://goo.gl/forms/GBi0wABuvn>

Select one of the following five alternatives by doing a cross in the selected answer (if possible try to prioritise the most important): Agree, Agree a bit, Neutral, Disagree a bit & Disagree.

Statement	Agree	Agree a bit	Neutral	Disagree a bit	Disagree	Score [0-100]
Setting a <b>modal shift</b> goal for each cargo segment at Europoort is crucial to avoid future bottlenecks (specially for pipelines, railways and barges)	4	2	3	-	2	<b>64</b>
The influence of Europoort on road traffic should remain at same levels as nowadays to avoid possible future bottlenecks	1	3	3	2	2	<b>48</b>
The <b>Nautical Efficiency Index</b> (NEI) is a good indicator of the reliability of ship handling at Europoort	2	4	4	1	-	<b>66</b>

*Note: The NEI gives information on the timelines of the schedule in nautical process (difference between planned and real times on piloting).*

Setting a **modal shift** goal resulted not a very relevant indicator for Europoort, mainly due to the type of terminals based in the area (mainly liquid bulk), but if cargo segments change this indicator may play an interesting role. Then again it depends on how the infrastructure for hinterland connections evolves as well. As result of the discussions the capacity of the inland waterways, specially the Caland canal may be challenged, therefore this specific indicator related to the **capacity of the inner harbour channel** is included as *high priority indicator* to address the hinterland connections success.

Some other issues regarding **road traffic** should be constantly monitored for the whole port area, but not only for the Europoort area. If traffic originated at, and with destination to, Europoort changes, then some indicators can be develop. On the safe side trying to maintain, or even decrease, the traffic volumes generated at Europoort can be thought as a possible conservative approach. The results as can be appreciated are scattered.

The **Nautical Efficiency Index** (NEI) presents also a large dispersion of results. This is based on the fact that is an interesting indicator for the overall port, but not for the Europoort area. For planning purposes at Europoort, and its relation to the success of the hinterland connections, a specific NEI only for the area needs to be developed. Therefore this modified NEI is considered an *intermediate priority indicator* to assess hinterland connections success.

How far do you agree with the listed statements defining **ECONOMIC & SOCIAL** success for Europort?

<http://goo.gl/forms/9weoFXpL9c>

Select one of the following five alternatives by doing a cross in the selected answer (if possible try to prioritise the most important): Agree, Agree a bit, Neutral, Disagree a bit & Disagree.

Statement	Agree	Agree a bit	Neutral	Disagree a bit	Disagree	Score [0-100]
In 2030 the <b>total cargo throughput</b> for PoR should reach values in between 575Mtons (High Oil Price scenario) to 750Mtons (Global Economy scenario)	1	4	3	2	1	55
PoRA <b>direct employment</b> in 2030 should increase, generating at least 97,500 jobs (current jobs generated at PoR are 87,111 -2012-)	5	-	5	1	-	71
<b>Indirect employment</b> generated by PoR is an important indicator for economic & social success of the port, therefore a goal should be defined for the future	6	5	-	-	-	87
Even if the future estimations of PoR <b>contribution to the Dutch GNP</b> are inaccurate, it is a relevant indicator for the success of the port	3	6	2	-	-	77
Using <b>business investments</b> as an indicator for evaluating PoR economic & social success is essential (e.g. between €25.0B to €35.0B up to 2030)	5	6	-	-	-	87
Sharing or transferring companies risks to PoR for developing new potential business is imperative for the economic success for the port	4	5	1	1	-	77
Including <b>social valuation</b> in standard PoRA processes and business cases will enhance PoR license to operate, hence lead to social success for the port	7	3	1	-	-	87

*Note: every statement is for the whole port area.*

The first indicator related to **total cargo throughput** predictions obtained a large dispersion of answers. The arguments in favour of keeping this KPI as indicator for economic & social success are only a few, and mainly it is associated to maintain a future economic target. However, most of the participants agreed that this indicator does not seem realistic. Besides it does not provide any valuable information related to Europort.

In second place, **direct employment** generated at PoRA was considered a relatively good indicator within this category, however due to the fact that is not providing specific insights related to Europort,

it did not score sufficiently high to be selected as a priority indicator. However, the next indicator refers to **indirect employment** generated at PoR and it proved to be crucial for economic and social success for PoR. Almost everybody agreed on this and on the importance of positioning PoR as a major facilitator of Dutch employment. This is not easy to assess. Therefore it is proposed to elaborate a figure in terms of percentage of generated jobs at regional, or even national, level by PoR. Besides it would be of significant progress to establish a correlation between the jobs generated by PoR (direct and indirect) and the related welfare of those workers. As this KPI is not specifically thought for Europoort, its modification is recommended. It is selected as *high priority indicator* for the economic & social success.

The contribution of the port to the **Dutch GNP** resulted in a rather important indicator to take into consideration due the fact that most of the population can understand these figures. If this can be distributed for each port area, it would become an *intermediate priority indicator*.

The fifth indicator is correlated with the attraction of **business investments** to the port (new and upgrading facilities investments) which are regarded as an essential value for economic & social success of the port. It arose as a *high priority indicator*, but it is not simple to assess for a specific area. At first glance, it can be drawn within a range of expected investments. Nevertheless, if it can be expressed with the amount of investments in relation with real capital (or capital assets) it may provide a clearer image. In addition of this investments also take into consideration **social valuation**, because it may become a very strong indicator.

In summary, the ultimate goal is to bond these last three indicators, and express them in terms of social inequality in the influence area of PoR (Stiglitz, 2012).

Lastly, sharing or transferring some private company's risks to PoRA for developing new potential business obtained some dispersion on the answers; however during the discussions a common ground is founded. To develop a new and innovative business PoRA should become an enabler of opportunities as well, hence this is considered as an *intermediate priority indicator*.

How far do you agree with the listed statements defining **ENVIRONMENTAL** success for Europort?  
<http://goo.gl/forms/1ou4kwPTJo>

Select one of the following five alternatives by doing a cross in the selected answer (if possible try to prioritise the most important): Agree, Agree a bit, Neutral, Disagree a bit & Disagree.

Statement	Agree	Agree a bit	Neutral	Disagree a bit	Disagree	Score [0-100]
<b>CO<sub>2</sub> emissions</b> in the whole port and industrial complex should be reduced by 60% (compared to 1990 - 24Mton-) in 2030	2	6	1	1	1	<b>66</b>
Defining desirable future <b>CO<sub>2</sub> emissions per cargo ton</b> , for each cargo segment, at Europort is a key indicator for tracking environmental success	2	4	2	1	2	<b>57</b>
Acknowledging <b>CO<sub>2</sub> emission per industrial hectare</b> for each terminal at Europort and defining future goals is relevant for environmental success	3	2	1	3	2	<b>53</b>
Defining a <b>maximum daily load of noise levels (50db) in residential areas</b> for 2030 is important to accomplish environmental success of Europort	2	4	3	-	2	<b>59</b>
Limiting overall <b>annual emissions of DPM, NO<sub>x</sub>, SO<sub>x</sub> and PM</b> for the year 2030 is relevant to achieve environmental Europort success	8	3	-	-	-	<b>93</b>
Measuring, start remediating and limiting future <b>emissions to the subsoil</b> at Europort is central to achieve environmental success	3	3	3	2	-	<b>66</b>
Valuing ecosystem services, including them into PoRA business cases and monitoring afterwards, will contribute to environmental success of the port	6	3	2	-	-	<b>84</b>

*Note: some statements are for the whole port area. Ecosystem services can be defined in four categories: Supporting services (necessary for the production of every other ecosystem service), Provisioning services (products obtained from ecosystems, like energy), regulating services (e.g. carbon capture, waste decomposition, water and air purification, et cetera), and Cultural services.*

Reducing **CO<sub>2</sub> emissions** is important for the whole port area, however almost everybody agreed that this should be within a national, regional and then at city regulatory framework. Currently PoR seems to be one of the few Dutch parties committed to move in this direction. Besides established goals seems to be extremely high, therefore several participants agreed on the need to redefine them into achievable objectives. Another important finding related to the way of assessing this goals was the

necessity to associate **CO<sub>2</sub> emissions** for industrial areas, and to cluster them in relation to their production (as general as possible, appears to be the most realistic approach), but again always starting from national policies, then regional, and finally at city and port level. Nevertheless, PoR can play a major role, and almost everybody coincided on the obligation of moving in this direction. The combination of these two indicators is regarded as an *intermediate priority indicator* for environmental success.

Then **regarding maximum daily load of noise levels in residential areas**, although most of the participants thought that is a good indicator, some specialists indicated that current norm is too low and that higher values can be proposed. Special attention should be paid to the frequency of the noises and limits may be specified. Monitoring noise levels is important; however it is not considered a crucial indicator.

Limiting overall **annual emissions of DPM, NO<sub>x</sub>, SO<sub>x</sub> and PM** resulted as the *highest priority indicator*. Besides during the discussion sessions, everybody agreed on the necessity to quantify the contribution to the total annual emissions of DPM, NO<sub>x</sub>, SO<sub>x</sub> and PM generated at Europoort, and at any other area of the port. Despite this common understanding, aside of Maasvlakte 2, there is not any defined goal for other existing parts of the port, including Europoort. Therefore the necessity of defining achievable targets appeared as a very important requisite.

During the discussions, environmental specialists clarified that currently **emissions to the subsoil** are well-monitored and under control. Therefore, it is not regarded as a crucial indicator to address the environmental success of Europoort. However it is still viewed as a control to be followed as close as possible. PoR cannot afford facing another situation as the experienced with Odjfell Terminal Rotterdam B.V. in 2012. At that time serious deficiencies were revealed in the safety systems within the terminal, especially on the oil storage tanks. Initially, due to oil infiltration to the subsoil, five tanks were shut down, subsequently another fifty. This case was on the media for weeks, and clearly weakened PoR image. The negative social perception achieved with these circumstances is undoubtedly undermining PoR license-to-grow (Visser, 2014). In addition, non-complying with Dutch laws and regulations directly damaged PoR license-to-operate.

Finally, every participant highly supported the inclusion of **valuing ecosystem services** within PoRA business cases, and of course, to continue their monitoring during the whole lifetime of the project. This endorsement is revealing, because challenges current way of performing business cases at PoRA. Almost everybody fully agrees on implementing this processes, and something similar occurs with social valuation. Therefore reviewing present business cases standards and procedures is a must. Once valuing ecosystem services is implemented for the Europoort area, it is recommended to introduce the variation of this value as an indicator for addressing environmental success. From the surveys it resulted as a *high priority indicator*.

How far do you agree with the listed statements defining **SAFETY** success for Europoort?

<http://goo.gl/forms/XihqA4mSAs>

Select one of the following five alternatives by doing a cross in the selected answer (if possible try to prioritise the most important): Agree, Agree a bit, Neutral, Disagree a bit & Disagree.

Statement	Agree	Agree a bit	Neutral	Disagree a bit	Disagree	Score [0-100]
Monitoring and defining goals for 2030 concerning annual <b>nautical accidents</b> in the whole port area is key for the safety of Europoort	2	8	1	-	-	<b>77</b>
The <b>Nautical Safety Index (NSI)</b> is an insightful indicator for recognising nautical safety at Europoort	1	6	4	-	-	<b>68</b>
Clearly dividing a <b>Port Safety Board</b> for wet and dry areas in the port will contribute to the safety success of the port	2	2	3	3	1	<b>52</b>

*Note: NSI is the number of collisions related to the number of ship visit. Some statements are for the whole port area.*

Addressing **nautical accidents** and associating goals to reduce them, resulted in a *high priority indicator*, however several drawbacks can be found to use as it is for safety success at Europoort. Mainly this indicator is presented for the overall port and not for each specific area. Besides it does not include the magnitude of the nautical accidents. Therefore modifications are needed to obtain a more suitable KPI.

A similar situation occurs with the **Nautical Safety Index (NSI)** which resulted as an *intermediate priority indicator*, based on the results given by the participants of the workshop. Therefore the adaptation of this indicator specifically for Europoort is recommended to evaluate safety success of this port area.

A **Port Safety Board** occasioned a large variety of reactions within the participants of the workshop. In general, everybody considers this interesting, but most of them are reluctant on the members of such a board. It may become a very useful body, but only in some specific topics and not including every actor.

## B.2. Identified underlying assumptions by category

These acknowledged underlying assumptions are the answer to research SQ3 discussed in section 3.5 *Underlying assumptions*. These are based on the scenario analysis done in sub section 2.4.1.

### PoRA internal organization

This category deals with in-house business management, human resources structure, usual procedures and common practices within the port authority.

Statement 1: PoRA invest in both: the economy and the quality of living (Port of Rotterdam, 2011).

*Assumption: Port of Rotterdam finances in the **long-term** are strong enough to keep investing in both, life quality and business developments.*

Statement 2: The influence of PoRA on business operations is high (OECD, 2010b; OPEN, 2011; Port of Rotterdam, 2011; Stiglitz, 2014).

*Assumption alternative 1: PoRA remains as an independent public limited company (N.V.) in the Netherlands in the **medium-term**.*

*Assumption alternative 2: PoRA becomes part of a national public limited company (N.V.) in charge of every Dutch port in the **medium-term**. [Included in the survey as 1.1.a.](#)*

*Assumption alternative 3: PoRA becomes part of an International public limited company in the **long-term** (with shares from different countries like Brazil, Oman, China, Romania, et cetera). [Included in the survey as 1.1.b.](#)*

Statement 3: The PoRA is recognised as a leader in modern business operations in general, and in HR management in particular. PoRA serves as an example for other organizations here and abroad. Continuous meetings are held between professionals of different departments (Port of Rotterdam, 2011).

*Assumption: Excellent communication and cooperation amongst PoRA internal departments is fully achieved in the **short- and medium-term**. This means that information for planning purposes within PoRA is fully available (internally), and not clustered within each department. [Included in the survey as 1.2.](#)*

Statement 4: For commercial development of projects, PoRA has an integral project management methodology ("Processchema"), based on best practice, that applies to all investment and operating projects within the Port Authority from phase 1 onwards (Port of Rotterdam, 2013i).

*Assumption alternative 1: The planning period of a project (phase 0) remains without an explicit project management methodology in the **short-term**.*

*Assumption alternative 2: The selection of a project to be constructed (amongst different alternatives in phase 1), basically relies on present business cases in the **short- and medium-term**.*

*Assumption alternative 3: "Processchema from PM@HbR" methodology is similarly applied by every professional involved in the process for any new project.*

*Assumption alternative 4: “Gebiedsmanagers” remain with a null or minor participation, in the **short- and medium-term**, for the development phases of a commercial project from existing clients.*

**Statement 5:** Business managers are the link between PoRA and potential clients, before starting a commercial project within Port Planning (Port of Rotterdam, 2013c).

*Assumption: The only link between clients (potential and existing) and PoRA are the commercial managers in the **short- and medium-term**. Included in the survey as 1.3.*

**Statement 6:** Possible commercial investments, before becoming a project are study in depth from a commercial and business perspective. Then an initial conceptual design is prepared in accordance with current masterplans (if fits). In case of approving this conceptual design, a business case is performed. Finally, if the business case is positive with an IRR of at least 8.5% in 25 years (without residual value after this period), the project is approved to proceed into the realisation phase (Port of Rotterdam, 2014e).

*Assumption alternative 1: Possible new commercial projects are explicitly checked and clearly justified, either to fit or not to fit in a masterplan in the **short-term**.*

*Assumption alternative 2: Conceptual designs (phase 0) for new or existing clients are performed with a full multidisciplinary team of professionals (including “Gebiedsmanagers”, asset managers, environmental professionals, financial experts, project engineers and project managers) in the **short-term**. Included in the survey as 1.4.*

*Assumption alternative 3: A financial business case (as currently performed) remains as the main parameter in the decision-making process for building a project in the **medium-term** (of course, if it fits in current masterplans).*

*Assumption alternative 4: Using a general Internal Rate of Return of 8.5 % for commercial projects remains as common practice in the **medium-term** (without considering social valuation and valuing ecosystem services).*

*Assumption alternative 5: Adopting 25 years as financial time-horizon for almost every commercial project in the business cases stays as common practice in the **medium-term**.*

*Assumption alternative 6: Assuming from the financial perspective that the value of an asset after 25 years is zero stays within PoRA practices in the **short- and medium-term**.*

*Assumption alternative 7: Predicted IRR (in a business case) is achieved during the commercial lifecycle of a project and internally controlled (also stated) for each terminal in the **short- and medium-term**. Included in the survey as 1.5.*

*Assumption alternative 8: Once the construction of a project is finished (capitalised), PoRA assigns a multidisciplinary team (“Gebiedsmanager”, Business/Financial controller, Environmental controller and Asset Manager) to control the estimated asset performance during the lifecycle (**shot-term**). Included in the survey as 1.6.*



## Government

This category encompasses some Dutch, European and global policies that may affect any port related activity. The presented statements are specially focussed on Europoort.

Statement 7: The operations at PoR Industrial Complex with its heart in Botlek, Europoort and Maasvlakte relies in spatial policies at European, national, provincial, regional and local levels (European Commission, 2011; OPEN, 2011; OECD, 2012a; Port of Rotterdam, 2014a; Stiglitz, 2014).

*Assumption alternative 1: Existing policies related to spatial planning and sustainable development stays without major modifications in the **medium-** and **long-term**.*

*Assumption alternative 2: Spatial planning obligations are accurately followed in the **long-term** by every inherent body involved in the process.*

Statement 8: To accomplish Europe's Industrial Complex several visions are converted into policies at local, regional, provincial, national and European level (European Commission, 2011; OPEN, 2011; Port of Rotterdam, 2011, 2014a; Stiglitz, 2014).

*Assumption alternative 1: Policy-making bodies at local, regional, provincial, national and European level facilitate the required steps to achieve Europe's Industrial Cluster vision at PoR in the **long-term** (less bureaucracy, less time needed for consultation and fewer regulations). [Included in the survey as 2.1.](#)*

*Assumption alternative 2: European policies become much more relevant than any other policy in the **long-term**.*

*Assumption alternative 3: Europoort complies with every safety and environmental requirements, even for handling LNG vessels in the Calandkanaal in the **long-term**.*

Statement 9: The Netherlands has a good tax environment, mainly for corporate taxes (OECD, 2012a).

*Assumption: Dutch corporate tax environment keeps facilitating the development of business in the **medium-** and **long-term** with better conditions than other countries in NW Europe. Dutch government can create a good investment climate, even if other European governments subsidise the industries established in their own countries. [Included in the survey as 2.2.](#)*

Statement 10: Current environmental restrictions for the Europoort area shows the area as one of the most attractive within PoR for developing new business strengthening Europe's Industrial Complex vision (OECD, 2010b; Port of Rotterdam, 2013d).

*Assumption alternative 1: Estimated environmental emissions and risks in the Europoort area are complying acceptable limits in the **medium-** and **long-term**. [Included in the survey as 2.3.](#)*

*Assumption alternative 2: Minimum distance from chemical clusters to the residential areas are demanded to be increased in the **medium-** and **long-term**. [Included in the survey as 2.4.](#)*

## Port competitiveness

This category presents assumptions dealing with the ability and performance of the port to perform its activities in a given market, in relation to the ability and performance of other ports in the same market. Two main distinctions can be made here, competitiveness at EU level or within the HLH range, and competitiveness at global scale (World Economic Forum, 2013).

Statement 11: PoR competitiveness and market share is increasing in the HLH range (OECD, 2010b; Port of Rotterdam, 2011; Club of Rome, 2013).

*Assumption alternative 1: PoR market share (in terms of throughput) in the Hamburg-Le Havre range increases in the **medium-term**.*

*Assumption alternative 2: Port competitiveness and market share are still computed in terms of throughput in the **medium-** and **long-term**.*

Statement 12: Port of Rotterdam has growth opportunities for the industry (Club of Rome, 2013; OECD, 2010b; Port of Rotterdam, 2011, 2014a; TGI et al., 2013).

*Assumption alternative 1: the industries are willing to set new business in Rotterdam, and not in Eastern Europe or BRICS countries in the **medium-** and **long-term**.*

*Assumption alternative 2: Long lasting contracts are a common practice to attract companies in order to achieve Europe's Industrial Complex vision (**medium-** and **long-term**). [Included in the survey as 3.1.](#)*

Statement 13: PoR becomes Europe's Industrial cluster, leading in efficiency and sustainability (European Commission, 2013; Port of Rotterdam, 2011).

*Assumption alternative 1: World-class industrial companies are willing to settle in Rotterdam with the same spirit of PoR (efficiency and sustainability) and do not prefer other ports with different requirements in the **medium-** and **long-term**. [Included in the survey as 3.2.](#)*

*Assumption alternative 2: Although PoRA maintains current policies, new industrial companies (growing markets) are able to afford allocating their main operations in Rotterdam in the **medium-** and **long-term**.*

Statement 14: Presence of very strong players in all market sectors (Port of Rotterdam, 2011).

*Assumption: PoR accommodates strong players in all market segments in the **long-term**. [Included in the survey as 3.3.](#)*

Statement 15: PoR has an extremely strong position for large-scale energy generation due to location, depth, cooling water facilities, et cetera (TGI et al., 2013).

*Assumption: In the **long-term** large-scale centralised energy generation plays a crucial role in the energy sector.*

Statement 16: Rotterdam's industrial complex is competing to an increasing extent to similar complexes elsewhere in the world. Thus optimisation of supply chains and cost cutting is needed. Integration of

the industrial complexes in Antwerp, Moerdijk, Terneuzen and Vlissingen by 2030 is achieved. Rotterdam and Antwerp are stronger together (Port of Rotterdam, 2011).

*Assumption: In the **long-term**, Port of Rotterdam and Port of Antwerp develop new industrial business together using its integration as main driver for competing with other industrial complexes in the world. Included in the survey as 3.4.*

## Cargo flows

One of the main reasons of existence for every port in the world is the cargo flows. Those cargo flows can dramatically change in the coming years due to better distribution of worldwide welfare. Besides cargo flows may be affected for several other external developments that are discussed in 2.4.1 *Future scenarios & external developments*. It is the aim of this subsection to present some of the underlying assumptions related to cargo flows that may affect the planning of Europort.

Statement 17: The main cargo segments at Europort are liquid bulk and dry bulk and these are the core for Europe's Industrial Complex (Club of Rome, 2013; Port of Rotterdam, 2010, 2013d, 2014a; Stiglitz, 2014).

*Assumption alternative 1: Europort primarily remains as a dry and liquid bulk port in the **long-term**.*

*Assumption alternative 2: Second- and/or third-generation products (break-bulk) replace raw materials cargo (liquid and dry bulk) in the **medium-** and **long-term**. Included in the survey as 4.1.*

Statement 18: Rotterdam is closely linked to the industrial and logistics hubs in Northwest Europe and it has an extremely strong position in tank storage with growth possibilities and trade activities. In addition, it leads on fuel and energy flows (Club of Rome, 2013; European Commission, 2011; OECD, 2012a; Port of Rotterdam, 2011, 2014a).

*Assumption alternative 1: Coal demand is reduced in NW Europe in the **medium-** and **long-term**.*

*Assumption alternative 2: Crude oil for refineries in NW Europe stays stable in the **long-term**.*

*Assumption alternative 3: In the **long-term** liquid bulk cargo still represents the most relevant cargo segment share for PoR, and Europort.*

*Assumption alternative 4: In the **medium-term** and **long-term** biomass starts to replace liquid bulk cargo, either for strengthening the Energy Port, or the Fuel Hub concept.*

Statement 19: The highest economic growth scenarios form the basis for the forecasts (Port of Rotterdam, 2011).

*Assumption: The cargo flows and economic growth are associated with one or two future scenarios (high economic growth).*

Statement 20: Larger ships require more depth, wider docks, stronger quays and larger cranes. This trend offers Rotterdam opportunities to further strengthen its European hub function and even expand into a hub for intercontinental cargo flows (NIC, 2012; OECD, 2010b; OPEN, 2011; TGI et al., 2013; Wolters & van Dorsser, 2014).

*Assumption: Further developments, such as company's merging have not a large impact for the cargo flows at Europoort in the **medium-** and **long-term**. Included in the survey as 4.2.*

**Statement 21:** In the long-term main route from Asia to Europe is going in the future via a northern route consolidating PoR position (Cann, 2010; Denton-Brown, 2014; NIC, 2012; OECD, 2012a; TGI et al., 2013; U.S. Coast Guard, 2013).

*Assumption alternative 1: The opening of the Arctic North route between Asia and Europe, in the **long-term**, is not challenging the Europoort position due to the limited available depth. Included in the survey as 4.3.*

*Assumption alternative 2: More trade disputes between China and third countries take place, creating a major impact on trade with Europe in the **medium-term**. Included in the survey as 4.4.*

## Fleet mix and evolution

As it was seen during the last decades, fleet mix and evolution of the vessels was unprecedentedly. PoR has already suffered the consequences of under predicting these situations. Therefore within this subsection, assumptions that may constrain Europoort development are presented.

**Statement 22:** Europoort can accommodate Ultra Large Crude Carrier (ULCC) and Very Large Ore carriers (VLOC) vessels (Denton-Brown, 2014; Port of Rotterdam, 2013d; TGI et al., 2013).

*Assumption alternative 1: Other large vessels with greater air draft and low manoeuvrability (e.g. large containerships or LNG carriers) are also accommodated in the Europoort area in the **long-term** without reducing the capacity of the "Calandkanaal". Included in the survey as 5.2.*

*Assumption alternative 2: In the **long-term** unmanned vessels are implemented at worldwide scale and current manoeuvring areas are sufficiently large to accommodate these vessels. Included in the survey as 5.3.*

*Assumption alternative 3: Current vessels are not increasing their size in the **medium-term**.*

**Statement 23:** For chemical carriers a maximum 100,000 DWT product tanker (256 x 45 x 13.7 m) call at Europoort (Port of Rotterdam, 2013d; TGI et al., 2013).

*Assumption: No Very Large (150,000-300,000 DWT) or Ultra Large (> 300,000 DWT) Chemical Carriers are expected, neither LNG vessels in the **medium-term**.*

**Statement 24:** In 2030, the port of Rotterdam is the world leader in shipping sustainability, efficiency and safety. Environmental impact of shipping must be reduced and nautical safety must remain guaranteed (European Commission, 2013; OECD, 2012b; PIANC, 2014b; Port of Rotterdam, 2011, 2014a; Wolters & van Dorsser, 2014).

*Assumption: Partial emissions from sea-going ships and inland barges are accepted in the **long-term**, therefore LNG does not become the main fuel in Rotterdam. Vessels are not running on LNG or fuel oil. Included in the survey as 5.1.*

## Dry & wet infrastructure

As it is inferred from the title of this subsection, assumptions related to uncertain developments in the dry infrastructure are introduced.

Statement 25: Unallocated plots will be developed, connected to the water and then allocated (Port of Rotterdam, 2011, 2013d).

*Assumption alternative 1: Seizing opportunities for "temporary" use of the unallocated plots is not considered as an option in the **short-** and **medium-term**. Included in the survey as 6.1.*

*Assumption alternative 2: The creation of maritime access to the not-in-use plots at Europoort is done in the **medium-term**, even if some terminals have restricted operations for a period of time (most of the terminals have contracts lasting over 2030) or some plots are reduced in size.*

Statement 26: PoRA wants to provide room for expansion to world-class business. One of the main criteria to make it possible is improving land use productivity and efficient use of the land (PIANC, 2014b; Port of Rotterdam, 2011).

*Assumption: Even if forecasted cargo throughput does not become reality, PoRA will also pursue every optimization opportunities (land use productivity and efficiency) to anticipate uncertain developments in the **medium-term**. Included in the survey as 6.2.*

Statement 27: Promoting the shared use of quay facilities (Port of Rotterdam, 2011).

*Assumption: Sharing quay or jetty facilities is a premise for any new infrastructure commercial development at Europoort in the **medium-term**. Besides, it is important to point out that within Europoort there are still a lot of facilities owned by the terminals and the amount of existing quay walls is minimum in this area. Included in the survey as 6.3.*

Statement 28: PoR has enough capacity to accommodate a large diversity of vessels without significant waiting times (Port of Rotterdam, 2013a; TGI et al., 2013).

*Assumption: The existing Euromaasgeul impose no restrictions on the shipping traffic to/from Europoort in the **long-term**.*

Statement 29: The Calandkanaal in all its extent is fully ready to physically accommodate any type of vessels (OECD, 2010b; Port of Rotterdam, 2013d).

*Assumption alternative 1: Access to the 7<sup>th</sup> Petroleumhaven at Europoort is not limited in the **medium-** and **long-term**, if traffic increases, or larger vessels are calling at the port.*

*Assumption alternative 2: Ship turning circles have in the 5<sup>th</sup> and 7<sup>th</sup> "Petroleumhaven" do not become too small (bottleneck) in the **short-** and **medium-term**.*

*Assumption alternative 3: The "Rozemburgesluis" has still sufficient capacity to accommodate future inland barges traffic, even if the cargo segments change in the **medium-** and **long-term**.*

*Assumption alternative 4: In the **long-term** N15 road becomes a physical barrier to directly divert cargo from the Europoort area to the Hartelkanaal.*

## Hinterland connections

Within this category, diverse situations related to every transport mode, and their linking role between PoR and the hinterland are presented.

Statement 30: There is enough capacity in every transport mode in the Europoort area (OECD, 2010b; Port of Rotterdam, 2013d; TGI et al., 2013; Wolters & van Dorsser, 2014).

*Assumption alternative 1: In the **medium-term** due to restrictions on emissions, inland barge's speed limit is reduced, decreasing the capacity of the inland waterways in the **medium-term**. Speed limit reduce of 20% in 2020 (an average of 15 kilometres per hour to 12 kilometres per hour) is applied to approximately 44% of the total fleet. This makes overtaking difficult. The measure applies to the "Hartelkanaal" ("Harmsenbrug" and "Botlekbrug") and the "Oude Maas" (between "Beerenplaat" and "Botlekbrug"). Included in the survey as 7.1.*

*Assumption alternative 2: Rail and road transport does not play a major role for cargo handled at Europoort in the **long-term** (in 2010, liquid bulk cargo transported to the hinterland by rail was 1% and by road was also 1%; in addition coal and biomass cargo connected to the hinterland by rail was 9% -0% by road-). Included in the survey as 7.2.*

*Assumption alternative 3: Construction of connecting pipelines is a reality in the **medium- and long-term** to integrate more the industrial cluster.*

Statement 31: Developments related to information processing and data will also have a major impact on the way in which nodes transport flows can be handled. This goes in the future, whether carriers at all still want to come to Rotterdam or not (OECD, 2010b; OPEN, 2011; World Economic Forum, 2014).

*Assumption: Limited collaboration between different parties brings inefficient bundling and transport to the hinterland in the **medium-term**.*

Statement 32: Very good existing hinterland waterways connections to NW Europe and in thoroughly expansion (OECD, 2010b, 2012a; Port of Rotterdam, 2013d; Wolters & van Dorsser, 2014).

*Assumption alternative 1: The "Seine-Nord" canal is constructed in the **long-term** extending the hinterland to the North of France.*

*Assumption alternative 2: The "Betuweroute" is improved in order to allow double-stack trains to the heart of Germany in the **medium-term**.*

*Assumption alternative 3: The speed with which goods can be successfully transported to the hinterland is partly related to the productivity of each terminal, that is constantly improved regardless the economic conditions in the **medium- and long-term**.*

*Assumption alternative 4: In order to achieve a more efficient transport chain the number of actors interacting from the port to the hinterland is strongly reduced by the creation of corporations (e.g. for inland barges transport) in the **long-term**. This could be to either address a management role or to invest in a relationship of trust with the parties in the hinterland. Included in the survey as 7.3.*

*Assumption alternative 5: Due to climate change the water level can fluctuate strongly, resulting in frequent periods of low or high water levels. Draught seasons in the Inland waterways limit transportation in the **long-term**.*

## Business development (terminals)

The evolution of business at the port industrial complex presents several uncertainties, mainly after the effects experienced from 2008 until now. Besides with the introduction of the new PoR Energy Scenarios (Port of Rotterdam, 2014a), these assumptions become very challenging.

Statement 33: In 2030 Rotterdam, and specially Europoort, is a premier location where the transition to bio-based chemicals is in full swing. Several factories in Europe's Industrial Complex run entirely on bio-based resources (Port of Rotterdam, 2011).

*Assumption alternative 1: Although companies in the bio-based sector are small players, PoRA takes the lead in promoting and supporting the development of those companies by several means in the **medium-term** (e.g. facilitating and providing access to first or second generation feeder stock, good logistical access, et cetera). [Included in the survey as 8.1.](#)*

*Assumption alternative 2: First-generation of bio-based production (using soy, rape, palm, sugarcane, wheat, corn, et cetera) is fully accepted and the "food for fuel" debate is totally overcome in the **long-term**. [Included in the survey as 8.2.](#)*

*Assumption alternative 3: Bio-based industries are hindered by the growth of shale gas in the **medium-term**.*

Statement 34: Co-investing with customers, to which extent? (Port of Rotterdam, 2015a; Stiglitz, 2014).

*Assumption: Translating risk from the clients to PoRA is convenient for the port in the **medium-term** to develop new front runner businesses.*

Statement 35: Europoort is an important part of the Europe's industrial complex. Large quantities of crude oil, chemicals and biofuels are traded all over the world via Europoort (Port of Rotterdam, 2011).

*Assumption alternative 1: In the **short- and medium-term**, only terminals related with the vision of Europe's Industrial complex are interested in developing their business in the Europoort area. The port's motto is "The right company in the right place", and the statement "a missed opportunity is greatest risk!" is totally left aside. [Included in the survey as 8.3.](#)*

*Assumption alternative 2: Oil price is very high, world transport decreases and local production is increasing in the **medium- and long-term**.*

*Assumption alternative 3: Shale gas is a game changer in the **medium- and long-term**.*

Statement 36: In current masterplans, the space requirements at Europoort in 2020 and 2030 appear to be sufficient to accommodate the forecasted cargo (Port of Rotterdam, 2013d).

*Assumption: Forecasted cargo throughput is taking place in the **medium- and long-term**.*

Statement 37: New terminal concepts with twice higher throughput per hectare have great impact on every basic infrastructure and logistics (Cann, 2010; Denton-Brown, 2014; TGI et al., 2013; Zwakhals et al., 2012).

*Assumption alternative 1: Terminal productivity is not significantly higher in the **medium-term** future (terminal equipment, logistics concept, loading/unloading techniques remain almost unchanged).*

*Assumption alternative 2: Efficient and reliable cargo handling intra-terminal is achieved for each cargo segment in the **medium-term** to increase efficiency.*

## Expertise and know-how

The topics dealt in this category are related with future labour, general employees' skills, and PoRA position to develop and support high tech innovations and business.

Statement 38: The knowledge and expertise in NW Europe is essential to be able to contribute to the development of PoR in the future (Port of Rotterdam, 2011; TGI et al., 2013).

*Assumption: In **long-term** there is not a shortage of (skilled) labour. [Included in the survey as 9.2.](#)*

Statement 39: The aim is to realise a synthesis gas cluster, carbon capture and storage facilities and a further extension of bio-based industries in this area by 2030 (Club of Rome, 2013; Port of Rotterdam, 2011).

*Assumption: The companies and terminals emerging in new market segments like synthesis gas (or syngas), carbon capture and bio-based can find enough local professionals with the right expertise in the **medium-term**. [Included in the survey as 9.3.](#)*

Statement 40: Close partnerships between business, government agencies and knowledge institutions (Port of Rotterdam, 2011, 2013a).

*Assumption: There are plenty of high-qualified employees and supporting parties enhancing a healthy competition within the port area in the **medium-term**.*

Statement 41: PoRA is evolving into a management-driven organization (Port of Rotterdam, 2011).

*Assumption: In the **medium-** and **long-term** PoRA has strong technical professionals. It is a worldwide front-runner company in the field of technical innovation, leading international best practices. PoRA is not only a management company, it also develops first-class technical know-how. [Included in the survey as 9.1.](#)*






## Given votes to reach an abridged list of underlying assumptions

Only statements with at least two yellow and one green are selected, except Additional statements.

Category	Statement	Assumption	P. Arecco	P. Vervoorn	M. Oosting	Selected?	
1 PoRA internal organization	1	1	Yellow	Yellow	Red	no	
	2	2	2	Yellow	Red	Yellow	no
		3	3	Green	Yellow	Green	Yes
		4	4	Green	Green	Yellow	Yes
	3	5	Yellow	Green	Green	Yes	
	4	6	6	Green	Green	Red	no
		7	7	Red	Red	Yellow	no
		8	8	Yellow	Yellow	Red	no
		9	9	Red	Yellow	Red	no
	5	10	Green	Green	Yellow	Yes	
	6	11	11	Yellow	Green	Red	no
		12	12	Yellow	Yellow	Green	Yes
		13	13	Yellow	Red	Green	no
		14	14	Red	Green	Yellow	no
		15	15	Red	Yellow	Green	no
		16	16	Red	Yellow	Red	no
		17	17	Green	Green	Green	Yes
	18	18	Yellow	Green	Green	Yes	
2 Government	7	19	Red	Yellow	Yellow	no	
		20	Yellow	Red	Red	no	
	8	21	Green	Yellow	Green	Yes	
		22	Red	Red	Red	no	
		23	Red	Green	Green	no	
	9	24	Green	Yellow	Yellow	Yes	
10	25	Green	Green	Green	Yes		
	26	Green	Green	Yellow	Yes		
3 Port competitiveness	11	27	Red	Red	Red	no	
		28	Yellow	Yellow	Red	no	
	12	29	Red	Red	Yellow	no	
		30	Yellow	Green	Green	Yes	
	13	31	Green	Green	Green	Yes	
		32	Red	Red	Red	no	
	14	33	Green	Yellow	Green	Yes	
15	34	Red	Yellow	Red	no		
16	35	Green	Green	Yellow	Yes		
4 Cargo flows	17	36	Red	Red	Yellow	no	
		37	Green	Green	Green	Yes	
	18	38	Red	Red	Yellow	no	
		39	Yellow	Red	Green	no	
		40	Red	Red	Red	no	
		41	Yellow	Red	Red	no	
	19	42	Green	Yellow	Red	no	
	20	43	Yellow	Yellow	Green	Yes	
	21	44	Green	Yellow	Green	Yes	
45		Yellow	Green	Red	Additional		

5	Fleet mix & evolution	22	46	Low	Low	Low	no
			47	Intermediate	Intermediate	Intermediate	Additional
			48	Low	High	High	Additional
		23	49	Intermediate	Low	Intermediate	no
		24	50	Intermediate	High	High	Yes
6	Dry & wet infrastructure	25	51	High	High	High	Yes
			52	Low	Low	Intermediate	no
		26	53	High	High	Intermediate	Yes
		27	54	High	High	High	Yes
		28	55	Intermediate	Low	Low	no
		29	56	Low	Low	Low	no
			57	Low	Low	Intermediate	no
			58	Low	Intermediate	Low	no
59	Intermediate		Intermediate	Low	no		
7	Hinterland connections	30	60	High	High	High	Yes
			61	High	High	High	Yes
			62	Low	Intermediate	Low	no
		31	63	Low	Low	Low	no
		32	64	Intermediate	Low	Low	no
			65	Low	Low	Intermediate	no
			66	Low	Low	Low	no
			67	High	Intermediate	Intermediate	Yes
68	Low		Low	Intermediate	no		
8	Business development (terminals)	33	69	High	High	High	Yes
			70	High	Intermediate	High	Yes
			71	Intermediate	Low	Low	no
		34	72	Low	Low	Intermediate	no
		35	73	Intermediate	High	High	Yes
			74	Low	Low	High	no
			75	Low	Low	Intermediate	no
		36	76	High	Intermediate	Low	no
37	77	Intermediate	Intermediate	Low	no		
	78	Intermediate	Low	Low	no		
9	Expertise & know-how	38	79	High	Low	High	Additional
		39	80	Intermediate	Intermediate	Intermediate	Additional
		40	81	High	High	Intermediate	Yes
		41	82	Intermediate	Low	Low	no

	High relevance
	Intermediate relevance
	Low relevance

In total thirty four (34) assumptions are selected to be categorise as vulnerabilities and opportunities in a later stage. Of those twenty nine (29) resulted from this voting process; the other five (5) were added to balance the amount of assumptions within each category. This voting process is reasonably implemented due to time constraints of this study, and it is meant for narrowing down the number of assumptions to be analysed. It is comprehensively explain within subsection 3.5.1 in *Chapter 3* of the main report.

### B.3. From underlying assumptions to opportunities & vulnerabilities

In this section of the Annex, results of the second part of the workshop are presented, including summary graphs to identify vulnerabilities and opportunities for each category of the underlying assumptions. Opportunities (certain and uncertain) and Vulnerabilities are noticeably appreciated.

#### PoRA internal organisation



**X 1.1 a.** PoRA becomes part of a national public limited company (N.V.) in charge of every Dutch port in the **medium-term**. **b.** PoRA becomes part of an International public limited company in the **long-term** (with shares from different countries like Brazil, Oman, China, Romania, et cetera).

**X 1.2** Excellent communication and cooperation amongst PoRA internal departments is fully achieved in the **short-** and **medium-term**.

**X 1.3** The only link between clients (potential and existing) and PoRA are the commercial managers in the **short-** and **medium-term**.

**X 1.4** Conceptual designs (phase 0) for new or existing clients are always performed with a full multidisciplinary team of professionals (including “Gebiedsmanagers”, asset managers, environmental professionals, financial experts, project engineers and project managers) in the **short-term**.

**X 1.5** Predicted IRR (in a business case) is achieved during the commercial lifecycle of a project and internally controlled (also stated) for each terminal in the **short-** and **medium-term**.

**X 1.6** Once the construction of a project is finished (capitalised), in the **short-term** PoRA assigns a multidisciplinary team (“Gebiedsmanager”, business/financial controller, environmental controller and asset manager) to control the estimated asset performance during the lifecycle.

## Government



**X 2.1** Policy-making bodies at local, regional, provincial, national and European level facilitate the required steps to achieve Europe's Industrial Cluster vision at PoR (less bureaucracy, less time needed for consultation and fewer regulations) in the **long-term**.

**X 2.2** Dutch corporate tax environment keeps facilitating the development of business in the medium- and long-term with better conditions than other countries in NW Europe. Dutch government can create a good investment climate, even if other European governments subsidise the industries established in their own countries in the **medium-** and **long-term**.

**X 2.3** Estimated environmental emissions and risks at Europoort are complying acceptable limits in the **medium-** and **long-term**.

**X 2.4** Minimum distance from chemical clusters to the residential areas are demanded to be increased in the **medium-** and **long-term**.

## Port Competitiveness



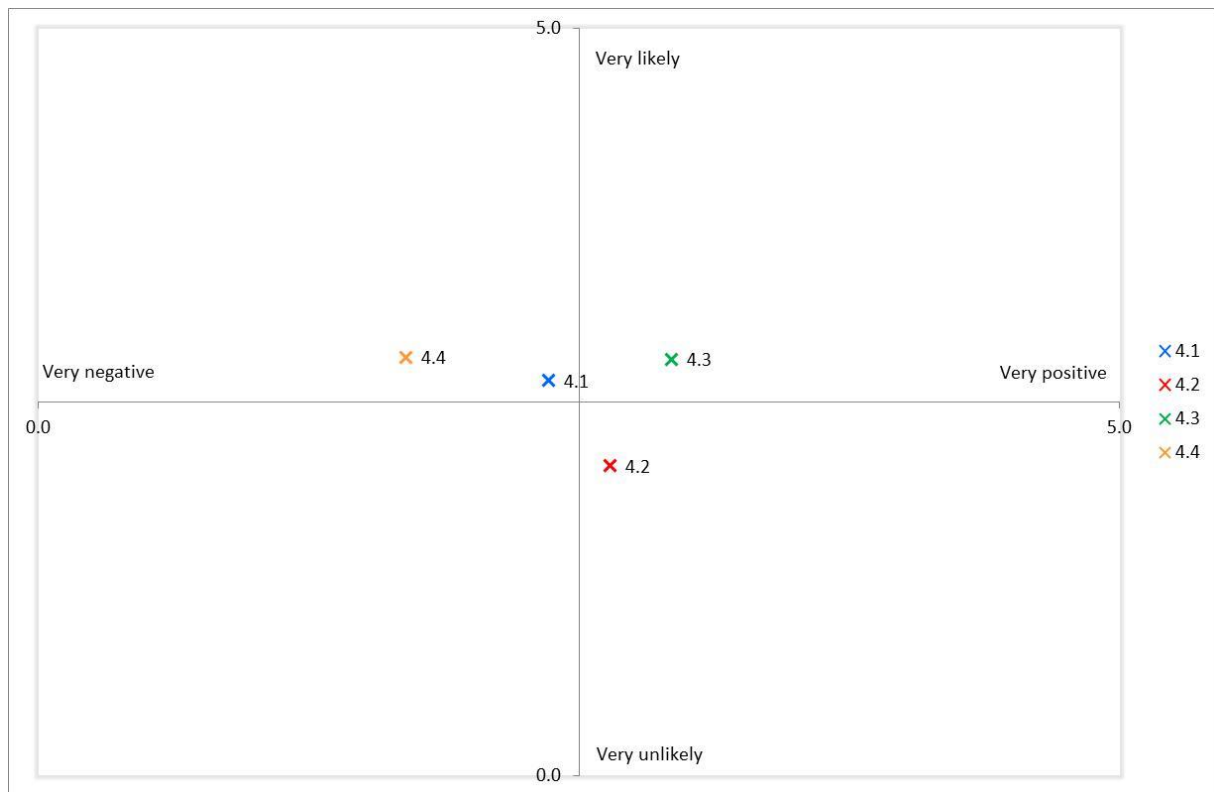
**X 3.1** Long-lasting contracts are a common practice in the **medium-** and **long-term** to attract companies in order to achieve Europe's Industrial Complex vision.

**X 3.2** World-class industrial companies are willing to settle in Rotterdam with the same spirit of PoR (efficiency and sustainability) and do not prefer other ports with different requirements in the **medium-** and **long-term**.

**X 3.3** PoR accommodates strong players in all market sectors in the **long-term**.

**X 3.4** In the **long-term** Rotterdam and Antwerp team-up as a single port and develop new industrial business together using its integration as main driver for competing with other industrial complexes in the world.

## Cargo flows



**X 4.1** Second- and/or third-generation products (break-bulk) replace raw materials cargo (liquid and dry bulk) in the **medium-** and **long-term**.

**X 4.2** Further developments, such as company's merging have not a large impact for the cargo flows at Europoort in the **medium-** and **long-term**.

**X 4.3** The opening of the Arctic North route between Asia and Europe, in the **long-term**, is not challenging the Europoort position due to the limited available depth.

**X 4.4** More trade disputes between China and third countries take place, creating a major impact on trade with Europe in the **medium-term** (*additional assumption incorporated during a second discussion session*).

## Fleet mix and evolution



**X 5.1** Partial emissions from sea-going ships and inland barges are accepted in the **long-term**, therefore LNG does not become the main fuel in Rotterdam.

**X 5.2** Other large vessels with greater air draft and low manoeuvrability (e.g. large containerhips or LNG carries) are also accommodated within Europoort in the **long-term** without reducing the capacity of the “Calandkanaal” (*additional assumption incorporated during a second discussion session*).

**X 5.3** In the **long-term** unmanned vessels are implemented at worldwide scale and current manoeuvring areas are sufficiently large to accommodate these vessels (*additional assumption incorporated during a second discussion session*).

## Dry & wet infrastructure



**X 6.1** Seizing opportunities for "temporary" use of the unallocated plots is not considered as an option in the **short-** and **medium-term**.

**X 6.2** Even if forecasted cargo throughput does not become reality, PoRA will also pursue every optimization opportunities (land use productivity and efficiency) to anticipate uncertain developments in the **medium-term**.

**X 6.3** Sharing quay or jetty facilities is a premise for any new infrastructure commercial development at Europoort in the **medium-term**.



## Hinterland Connections



**X 7.1** In the **medium-term** due to restrictions on emission, inland barges speed limit is reduced, making overtake difficult and reducing capacity of the inland waterways.

**X 7.2** Rail and road transport does not play a major role for cargo handled at Europort in the **long-term** (in 2010, liquid bulk cargo transported to the hinterland by rail was 0.5% and by road was also 0.5%; in addition coal and biomass cargo connected to the hinterland by rail was 9% -0% by road-).

**X 7.3** In order to achieve a more efficient transport chain the number of actors interacting from the port to the hinterland is strongly reduced by the creation of corporations (e.g. for inland barges transport) in the **long-term**. This could be to either address a management role or to invest in a relationship of trust with the parties in the hinterland.

## Business developments (terminals)



**X 8.1** Although companies in the bio-based sector are small players, PoRA takes the lead in promoting and supporting the development of those companies by several means in the **medium-term** (e.g. financially, but also by providing access to first or second generation feeder stock, good logistical access, et cetera).

**X 8.2** First-generation of bio-based production (using soy, rape, palm, sugarcane, wheat, corn, et cetera) is fully accepted and the “food for fuel” debate is totally overcome in the **long-term**.

**X 8.3** In the **short-** and **medium-term**, only terminals related with the vision of Europe’s Industrial complex are interested in developing their business at Europoort. The port’s motto is “The right company in the right place”, and the statement “a missed opportunity is greatest risk!” is totally left aside.

## Expertise & know-how



**X 9.1** In the **medium-** and **long-term** PoRA has strong technical professionals. It is a worldwide front-runner company in the field of technical innovation, leading international best practices. PoRA is not only a management company; it also develops first-class technical know-how.

**X 9.2** In the **long-term** there is not a shortage of (skilled) labour (*additional assumption incorporated during a second discussion session*).

**X 9.3** The companies and terminals emerging in new market segments like synthesis gas (or syngas); carbon capture and bio-based can find enough local professionals with the right expertise in the **medium-term** (*additional assumption incorporated during a second discussion session*).

## B.4. Overview of the vulnerabilities and opportunities

Even if the focus of this research is on the long-term, some useful insights are also obtained for short- and medium-term planning. Within the following sections summary tables are presented with every identified vulnerability and opportunity. These tables are the answer of research SQ4 discussed in section 3.6 *Vulnerabilities and opportunities for each planning-horizon* in the main body of the report.

Vulnerabilities and opportunities related with PoRA internal organisation are clearly noted with \*.

Vulnerabilities and opportunities with a  $\Delta < 0.5$  are indicated in *italic* font. This means that given votes have a large variance. Thus, these can be either vulnerabilities or opportunities.

### Project planning (short-term)

Vulnerabilities	Opportunities
* The only link between clients (potential and existing) and PoRA are the commercial managers.	* Conceptual designs (phase 0) for new or existing clients are always performed with a full multidisciplinary team of professionals (including asset manager, environmental professional, "Gebiedsmanager", financial expert, project engineer and possible future project manager).
Seizing opportunities for "temporary" use of the unallocated plots is not considered as an option	<p>* Excellent communication &amp; cooperation amongst PoRA internal departments is fully achieved.</p> <p>* <i>Predicted IRR (in a business case) is achieved during the commercial lifecycle of a project and internally controlled (also stated) for each terminal.</i></p> <p>* Once the construction of a project is finished (capitalised), PoRA assigns a multidisciplinary team ("Gebiedsmanager", financial controller, environmental controller and asset manager) to control the estimated asset performance during the lifecycle.</p> <p>Terminals related with the vision of Europe's Industrial complex are interested in developing their business at Europoort. The port's motto is "The right company in the right place", and the statement "a missed opportunity is greatest risk!" is totally left aside.</p>

## Strategic planning (medium-term)

Vulnerabilities	Opportunities
<p><i>Minimum distance from chemical clusters to the residential areas are demanded to be increased.</i></p> <p><i>Second- and/or third-generation products (break-bulk) replace raw materials cargo (liquid and dry bulk).</i></p> <p>More trade disputes between China and third countries take place, creating a major impact on trade with Europe.</p> <p>“Hartelkanaal” capacity is challenged due to restrictions on emission. Inland barges speed limit is reduced (difficult overtaking).</p> <p>* The only link between clients (potential and existing) and PoRA are the commercial managers.</p>	<p>PoRA becomes part of a national public limited company (N.V.) in charge of every Dutch port.</p> <p>Estimated environmental emissions and risks at Europort are complying acceptable limits.</p> <p><i>Long-lasting contracts are a common practice to attract companies.</i></p> <p>World-class industrial companies are willing to settle in Rotterdam with the same spirit of PoR (efficiency and sustainability) and do not prefer other ports with different requirements.</p> <p>* PoRA will also pursue every optimization opportunities (not-in-use land, productivity and efficiency) to anticipate uncertain developments.</p> <p>Sharing quay or jetty facilities is a premise for any new infrastructure commercial development.</p> <p>PoRA takes the lead in promoting and supporting the development of bio-based companies by several means (e.g. facilitating and providing access to first or second generation feeder stock, good logistical access, et cetera).</p> <p>* PoRA has strong technical professionals. It is a worldwide front-runner company in the field of technical innovation, leading international best practices. PoRA is not only a management company; it also develops first-class technical know-how.</p>
<p>Seizing opportunities for "temporary" use of the unallocated plots is not considered as an option.</p>	<p>* Excellent communication &amp; cooperation amongst PoRA internal departments is fully achieved.</p> <p><i>* Predicted IRR (in a business case) is achieved during the commercial lifecycle of a project and internally controlled (also stated) for each terminal.</i></p> <p><i>Company’s merging has not a large impact for the cargo flows at Europort.</i></p> <p>Terminals related with the vision of Europe’s Industrial complex are interested in developing their business at Europort. The port’s motto is “The right company in the right place”, and the statement “a missed opportunity is greatest risk!” is totally left aside.</p> <p>The companies and terminals emerging in new market segments like synthesis gas (or syngas), carbon capture and bio-based can find enough local professionals with the right expertise</p>

## Masterplanning (long-term)

Vulnerabilities	Opportunities
<p>Minimum distance from chemical clusters to the residential areas are demanded to be increased.</p> <p>Second- and/or third-generation products (break-bulk) replace raw materials cargo (liquid and dry bulk).</p> <p>“Calandkanaal” capacity is challenged by other large vessels with greater air draft and low manoeuvrability (e.g. large containerships or LNG carriers) or for too much traffic (two-way req.).</p> <p><i>Rail and road transport does not play a major role for cargo handled.</i></p>	<p>PoRA becomes part of an International public limited company (with shares from different countries like Brazil, Oman, Romania, et cetera).</p> <p>Estimated environmental emissions and risks at Europort are complying acceptable limits.</p> <p><i>Long-lasting contracts are a common practice to attract companies.</i></p> <p>World-class industrial companies are willing to settle in Rotterdam with the same spirit of PoR (efficiency and sustainability) and do not prefer other ports with different requirements.</p> <p><i>Rotterdam and Antwerp team-up as a single port and develop new industrial business together using its integration as main driver for competing with other industrial complexes in the world.</i></p> <p>The opening of the Arctic North route between Asia and Europe is not challenging the Europort position due to the limited available depth.</p> <p>* PoRA has strong technical professionals. It is a worldwide front-runner company in the field of technical innovation, leading international best practices. PoRA is not only a management company; it also develops first-class technical know-how.</p>
<p>Partial emissions from sea-going ships and inland barges are accepted in the long-term; therefore LNG does not become the main fuel in Rotterdam.</p> <p>Unmanned vessels are implemented at worldwide scale and current manoeuvring areas are sufficiently large to accommodate these vessels.</p> <p><i>First-generation of bio-based production (using soy, rape, palm, sugarcane, wheat, corn, et cetera) is fully accepted and the “food for fuel” debate is totally overcome.</i></p> <p>* There is a shortage of (skilled) labour in the region.</p>	<p>Policy-making bodies at local, regional, provincial, national and EU level facilitate achieve Europe’s Industrial Cluster vision at PoR (less bureaucracy, less req. time for consult. and less regulations).</p> <p>Dutch corporate tax environment keeps facilitating the development of business with better conditions than other NW EU countries</p> <p>PoR houses strong players in all market sectors.</p> <p>Company’s merging has not a large impact for the cargo flows at Europort.</p> <p>To achieve a more efficient transport chain the number of actors interacting from the port to the hinterland is strongly reduced by the creation of corporations (e.g. for inland barges transport).</p>