Partners:

The Second Erasmus Smart Port Rotterdam / Port Research Centre Rotterdam-Delft / Next Generation Infrastructures
Poster Session

Rotterdam, June 27, 2013

Colofon

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Introduction

Some consider universities 'ivory towers'—towers in which anonymous researchers are writing research articles with as the main goal to convince anonymous reviewers to publish this research in high ranking scientific journals. By organizing a PhD poster session, Erasmus Smart Port, Port Research Centre Rotterdam-Delft and Next Generation Infrastructures, together with the Port of Rotterdam Authority, prove this ivory tower vision a caricature. In this poster session, individual researchers, their work and their supervisors become visible. PhD-students present their work to an audience of other port researchers and port professionals, offering the possibility to discuss the contents of their research with related and concerned stakeholders. One of the main goals of Erasmus Smart Port is to exchange knowledge between university and the port business community. The tower of the World Port Centre, home of the Port of Rotterdam Authority and a well known location for everyone in the port business, therefore is the best location possible for presenting port research! We are very grateful the Port of Rotterdam is willing to host the 2013 port poster session.

The Port of Rotterdam Authority is sponsor and founding father—together with the City of Rotterdam, Deltalinqs and Erasmus University Rotterdam—of *Erasmus Smart Port*. In addition, the Port of Rotterdam Authority cooperates with Delft University of Technology by means of the *Port Research Centre Rotterdam-Delft*. Also, the Delft based research institute *Next Generation Infrastructures* cooperates with the Project Organization Maasvlakte 2, part of Port of Rotterdam. The joint mission of these three research institutes is the development and dissemination of innovative, strategic research projects for the port of Rotterdam, both for companies in the port and port-city and for the port authority. This is the reason for relating the ongoing port PhD-research in this poster session to the strategic vision of the Port of Rotterdam: the Port Vision 2030.

'Main port of knowledge' is the motto of Erasmus University Rotterdam. Smart Port wants to be the gateway for linking the port business community to port research—research executed both within and outside of the Netherlands. Last year, PhD-students from Antwerp University/ITMMA participated in the poster session. This year, in addition, students from KU Leuven and Hamburg University of Technology present a poster. We asked students from Antwerp and Hamburg to relate their poster to the strategic visions of the port of Antwerp and Hamburg respectively. In this way, the result is a nice overview of the relation of PhD-research and port strategy in the three largest ports in North West Europe.

It is with pride that we present 30 posters this year. After the previous poster session ba number of students received a PhD, a number of students unfortunately stopped researching and a number of students considered the time of one year too short to produce a new poster. Two students gave priority to finishing their research in a crucial phase—"To keep a chicken laying, it's best not to disturb her" is a Dutch phrase suited to this situation. However, we think that a continued discussion between PhD-students and the users of their knowledge is of crucial importance. From the perspective of the PhD-students, as well as from the perspective of the users of knowledge, discussion on the relevance, applications and research strategy applied is very useful. This year a number of participants of expert groups related to the execution of the Agenda of the Port Vision 2030 will attend the

session. Also, we are very happy that two fresh post-doc students—Amir Gharegozli and Nima Zaerpour—continued their presence at the poster session after their graduation. Also after receiving a PhD, new and innovative research continues—as both researchers prove.

We at Erasmus Smart Port—but also the broader port research community—were shocked and very sad because of the sudden demise of our colleague Eelco van Asperen. Eelco received a PhD in 2009 with his thesis 'Essays on Port, Container, and Bulk Chemical Logistics Optimization'. Eelco was program director of the postgraduate course Maritime Economics and Logistics (MEL) and deputy director of Smart Port BV. Eelco visited the poster session of last year and was very enthusiastic about all the young and dedicated port researchers brought together. We will remember Eelco as a very dedicated, accurate and serious colleague, always going the extra mile. Both the MEL program and the Smart Port community will miss him very much.

Finally, with these posters, we literally bring our port knowledge to the port. With this bundle in which the posters are collected and some further information is provided you are able to bring this knowledge to your own working environment. We hope that these posters will inspire you and will be of use for your business. Therefore, this is a work book and also a bundle of contact advertisements because we hope to come into direct contact with you as one the decision makers in the port

On behalf of the organizers,

Rob Zuidwijk
Scientific director Erasmus Smart Port Rotterdam

Bart Kuipers
Director Business development and Business relation Erasmus Smart Port Rotterdam

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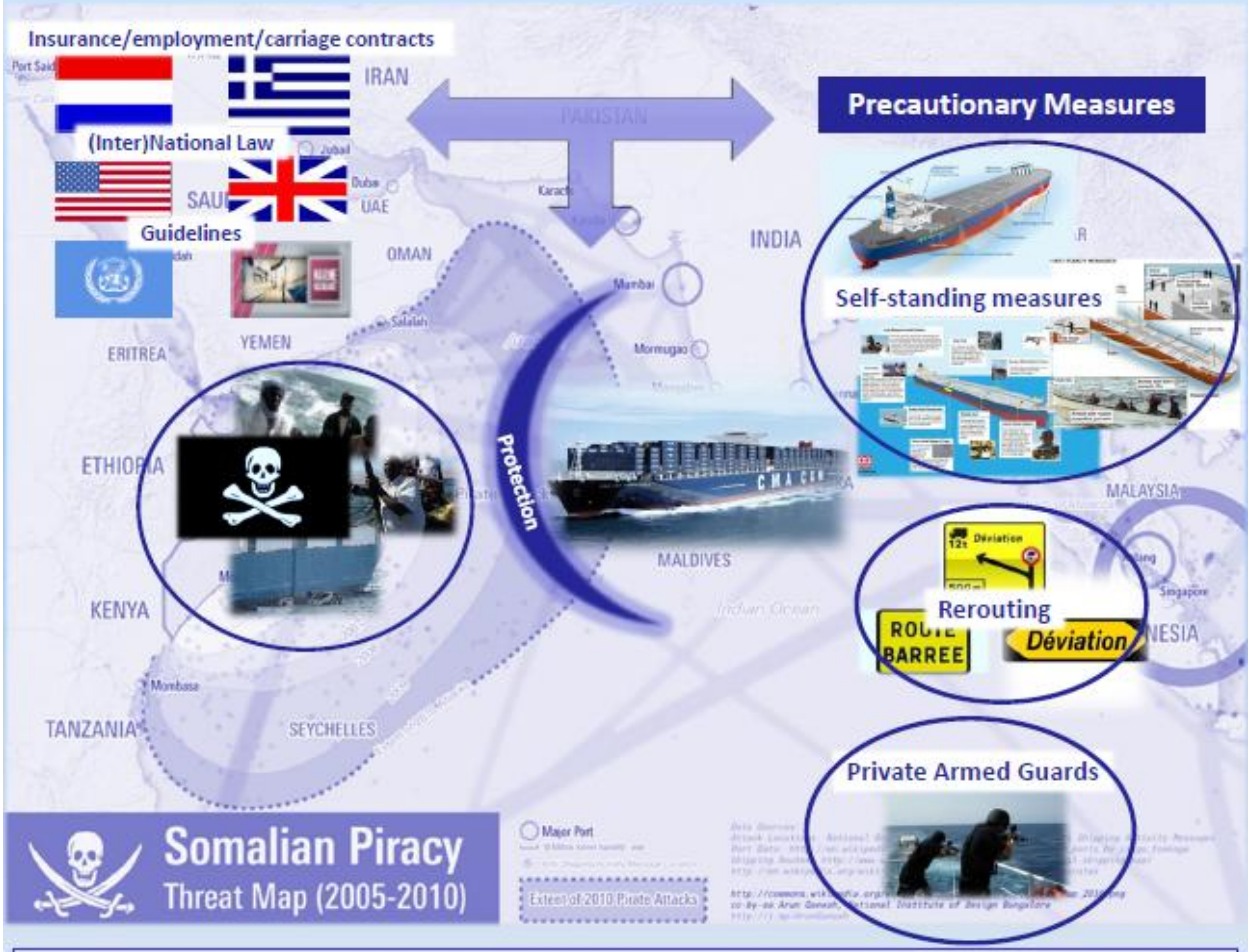

Which precautionary measures can and should ship owners take in order to protect their vessels, crew and cargoes from the risk of pirate attacks?
Is there any obligation upon the ship owners to provide precautionary measures based on their different contractual relationships?
Is this obligation an absolute duty or is it a relative one, subject to the principle of reasonableness and the principles of business?

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Private Law Aspects of Precautionary Measures by Ship Owners Against Maritime Piracy

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Curriculum Vitae

Myrto Vasili was born in 1985 in Amarousio Attikis, Greece. After graduating from the General High School in 2003, she studied law at the National and Kapodiastrian University of Athens from which she graduated with a bachelor degree in 2009. In 2012 she graduated from the Erasmus University of Rotterdam with a Master of Laws after successfully completing the LL.M Commercial Law. In November 2012 she became a PhD candidate at the Erasmus School of Law where she is working on her PhD-thesis under the supervision of Prof. Dr. F.G.M. Smeele. The topic of her PhD-research is the private law aspects of precautionary measures by ship owners against maritime piracy.

Introduction

In recent years, piracy appeared once again in the high seas causing enormous complications to the maritime industry. The increased number of successful attacks against merchant vessels and the taking hostage of crew members, especially off the coast of Somalia, has raised the problem of maritime piracy to the highest political levels. As a consequence, the maritime nations have joined forces along with the support of international institutions to repress piracy. Nevertheless, the recent efforts to

combat maritime piracy have not eliminated the threat of pirate attacks, but have merely reduced that risk.

Research Question

The fact that the military and navy resources are limited in comparison with the vastness of the areas where the pirates are active and that there is not sufficient capacity of escorting each and every merchant vessel which transits waters where there is a risk of maritime piracy, leads to the question*: which are the precautionary measures available to ship owners, under private law, so as to combat the risk of maritime piracy?*

Research problem

Ship owners in order to operate their ships enter into various contractual relations with their customers (contracts of affreightment and contract of carriage), with their crew members (contract of employment) and with their underwriters (insurance contracts with regard to Hull & Machinery risks, War risks, Protection & Indemnity risks). As a result of piracy risk, ship owners confront practical problems regarding the issue whether it is profitable to continue their business in those troubled waters and in the affirmative under which conditions they can operate.

The questions which arise concern: -which precautionary measures ship owners can and should take in order to protect their vessels, crew and cargoes from the risk of pirate attacks, - whether there is any obligation upon the ship owners to provide precautionary measures based on the different contractual relationships they are engaged to and – in the affirmative whether this obligation is an absolute duty or it is a relative one subject

to the principle of reasonableness and the principles of business.

Precautionary measures

- Self-standing measures

The international maritime community facing the continual increase of pirate attacks tried to address this issue by issuing guidelines and safety orders which ship owners can implement so as to minimize the risk of successful pirate attacks. For instance, the International Maritime Organization has issued the Best Management Practices, which are non-mandatory guidelines providing a minimum level of protection to the vessels transiting areas affected by maritime piracy. Ship owners can also use the International Recommended Transit Corridor which is established to provide a safe passage to/and the Suez Canal.

- Rerouting

Ship owners have an alternative solution to travel via the Cape of Good Faith. This choice can cause various complications under the provisions of the charterparty. Under a time charterparty, the charterer has the right to instruct the vessel regarding the route has to follow. In case where the indicated route includes high risk areas for pirate attacks, the question which arises is whether the ship owner is entitled to reject the given orders. This problem statement can be distinguished in three different cases further than the principle that the ship owner has the right to reject the charterer's orders. These case are as follow: (a) the ship owner agrees on the risk, charges extra money but at the end he declines to proceed via the recommended route, (b) he assumes the risk but even then he has a right to decline the orders and (c) he assumes the risk but it is no longer possible to decline the orders.

- Private armed guards

The issue of employment of private armed guards by ship owners onboard of merchant vessels consists one of the most critical dilemmas the shipping industry and the governments have to confront. The employment of private armed guards by private parties has not been regulated by an international convention and the national legislation of the maritime States is segmented. Different opinions argue in favor of the presence of private armed guards onboard of merchant vessels, especially after the latest reports of the International Maritime Bureau which state that no vessel carrying armed guards has been successfully hijacked. The contrary view underlines the complications creating by the non-regulation of the issue.

It is recognized that the legal framework governing the use of private armed guards is still vague and ambiguous. Many States have altered their national legislation so as to provide a regulatory framework which applies to the vessels flying their flag. However, each State applies different criteria according to their public policy and the interests that they want to protect and secure. England, USA, Greece permit the employment of private armed guards but they impose different requirements both on ship owners and securities companies. The Netherlands until recently prohibited the employment of private armed guards by private parties. The government had a military monopoly but there is a change to the parliament's attitude towards this issue due to the discontent of the Dutch ship owners.

Another issue is the regulation of possessing weapons on board commercial vessels and the conflicts of law which might be caused when a vessel, while carrying weapons on board, enters the territorial waters of a Coastal State which forbids them (ex. Egypt).

Another question is which law applies to the contract between the ship owner and the private security company. Which requirements should be met in order for ship owners to legitimately employ securities companies? Are these requirements considered as warranties under the insurance contract so that ship owners can obtain insurance cover? BIMCO has issued a standard contract called GUARDCON, even though BIMCO has not explicitly recognized the employment of private armed guards by ship owners, so as to provide a minimum level of security and a threshold of standards to the contracting parties.

Furthermore, questions arise concerning the relations between the master of the vessel and the guards in case of an attack. Who is in charge and who makes the calls? Last, but most importantly, in case of a casualty who is liable and who bears the risk? Is it the ship owner/master or the guards?

Research approach

In order to answer the above mentioned questions, it is required to submit the basic principles of contract law, employment law and insurance law to a process of fundamental analysis based on the factual conditions which gave rise to those questions. Moreover, it is worth researching the courts decisions which interact with the prevailing views of the legal literature. Legal literature evolves as the legislation is transformed so as to reflect the needs and to provide adequate solutions to the legal questions of the era.

Plans for 2013

In 2013 research will be conducted on the legal position of all parties under the contract of carriage and the contract of affreightment. For example, the carrier, by entering into those contracts, undertakes certain obligations pursuant to the applicable law governing the contracts. These obligations will be analyzed and examined in relation to the risk of maritime piracy. As the contracts of carriage are by its nature of an international character different national and or international rules might apply to the contracts. This research will at least include and thus compare those rules applicable in: the United Kingdom, the United States of America, the Netherlands and Greece. The year 2013 will mainly be dedicated to gathering all relevant materials, i.e. case law and legal literature, from the different legal systems. Therefore visits will be made to different research facilities, e.g. Max Planck institute and IMO.

The 2nd Erasmus Smart Port Rotterdam/Port Research Centre Poster Session, Rotterdam, June 27, 2013

Freight integration.

Legal uncertainty as hindrance to transport optimization?

Port Vision 2030: "Global Hub"
Crucial action: creation efficient logistic chains

Research and port strategy

Sustainability report:
Weakness: modal split in container transportation

Freight Integration

Logistic innovations:
Extended gateways: road, rail and inland water as alternatives
European integrated transportation: road, rail, inland water and short sea shipping as alternatives

Legal innovation required?
Does the existing regime offer legal certainty at the time of conclusion of the contract?

Research Question: can parties leave the mode of transportation open, and thus allow for freight integration, without creating legal uncertainty?

Research field: Belgium, the Netherlands and three most important trade partners: Germany, UK and France

Freight integration requires free choice to determine the mode of transportation at the time of performance of the contract.

Uncertainty with regards to **the applicability of transport law?**

Relevance? (examples)

Mandatory nature:
transport law (mostly) mandatory
Expedition law (mostly) non mandatory

Presumption of liability:
Carrier presumed to be liable
Freight forwarder (mostly) not

Efficient logistics OR legal certainty?

Uncertainty with regards to **the applicable transport law?**

Relevance? (examples)

Compensation:
Sea or Inland water: +/- € 2,3/ kg
Rail: +/- €19,5/kg

Exclusive jurisdiction clauses:
Rail/ Road: invalid
Sea/inland waterways: valid

Applicable liability regime largely depends upon mode of transportation

Research outcome: Legal framework does not allow for legal certainty

Solutions?

Active contract drafting

Problem: mandatory nature transport law (no opt out)
Solution: Including forum and choice of law clauses to create legal certainty

Suggestions for jurisprudence

Can courts interpret existing laws in a way that offers legal certainty?

Suggestions for legal intervention

How can law offer legal certainty?

-shift from mode based to cargo based regime
-uniform liability regime
-limited mandatory scope

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Freight integration and carrier liability

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Curriculum Vitae

Wouter Verheyen (03/05/1985) obtained his bachelor (cum laude) and master (magna cum laude) of laws at the KU Leuven. He was ranked 5/316 of his year. Additionally he obtained an academic teaching degree (magna cum laude). During his education he was selected to participate for his university at the Willem C VIS Commercial law moot court (team result: 67/205) and the Intensive Programme 2007 of Deusto university in Bilbao: "General Problems of Transnational Law and its Implications for the Companies in International Trade". Moreover, as a student Wouter was chief editor of Jura Falconis Law Review. In 2008 Wouter started as a PhD-candidate a research on options in transport contracts and carrier liability. This research entails an in depth study of Belgian law and the law of Belgium's four most important trade partners, The Netherlands, Germany, France, and the UK. During his first PhD-year he gained in-depth knowledge in transport and shipping law, by means of internships at a transport law firm (Van Doosselaere) and a LNG/LPG shipping firm (EXMAR Shipping) and by participating at the Southampton Maritime Law Short course. After this first year the Flemish institute for technology and science awarded Wouter a scholarship

(IWT-scholarship, only 2 scholarships awarded in human sciences).

Wouter's research resulted in 11 publications, among which two contributions in peer reviewed international books, three contributions in national peer reviewed journals, one co-editorship of a book and one co-publication with Erasmus University professor K.F. HAAK. One further publication is accepted. 10 times Wouter acted as a speaker on a conference, Among which five international conferences, one other conferences is planned. Defence of the PhD is scheduled in the autumn of 2013.

Research presentation

Recently the transport sector has seen a strong growth of freight integration. Contrary to classic carriers, integrators leave the mode of transportation open, and can select the most efficient mode of transportation at the time of the performance of the contract. (Hereinafter referred to as optional carriage contract) Both for the parties to the contract, as for society this evolution can make transport more efficient. Although the mode of transportation is often not agreed upon in the contract of carriage, still most liability regimes depend upon the mode of transportation. Therefore the hypothesis underlying this research is that the parties to the carriage contract cannot predict their liability position at the time of the conclusion of the contract, when they leave the mode of transportation open.

In its first part, this research examines whether freight integrators can be qualified as carriers and whether parties can predict this qualification at the time of the conclusion of the contract. Freight

integrators can only be qualified as carriers insofar as the agreement upon the mode of transportation is not an essential characteristic of the contract of carriage. Even if the agreement on the mode of transportation is not an essential characteristic, still this qualification might not be upheld in specific cases, as there is only a thin line between contracts of carriage and other types of contracts for the organisation of carriage (such as freight forwarder contracts and contrats de commission de transport.) Consequently we examine whether the typical characteristics of the freight forwarder can influence the qualification as a carrier or rather as a freight forwarder. The relevance of this question lies in the fact that while the carrier liability is mostly governed by a mandatory liability regime, from which the carrier cannot deviate, freight forwarders mostly do have the possibility to include contractual exonerations of liability in their contract. Moreover, upon the carrier rests a presumption of liability, whilst in order for the freight forwarder to be held liable, his fault must be established. Consequently a qualification of the freight integrator as a freight forwarder, is very disadvantageous for the cargo claimant.

In the second part we examine whether, if the qualification as a contract of carriage is upheld, parties can predict the liability regime that will be found applicable to the contract. This possibility depends first of all on the scope of application of legal instruments: when a regime applies to a wider variety of means of transportation, also when the carrier has a freedom to choose the means of transportation, all these means might still fall within the scope of application of the law. Thus, for example in German transport law, all possible means of transportation for integrated hinterland logistics (rail, road and inland waterways) fall within the scope of §407 HGB and here the parties know the applicable liability regime at the time of conclusion of the contract. On the contrary in international law, just like in Dutch and Belgian national law, these different means of transportation are governed by different liability regimes. Second important question is whether the scope rule refers to the means of transportation used for the performance of the contract (real scope rule), or rather the means of transportation contractually agreed upon (contractual scope rule). If the scope rule refers to the means for the performance of the contract, parties cannot have certainty with regards to the applicable regime when the choice given to the carrier does not fall entirely within the scope of a single regime. If the scope rule refers to the means of transportation contractually agreed upon, certainty might be possible insofar as the contract is interpreted by the judge only taking into account context prior to the conclusion of the contract. This interpretation question is the third question addressed in the second part.

Taken into account the uncertainty we identified in the first two parts, in the third part we examine whether parties can achieve legal certainty contractual. Here, a hindrance is the mandatory nature of carriage law within its scope of application. However by including choice of law clauses and forum clauses, uncertainty can be limited. As these contractual techniques add on to negotiation costs, a legal intervention is desirable. Therefore we conclude this third part of the research by making suggestions for a legal intervention.

Relationship between research and port strategy Antwerp-Rotterdam.

The port vision of the port of Rotterdam brings forward the creation of efficient logistic chains as one of the crucial actions

to realize the port strategy. Also sustainability of the port of Antwerp can be served by more efficient logistic chains as road transportation still has a share of over 50% in container movements. Freight integration can both bring down the share of road transportation in the modal split and in creating more efficient legal chains. As the lack of predictability of the risk is a competitive disadvantage to freight integration, this research also contributes to the realisation of the port strategy of both ports.

Freight integration can play an important role in optimizing logistic chains. The study on Freight integrators to the commission of the European communities[1] states in this regard that" 'In accordance with the transport policy which aims to rebalance the modal shift and to increase the ecological friendly share of alternatives to road, the emergence of such Freight Integrators should be supported.' The fitness of freight integrators for the purpose of realising the strategy of both ports is illustrated by some of the 10 indicators for the identification of Freight Integrators, e.g. their commitment to intermodality, their support for the idea of environmental sustainability and the economic substantiation of intermodality.' Likewise, the Dutch topteam Logistiek concluded that "Synchromodaliteit[2] … de oplossing voor economisch efficiënt en duurzaam vervoer met optimale benutting van de aanwezige infrastructuur…Deze synchromodale afstemming en bundeling kan juist in Nederland plaatsvinden, omdat in Nederland, als Gateway to Europe, grote stromen samenkomen. Een forse groei in het vervoer, verduurzaming van dat vervoer en een betere benutting van de infrastructuur gaan in deze visie samen en versterken elkaar bovendien – simpelweg omdat dit ook economisch het meest aantrekkelijk is.."

Freight integration can also help accelerating the modal shift, as it does not require other modes of transportation to be efficient in abstracto, i.e. for any carriage on the selected route, but merely in concreto, for the given transportation. Consequently, also when road transportation is less efficient for the specific transportation, due to, for example, road works, the cargo can be shifted to another mode of transportation. When the mode of transportation is contractually agreed upon on the contrary, the carrier is obliged to carry the cargo by road, even if in casu road transportation is less efficient.

Although freight integration is both economically and ecologically efficient, the lack of predictability of the risk is a competitive disadvantage of freight integration. The ZLU-study names liability as one of the problem areas in the field of freight integration.[3] An earlier study to the EU[4] illustrates that legal uncertainty is

[1] ZLU e.a., "Studie on Freight integrators, to the commission of the EU, Final report", Berlijn 2003, http://ec.europa.eu/transport/logistics/documentation/freight_integrators/doc/final_report_freight_integrators.pdf; 1; see also: Communication from the commission, The EU's freight transport agenda: Boosting the efficiency, integration and sustainability of freight transport in Europe, Brussels, 18.10.2007, COM(2007) 606 final

[2] See on the concept of synchromodality: TNO, "Verkenning synchromodale transportsystemen", *ttps://mkb-mainports.hva.nl*, 19("*Synchromodaliteit wordt theoretisch gezien geoptimaliseerd door de volledige vrijheid en mogelijkheid om supply chains zodanig in te richten, goederenstromen zodanig aan te sturen en vervoersdiensten zodanig te plannen en in te zetten, dat voor elke lading de juiste (in termen van economie en duurzaamheid) oplossing wordt gekozen.")*

[3] ZLU e.a., "Studie on Freight integrators, to the commission of the EU, Final report", Berlijn 2003, http://ec.europa.eu/transport/logistics/documentation/freight_integrators/doc/final_report_freight_integrators.pdf; 54

[4] IM Technologies Limited, "*The Economic Impact of Carrier Liability on Intermodal Freight Transport*", final report,

no mere secondary problem: the annual costs of the lack of an efficient legal framework are estimated in this study at € 500-550 million per annum. These costs have to be taken into account when determining whether freight integration is an efficient alternative. Consequently, bringing down legal uncertainty, and creating a solid legal framework, can help to make freight integration an alternative for a larger share of total transportation, and thus to realise the strategy of the port of Antwerp and Rotterdam. An advantage of this research is that it not merely focusses at making suggestions for legal intervention, as making new law often requires several years. Instead the study primarily focusses on making suggestions to the parties on how to create legal certainty in their contracts.

10 January 2001, (EC contract No: B99-B2 7040 10-SI2.81489/P E1 99 002/ETU/IM)

The 2nd Erasmus Smart Port Rotterdam/Port Research Centre Poster Session, Rotterdam, June 27, 2013

THE PAST IS ALWAYS PRESENT IN THE PORT

The decision-making process of Maasvlakte II (1993-2009)

Dirk M. Koppenol MA

RESEARCH PROBLEM:

During the 1950s and 1960s the port of Rotterdam became the largest seaport in the world and physical expansion was needed. This resulted in expansion by the Botlek, Europoort and Maasvlakte I plan. Already, during the construction of Maasvlakte I, a plan for Maasvlakte II was put forward. However, in the early 1970s, the decrease of world trade and opposition from environmental groups resulted in the postponement of the execution. Eventually, in 1993 a new decision-making process began and sixteen years later the construction of a much smaller Maasvlakte II was finished.

Theory on decision-making processes focusses mostly on the procedure rather than on persons involved; moreover, the time dimension is often left aside. Strategic planning of persons and the time dimension were, however, of essential importance. For example, the first research results show that support of key-ministers and socio-economic tendencies formed the basis on which crucial decisions were made.

MAIN QUESTION:

Why did the decision-making process of Maasvlakte II (1993-2009) take more than sixteen years? Moreover, which factors caused the fastening and slowing down of the decision-making process since the 1970s?

APPROACH:

Three intertwined factors form the basis of this research: **socio-economic developments, freedom to act** and **path creators**.

For example, a decisive minister (path creator) with a favourable attitude towards the port is needed to make a port expansion acceptable. However, a minister is depended on the public and parliamentary approval (freedom to act) to implement its policy. This approval is depended on the attitude of the Dutch population, which is strongly influenced by socio-economic developments. For instance, high unemployment rates can have positive effects on the attitude towards port expansions. This interrelation is the core of this research.

RESEARCH GOAL:

-Determine the most important factors contributing to the eventual success of this decision-making process.

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The Past is always Present in the Port: the decision-making process of Maasvlakte II (1993-2009)

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Supervisors: prof. dr. H.A.M. Klemann and dr. B. Wubs.

Research: the decision-making process of Maasvlakte II (1993-2009)
Researcher: Dirk M. Koppenol MA

Research problem
During the 1950s and 1960s the port of Rotterdam became the largest seaport in the world and physical expansion was needed. This resulted in expansion by the Botlek, Europoort and Maasvlakte I plan. Already, during the construction of Maasvlakte I, a plan for Maasvlakte II was put forward. However, in the early 1970s, the decrease of world trade and opposition from environmental groups resulted in the postponement of the execution. Eventually, in 1993 a new decision-making process began and sixteen years later the construction of a much smaller Maasvlakte II was finished.

Theory on decision-making processes focusses mostly on the procedure rather than

on persons involved; moreover, the time dimension is often left aside. Strategic planning of persons and the time dimension were, however, of essential importance. For example, the first research results show that support of key-ministers and socio-economic tendencies formed the basis on which crucial decisions were made.

Main question
Why did the decision-making process of Maasvlakte II (1993-2009) take more than sixteen years? Moreover, which factors caused the fastening and slowing down of the decision-making process since the 1970s?

Approach
The decision-making process is divided into six parts, which all end with an important decision by the Dutch cabinet of parliament. Using this method it is possible to determine the forces which were important for the acceptance of Maasvlakte II. Overall this shows which factors caused the fastening and slowing down of the decision-making process.

Three intertwined factors form the basis of this research: socio-economic developments, freedom to act and path creators. For example, a decisive minister (path creator) with a favourable attitude towards the port is needed to make a port expansion acceptable. However, a minister is depended on the public and parliamentary approval (freedom to act) to implement its policy. This approval is depended on the attitude of the Dutch population, which is strongly influenced by socio-economic developments. For instance, high unemployment rates can

have positive effects on the attitude towards port expansions. In others words, there is an interrelation between these three factors.

Research goals

- Write a history of the decision-making process of Maasvlakte II (1993-2008).
- Determine the most important factors contributing to the eventual success of this decision-making process.

Curriculum vitae

- Studied History: International Relations (2006-2010) and Public Administration (2011) at the Erasmus University in Rotterdam.
- Started his Ph.D. project on the decision making process of Maasvlakte II September 2011.
- The Ph.D. project is financed by the Port of Rotterdam and supervised by prof. dr. H.A.M. Klemann and dr. B. Wubs.

The 2nd Erasmus Smartport / Port Research Centre Rotterdam-Delft / Next Generation Infra
Poster Session, Rotterdam, June 27, 2013

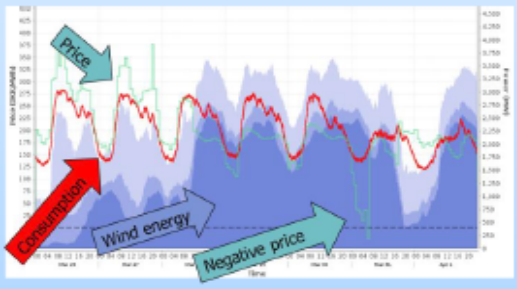
Converting excess wind power into valuable products

Greening the Port of Rotterdam by "transhipment" of wind

Hamilcar Knops, Anish Patil, et al

Introduction

Wind energy is a prospective option to achieve sustainable production of electricity, as already demonstrated in Denmark and Germany. However, the unpredictability of wind energy production may result in more volatile spot prices for power, extra forced interventions by the system operator causing financial commotion and the risk of congestion of the transmission grid. To elucidate the effect of the variable supply of wind energy, the demand and supply is for West Denmark for the last week of March 2012 given below. As Denmark is frontrunner in wind energy, these data can be regarded as a picture of the future of the Dutch state of affairs.



Research goal

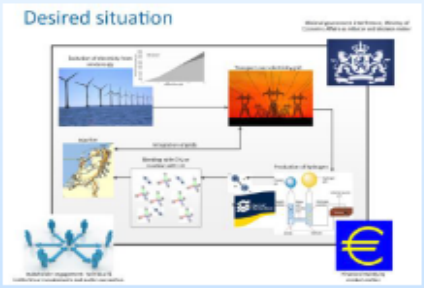
A group of private parties and TU Delft investigate how options for dealing with the intermittency of wind energy can be implemented in the Rotterdam Harbour, on Maasvlakte 2.

They will explore, assess, and select technical and institutional options for applying the dynamic surplus of wind energy for the production of hydrogen gas by electrolysis, including its injection into the natural gas grid, its use for the production of methanol or ammonia. Other innovative alternatives will be explored as well

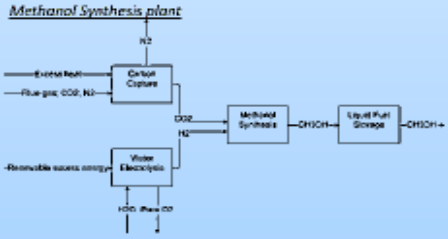
The scientific challenge is to incorporate the extreme dynamic behavior of the overall system into the assessment of several clustered production processes.

During this scouting project more stakeholders are cordially invited to on-board for the next phase: a demo project!

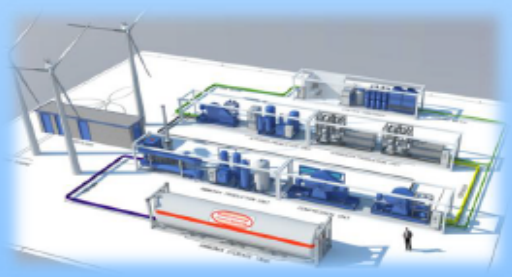
H_2 and injection in the natural gas grid



production of methanol using CO_2



production of ammonia.



Opportunities for PoR

- Reduction of the carbon footprint
- Greening of industrial processes and products within MV2
- Allowing a higher contribution of wind energy to the Dutch power production portfolio

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Hamilcar Knops & Anish Patil, Delft University of Technology

Converting excess wind power into valuable products: greening the Port of Rotterdam by "transhipment" of wind

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Hamilcar Knops is researcher at the Delft University of Technology.
With a background in physics and law, a PhD about the design of the rules for a liberalised electricity sector, and experience as a policy adviser, he focuses his research on how technological changes in the energy sector affect the sector's legal and institutional organisation and vice versa.
Anish Patil is currently working on his doctoral thesis at the Delft University of Technology. His research focuses on the transition towards a sustainable energy system. Also, he is working part-time as a business development manager with Proton Ventures, Netherlands. Focus of his work is to develop Proton's NFuel concept, which is based on decentralized production of Ammonia from surplus electricity from wind or solar, to be used as a fuel or a chemical feedstock.
Wind power is associated with fluctuations – that can be the difference between day and night, or seasonal, or in fact from minute to minute. These fluctuations are a big challenge for the electricity supply system. Technically they can lead to reliability and availability issues and economically they can cause volatile prices.
To elucidate the effect of the variable supply of wind energy, the demand and supply for West Denmark[5] for the last week of March 2012 are given in Figure 1. As Denmark is a frontrunner in wind energy, these data can be regarded as a picture of the future of the Dutch state of affairs. The demand line shows a day/night rhythm, where the maximum demand doubles the minimum demand. On the supply side, the wind energy production fluctuates, randomly distributed in time, from zero to almost the maximum demand, which equals around 2000 MW for this West Denmark example. When wind power production exceeds power consumption, the price drops below zero.

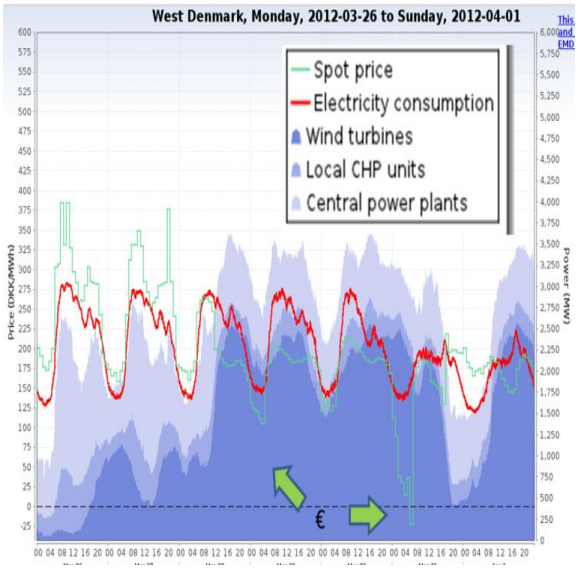

Figure 1 Electricity Demand and Supply in West Denmark[4]

The sustainability drivers at EU and Dutch level will result in an increased share of renewable energy sources. Wind energy is the most important renewable energy source in the Netherlands. To meet the long term targets, large investment in wind-energy will be inevitable in the near future. Operators of the grid and the system have to find ways to deal with the

[5] http://www.emd.dk/el/

technical challenges posed by the fluctuations accompanying wind. At the same time, a sizeable production of wind power may offer economic opportunities since its marginal cost is almost zero and, hence, it could be a source of very cheap power. Could it be possible to use this opportunity in order to develop an efficient mechanism through which the peaks and troughs of wind power can be managed?

A promising idea is to convert the temporary excess of wind-generated electricity into hydrogen gas and oxygen gas by electrolysis. The produced oxygen has (some) economic value in harbour industrial clusters, for instance in the Port of Rotterdam. The produced hydrogen can either be injected directly in the natural gas grid, mixed with evaporated LNG, or used as feedstock to produce ammonia or methanol
for industrial purposes. Another option is to apply the temporary excess of wind-generated electricity in batch processes that consume significant amounts of electricity, like the production of silicon carbide or for the production of steam.

The idea of combining wind power with other industrial sectors is not unique: German power provider Greenpeace Energy is constructing a unit that will convert excess wind power into hydrogen, which will then be sold to the German natural gas grid.[6.] RWE, Bayer and Siemens join forces in the Co2rrect-project to produce chemicals based on wind-based hydrogen[7]. Proton Ventures has developed a skid-based Wind2Ammonia unit, capable of storing fluctuating renewable energy in the form of Ammonia. Furthermore, in the Netherlands, stimulating results are being achieved on the island of Ameland[8].

In this project, a group[9] of private parties and TU Delft want to investigate how options for dealing with the intermittency of wind energy can be implemented in the specific context of the Rotterdam Harbour, on Maasvlakte 2. The project partners are exploring a 'greenfield situation': there are no promising technical designs yet, insight in the options and requirements for the necessary institutional design is still lacking, the economic prospects are not yet clear, and prospective investors and owners have not been identified yet.

Therefore, the aim of this research project is to make an integrated technical and institutional design to outline how wind energy peaks can be 'stored' in the form of chemical feedstock while aiming at the greening of industrial processes in the Maasvlakte 2 region by making optimal use of the synergies that may exist in the Rotterdam Harbour area. Essentially, it means finding ways of converting excess wind energy into new products that can be used in or transported from the Port of Rotterdam, which we shortly refer to as the 'transhipment of wind'.

6 http://www.renewablesinternational.net/greenpeace-launches-power-to-gas/150/537/56730/

7 http://www.utilities.nl/opslag-van-windenergie-stapje-dichterbij.98819.lynkx

8 http://www.ameland.nl/index.php?simaction=content&mediumid=11&pagid=648

9 Parties that show interest in the development of the idea of using excess wind energy to produce hydrogen gas on Maasvlakte 2 are: The Road Project, E.On, Tennet, Port of Rotterdam, Proton Ventures and Stedin.

The 2nd Erasmus Smart Port Rotterdam/Port Research Centre Poster Session, Rotterdam, June 27, 2013

Towards a Sustainable European Energy Port: Governing Local and International Ambitions

The Causes

- decline in natural resources
- climate change
- EU sustainability policies
- national sustainability policies
- changing landscape for energy companies

The Puzzle

- perceived mismatch between EU perceptions and Rotterdam Energy Port ambitions
- how to solve this by targeting public affairs management towards the EU?

The Relevance

- supports literature on the embeddedness of ports in the European Union policy process
- helps implement Havenvisie 2030
- matches identified success factors 'environment' & 'Europe'

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Towards a Sustainable European Energy Port: Governing Local and International Ambitions

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Supervisors: Prof.dr. H. Geerlings & dr. F.K.M. van Nispen, Department of Public Administration

Curriculum Vitae

My name is Natalya Rijk and I am a first year's Ph.D student of Public Administration. I am 24 years of age and currently live in Leiderdorp. I am employed by the Erasmus University Rotterdam, department of Public Administration, to carry out my research concerning port public affairs management in the EU.

I have obtained both my Bachelor's and Master's degrees at the same university, where I have studied Public Administration and International Public Management and Policy. I have completed a minor at Carleton University in Ottawa, Canada (with focus on internationally oriented subjects) and have worked on a project at the International Policy department of the Ministry of Education, Culture and Science during the second year of my bachelor education. I obtained my Bachelor's degree with a thesis on the impact of benchmark-setting in education policy on EU Member States. For my master thesis I wanted to look at the policy process from a different angle: more bottom-up. My thesis was centered around the influence national parliaments have in the European Union through the, at that time, newly introduced yellow and orange card procedures. As such, I was interested in how national parliaments deal with issues of subsidiarity. After obtaining the Master's degree I remained interested in the bottom-up processes of European policy-making and European governance. It was then that I developed an interest for interest group representation in the EU, specifically in the field of energy policy. In collaboration with the Port of Rotterdam, this research interest was worked out into a Ph.D research surrounding EU public affairs management of the Rotterdam Energy Port.

In my spare time I volunteer at the animal shelter in Leiden, am an avid video gamer, like to read books, practice yoga as well as modern ballet.

What am I researching?

The European Union has been slowly but surely taking hold of more and more policy fields over the years of its existence. The consequence of this Europeanization of policies is that its subjects have discovered that lobbying at the regional and national level often does not provide sufficiently satisfactory results. As the EU is a major source of legislation, lower governments, civil society and businesses have begun establishing their influence in 'Brussels', often with mixed success. The Port of Rotterdam is one example of such a 'subject' to many European policies. A quick scan shows that a wide array of policies affect port processes; such policies now extend to competition, energy, climate, labour market, industry, maritime, transport, trade, customs, and so on. This widespread effect of EU legislation on ports makes the EU a highly interesting actor to the Port of Rotterdam.

In its strategic document *Havenvisie 2030* the Port of Rotterdam envisages a

transformation towards a green Energy Port, which is backed by the Rotterdam Climate Initiative (RCI). The Energy Port concept entails a green, sustainable port with an energy carrousel. This goes particularly for CO_2, but also for oil, gas, coal and the upcoming trend of 'green' energy such as wind/water energy and biomass. However, the Energy Port concept cannot be realised without cooperation from the port's network (both public and private) and without backing from governmental authorities such as the Dutch nation state and the EU. The broader network the port is operating in gives rise to challenges and opportunities. Already being Europe's largest port, Rotterdam is a logical place for numerous activities concerning sustainable energy. RCI is a regional advocate and partner for CO_2-reduction, going even beyond EU regulation. The new Maasvlakte 2 has ample room for green businesses to settle, which is now beginning to take place, and is subject to stringent sustainability criteria. Moreover, the port is deep enough to be able to accommodate even the largest ships, which cannot be said for many other European ports. Its well-established connection to the German hinterland, also being the main destination of many goods, gives it a strategic advantage over other ports. On the flip side, however, Germany also causes problems for the port. The *en masse* investment of German citizens in green energy has led to a surplus, which mostly gets 'dumped' in Rotterdam, leading to sustainable projects such as 'De Nieuwe Warmteweg' becoming unprofitable. The large-scale development of shale gas in the U.S. has also led to American coal prices dropping to a low point, thereby effectively pushing away all competition from other energy sources. Newly built clean power plants are being shut down due to these developments. Although the port is advocating sustainable energy, the lack of investments elsewhere, for example Eastern Europe, hampers its effectiveness.

It would be in the interest of the Port of Rotterdam to have similar sustainability demands throughout Europe in order to uphold its competitiveness. At first glance it would seem that the port should have an easy time bringing this issue to the EU, since the EU is a staunch advocate for sustainability. Multiple strategies, green and white papers[10] have focused on issues such as green transport, bio-based economy (BBE), CO_2 reduction, energy efficiency and so on. However, the EU's recent denial of subsidy for a sustainable initiative has further fueled an already existing feeling that there is a fundamental misunderstanding between the port and the EU. There have been several instances where the port felt confused by the signals the EU sent. The port is of the opinion that it is an excellent partner for the EU in matters of sustainable energy but is concerned that the EU does not seem to acknowledge this view. This feeling of being misunderstood, at least from the port's side, is the starting point of the puzzle this study will try to solve. The question is whether such a misunderstanding exists and, if it does, what contributes to this misunderstanding. Solving this puzzle should help the port identify strategies to conduct its public affairs in the EU more effectively.

In doing so, this study will draw on network governance literature, more specifically policy network theory, to provide a starting point for further inquiry. I think knowledge of the network surrounding the Energy Port concept is necessary in order to understand the mechanisms contributing to the feeling of being misunderstood. In this way, the Energy Port concept could be given different meanings by different actors, leading to different strategies being pursued by them. This could in turn complicate the

[10] See, for example, the Energy2020 strategy: COM(2010) 639, the 2005 Green Paper on Energy Efficiency: COM(2005) 265, the Energy 2050 Roadmap: COM(2011) 885, and the White Paper on a Single European Transport Area: COM(2011) 144.

relationship between the port and the EU. Many of the sustainable energy-related initiatives supported by the port need additional funding in order to be financially feasible. As such, the port is dependent on actors such as the EU and the Dutch national government for both a policy framework and funding. This, then, creates a complex network of both private and public sector actors that are all in some way involved in the Energy Port.

Why am I researching this?

This research contributes directly to the implementation of an important part of *Havenvisie 2030*. As stated above, the Port of Rotterdam has high ambitions concerning its Energy Port. This ambition coalesces with the port's vision on its position as global hub and Europe's industrial cluster. Within this vision, the environment and Europe have been identified as success factors. Both will be explained in further detail and brought into the broader context of the vision and my research.

Global developments have led to rising awareness of the dwindling natural resources Earth holds. Scarcity can lead to high (energy) prices in the future. For Europe, this means that it is becoming increasingly important to be more self-sufficient in its energy supply. Sustainable (bio-)energy can contribute to solving this problem. Sustainable goals are, as a result, being formulated on all levels of government, including the European Union. Furthermore, global climate change is pushing the sustainability agenda forward and businesses are taking the lead in profiling themselves as being 'sustainable'. Such an image can give competitive advantage. The Port of Rotterdam realises that it has a part to play in the sustainable and self-sufficient scenario, since its industries can contribute to the development of more sustainable energy sources. This engagement also provides opportunities for the port to expand in this area. Developing the Energy Port further within the context of Europe is therefore deemed important. The changing energy mix in Europe can thus in part be driven, or facilitated, by the Port of Rotterdam. The port can function as a European hub in global sense, providing Europe with opportunities to secure its energy flows in an efficient and durable manner.

The vision on the industrial cluster encompasses cooperation between business, governments and knowledge institutions. This approach fits perfectly within my research, as this study is a perfect example of a joint-venture focusing on effective network management in a network consisting of both public and private actors. The specific focus on public affairs management of ports in the European Union is, in academic literature, still very new. In short, this study will thus contribute to the body of literature concerning the embeddedness of ports in the EU.

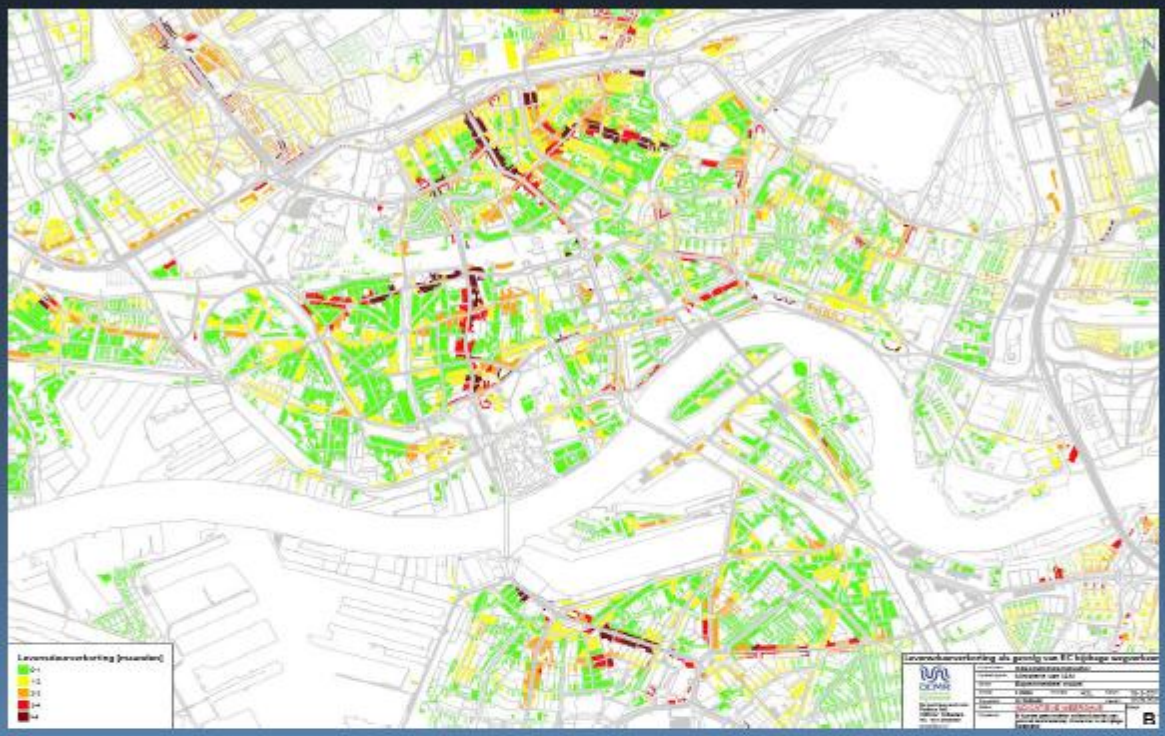
The Port of Rotterdam realises that the European Union has a great influence on the day-to-day operations of the port and its industry. In order to be able to realise its Energy Port agenda, the port needs to be able to comply with EU regulations and has much to gain from an EU-wide established level playing field for port authorities. However, certain EU policies may also hamper the growth and development of the Energy Port. It is therefore important that the port remains in constant dialogue with the EU and is recognised by it as an important stakeholder in matters of energy. Such recognition and dialogue would allow for synergy between EU policy and port development to arise. My Ph.D research will specifically contribute to the firmer establishment of the Port of Rotterdam within the EU decision-making process concerning energy and sustainability issues. As such it has very strong ties with the core ideas behind *Havenvisie 2030*. While

attention to ports and their environmental impact is starting to grow within EU institutions, it is important to study the interplay between these institutions and ports. Instead of making ports part of the problem, the EU can make them part of the solution by considering their specific positions and possibilities in the policy-making process.

The 2nd Erasmus Smart Port Rotterdam/Port Research Centre Poster Session, Rotterdam, June 27, 2013

Port vision 2030:

"In 2011, transport is one of the main culprits when it comes to CO2 emissions and is responsible for the problem of fine particles in many urban regions. This will have changed in 2030, at least in Rotterdam".



Quality of life in the Rotterdam urban area: health impact of black smoke (EC) caused by (local) transport

Black smoke (EC)

- Is part of particulate matter (PM)
- Is more observed in PM near busy roads

Health effects

- Emissions mainly caused by diesels
- Health impact underestimated using PM as indicator (x5)

Needed to achieve goals

- A better knowledge transfer: bridging instruments between science and policy practice needed

Erasmus University Rotterdam
SMARTPORT
Port Research Centre
TU Delft

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Promoters: prof.dr. H. Geerlings (EUR, Public Administration) & prof. dr. A. Burdorf (Erasmus MC)

Mariska van der Sluis, Erasmus University Rotterdam

Knowledge transfer in complex urban systems

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Supervisors: Harry Geerlings, professor in governance of sustainable mobility, Department of Public Administration & Alex Burdorf, professor of Determinants of Public Health at Erasmus MC.

Curriculum Vitae

Mariska van der Sluis is a researcher and Ph.D student of Public Administration. She currently lives in Rotterdam. Van der Sluis is employed by the Erasmus University Rotterdam, department of Public Administration, to carry out research concerning knowledge transfer in complex governance systems.

Van der Sluis obtained both her Bachelor's and Master's degrees at the Erasmus University, where she studied History and Environmental Policy. She has completed a bachelor in journalism too, as well as a postdoctoral research master at The Netherlands Graduate School of Urban & Regional Research (Nethur). After obtaining her Master's degree, she started to work as a researcher for the Erasmus Centre for Sustainability & Management. After 2 years, she switched universities and worked at the OTB Research Institute (TUDelft) for five years. In that period, she developed an interest for knowledge transfer issues.

Van der Sluis simultaneously works as a project coordinator for 'Kennisplatform Corpovenista', a platform of housing associations. In this function, knowledge transfer issues are a focus as well.

She's a mother and stepmom, who loves to garden and read poetry in her spare time.

PHD Research

The research bounded to this thesis aims to contribute to the development of knowledge transfer in complex urban systems by studying a particular complex (urban) health problem: air pollution.

The health effects of air pollution have been subject to intense study for a long time (Brunekreef, 2002). Despite all scientific evidence, even in Europe and the United States where a relatively long tradition of policy on public health (including policies to reduce air pollution) exists, health effects caused by air pollution are still severe. According to recent publications, across the world about 1.5 billion people are exposed to increased ambient air pollutant concentrations of particulate matter (PM), sulphur dioxide ($S0_2$), and ozone (Schwela, 2011). In the Netherlands for example, air pollution is calculated to be responsible for 3 -5 percent of the total disease burden. The World Health Organization estimated urban outdoor air pollution causes 1.3 million deaths worldwide per year. Air pollution is known to be contributing to respiratory diseases and cardiovascular disease (eg. Brunekreef, 2002; Demetriou, 2012). Recent studies also indicate long term exposure contributes to rapid brain aging and the development of dementia. There are also strong indications that it irreversible damages children's lungs, leaving them with lungs which function worse compared to children living in relatively clean areas.

Road Transport

Road transport is the most important source. Therefore, significant reduction of exposure to air pollution can be achieved through lowering the concentrations of several of the most common air pollutants emitted during the combustion of fossil fuels (e.g. black carbon).

The fact that road transport is the most important source already shows some the complex anatomy of this environmental

health problem. It touches on the collective macro level our believes on what progress means (mobility is progress), on the individual level it is for example related to our attachments to habits and our desire for comfort (e.g. going by car instead of by buss or bike). Health in this matter has to compete with other strong desires which, at least at this moment, conflict with the aspiration to reduce air pollution in order to improve public health in populations.
The aim of this thesis is not only to show and understand the process and the outcomes related to the integration of knowledge, but also to develop empirical strategies for better knowledge transfer suitable at least in the specific context(s) of this environmental health problem.

Connection: Port Vision 2030
The Rotterdam region is home to the largest port complex in the nation, which relies on diesel-powered ships, trains, and trucks to sustain its operations. Particulate matter pollution, especially diesel emissions, are linked to cancer, asthma, premature death and cardio-respiratory diseases.
The Rotterdam Port Authority focuses a lot on becoming a sustainable energy port. In her Port Vision 2030, the quality of life concerning the inhabitants of the port region is an important focus as well. She states: '*In 2011, transport is one of the main culprits when it comes to CO_2 emissions and is responsible for the problem of fine particles in many urban regions. This will have changed in 2030, at least in Rotterdam'*.
The ambition to establish a transport system that reduces the problem of fine particles significantly should be defined as a high one, since the past has proven this is a difficult problem to tackle. This phd research provides valuable insights in what is needed to achieve this goal. Reducing traffic and associated pollution will reduce health impact effects, but is barely an option: the port and therefore the transport of goods will probably increase with the advent of Maasvlakte 2. Recent scientific studies show that black carbon is one of the most damaging components of particulate matter and is greatly increased near busy roads, such as the highways in Rotterdam towards the port area. A shift from high polluting and damaging diesel fuels is needed to significantly reduce the health impact of port related transport, both on land as well as at sea.
This research already has shown a large gap between policy and science concerning air pollution and reducing the health impact of this pollution. While policy is still focused on the reduction of particulate matter, science shows that this indicator isn't the best to estimate the health impact, at least not near busy roads. This phd- research therefore focus on developing new communicational instruments for researchers to communicate with policymakers in a language that better connects to the complex environment in which a policymaker has to operate.

Analyzing Intermodal Freight Transport (IFT) Supply Chains

Hamid Saeedi
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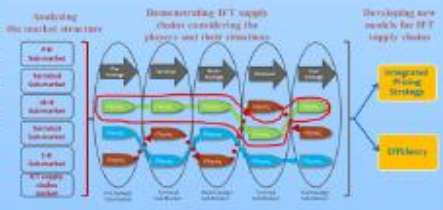
Promotor: Rob Zuidwijk
Supervisor: Bart Wiegmans

Main questions

1. What is the structure of the IFT market, who are the main players in the market of IFT services in Europe how are they related to each other?
2. How efficient are IFT supply chains and how could they be improved to realize a higher market share compared to road transport?
3. How does the competitive position of IFT supply chains influence its pricing strategy and vice versa and how could it be improved?

Relation with port

In this research, different players in IFT supply chains will be analyzed. Important players in the port are terminal operators and carriers at the sea- and landside. The Port of Rotterdam and its hinterland is an important case that will be considered in this research.



Societal problem

Road freight transport causes a lot of emissions and congestion, so finding the attractive substitute for road transport and trying to create a shift towards intermodal freight transport as an sustainable alternative is an important goal in the European Union (EU). Despite all policy and scientific efforts, the market share of intermodal freight transport in the EU remains low.

Main objective

The main objective of this research is to analyze the market of IFT services in Europe and develop instruments for IFT service providers. In particular, from a supply chain point of view, we consider their efficiency and we develop pricing strategies. We will also use the results to make recommendations to coordinators of IFT supply chains or policy makers to expand the market share of IFT services.

Methodology

1. Several different market analysis models (such as the extended Porter model, market share indexes) will be extended and applied to the respective intermodal market segments.
2. Development of a strategy for integrated pricing in IFT supply chains based on cooperative game theory, considering the value of the service as transfer price.
3. Conventional data envelopment analysis (DEA) cannot be employed directly to measure the performance of intermodal supply chains and their members, so the Network-DEA model will be extended. Especially, the value of freight services will be analyzed as one of the decision-making variables.

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Analyzing Intermodal Freight Transport (IFT) Supply Chains

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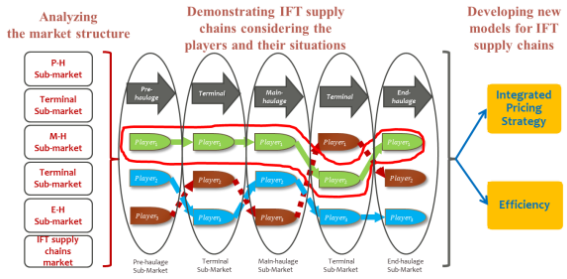
Supervisors: Rob Zuidwijk, Bart Wiegmans

I am a Phd student at transport planning department of Civil engineering faculty in TUDelft. I am doing my research in Intermodal freight transport (IFT) supply chains market in EU. My bachelor degree is in industrial engineering and master degree is in socio-economic systems engineering. I have more than 10-year experience in different disciplines such as Logistics planning, Manufacturing systems, Econometrics modelling, Market research & Pricing, Strategic planning. I have started my research from April 2012 under the supervision of professor Rob Zuidwijk and Dr Bart Wiegmans. These days I am working on my first paper about analysing structures of intermodal freight transport relevant markets in Europe which will focus on market of different players in IFT supply chain such as pre/post haulage operators, Terminal operators, main-haulage operators and forwarders/ LSPs.
Road freight transport causes a lot of emissions and congestion, so finding the attractive substitute for road transport and trying to create a shift towards intermodal freight transport as an sustainable alternative is an important goal in the

European Union (EU). Despite all policy and scientific efforts, the market share of intermodal freight transport in the EU remains low. My research tries to answer the question why is the intermodal freight transport market in EU still limited?, and the main objective of this research is to analyze the market of IFT services in Europe and develop instruments for IFT service providers. In particular, from a supply chain point of view, we consider their efficiency and we develop pricing strategies. We will also use the results to make recommendations to coordinators of

IFT supply chains or policy makers to expand the market share of IFT services.

The main question of research is: How could the market share of IFT in EU be increased by improving the internal mechanisms (efficiency and pricing) of IFT supply chains?, and there are three sub-questions related to that: what is the structure of the IFT market, who are the main players in the market of IFT services in Europe how are they related to each other?, how efficient are IFT supply chains and how could they be improved to realize a higher market share compared to road transport?, how does the competitive position of IFT supply chains influence its pricing strategy and vice versa and how could it be improved?, you could see the direction of this research in the below figure:



To answer these different questions different methodologies will be used: to explain the market structure, several different market analysis models (such as the extended Porter model, market share indexes) will be extended and applied to the respective intermodal market segments. To Develop a strategy for integrated pricing in IFT supply chains, cooperative game theory which consider the value of the service as transfer price will be used, and about the efficiency, conventional data envelopment analysis (DEA) cannot be employed directly to measure the performance of intermodal supply chains and their members, so the Network-DEA model will be extended. Especially, the value of freight services will be analysed as one of the decision-making variables.

in this research, different players in IFT supply chains will be analyzed. Important players in the port are terminal operators and carriers at the sea- and landside. The Port of Rotterdam and its hinterland is an important case that will be considered in this research. The relevant market is the market area which competition happen in it. Defining the market area for terminal operators across the EU, analyzing these different market structures, and comparing these findings with other relevant markets in different parts of IFT will assist in developing better IFT supply chains.

The 2nd Erasmus Smart Port Rotterdam/Port Research Centre Poster Session, Rotterdam, June 27, 2013

Designing liner shipping networks

Liner shipping

In liner shipping ships follow a fixed route within a fixed time schedule, which is published beforehand. Routes are cyclic and typically sailed once a week.

Example of a liner shipping route from Maersk Line

Problem formulation

- Determine set of routes in the schedule
- Allocate ships to the routes
- Determine sailing speed
- Determine cargo allocation

Solution approach

Three phases:

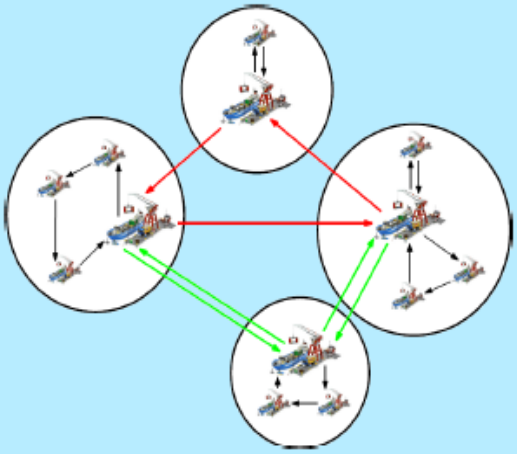
- Cluster ports
- Main route network connecting clusters
- Feeder route network connecting ports within each cluster

Port clusters

- Which ports belong to the cluster?
- Which port will be the hub that is visited on the main routes?

Main route network

- Connect hubs in such a way that each hub can be visited at most twice on a route
- Allocate ships to the routes
- Allocate cargo over the routes



Feeder route network

- Connect the ports in a cluster with the hub
- Each port is on exactly one route
- Vehicle routing problem with pickup and delivery

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Judith Mulder, Erasmus University Rotterdam

Operations Research methods for the design of robust liner shipping methods

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Supervisor: Prof.dr.ir. Rommert Dekker

Judith Mulder finished her master in Econometrics and Management Science at Erasmus University Rotterdam in August 2011 with a specialization in Operations Research and Quantitative Logistics. Her Master's thesis was on designing route networks in liner shipping. Before that, in 2009, she finished the Bachelor Econometrics and Management Science also at Erasmus University Rotterdam. In 2011, she also received a Bachelor's degree in Applied Mathematics at Delft University of Technology. Currently, she is a PhD-candidate at Erasmus Research Institute of Management (ERIM). Her promotor is prof.dr.ir. Rommert Dekker and her current research interests include designing robust liner shipping routes.

Broader research theme

In container liner shipping, the structure of maritime networks strongly influences the volumes handled by seaports. Shipping lines design these maritime networks and decide amongst others how often to call at specific ports, which ports to use for transshipment, and the rotation schedules of shipping services. These decisions are crucial for container terminals as well as ports. However, research to understand how these choices are made is limited. A model with assumptions concerning the demands, the various cost items, optimization criteria and resulting network structures could assist port authorities in their marketing policies and their long term planning. Such a model would also be relevant for shipping lines, even more if we can create robust schedules. The problem is important considering developments as increased ship sizes, slow steaming and maritime infrastructure changes (e.g the Panama Canal). Finally, we will also assess the differences in environmental friendliness of the network choices.

Research problem

In liner shipping networks, ships follow a fixed route within a fixed time schedule. These routes are typically sailed once a week and published beforehand. One part of the research focuses on the design of liner shipping route networks. Several decisions have to be made in the network design problem. A service network consists of a set of routes and the allocation of ships to the routes. Furthermore, the optimal sailing speed has to be determined for each route. A route is a sequence of ports that are visited by a ship. The routes are cyclic, so the begin and end port are the same. Furthermore, the shipping company has to decide which demands they accept and which routes are used to transport this cargo from the origin to the destination port.

Another aspect of the research is to design robust liner shipping routes. Ships can encounter delays both when sailing between ports and when berthing in a port. When ships are delayed, they can reduce their delay by taking recovery actions against certain costs. Examples of recovery actions are: increasing the sailing speed or port handling capacity.

Furthermore, buffer time can be incorporated in the route to capture (a part of) the delay.

Research goal

One goal of the research is to design liner shipping route networks. Furthermore, we want to develop robust liner shipping routes by finding a recovery policy and allocation of buffer time such that the total costs are minimized.

Solution methods

A combination of mathematical programming and heuristic methods are used to solve the problem. To design a service network in liner shipping, first the problem size has to be reduced. This is done by clustering ports into port clusters. In each cluster one port (the hub) will be visited on the main route network, while all other ports will be served using feeder networks. Therefore, we use a three-phase solution approach. First, we determine the port clusters and a hub in each cluster. In the next phase, the main route network will be constructed connecting the hubs in such a way that a hub is visited at most twice on a route. In this phase, we also allocate a ship type and sailing speed to each route and determine the cargo allocation over the routes. Finally, the feeder network is constructed, in which the ports in a cluster are connected to the hub. Each port will be visited on exactly one route. This phase is similar to vehicle routing problems with pickup and delivery

The problem of designing robust liner shipping routes can be modeled using a Markov decision process. Each state contains the name of the port that is visited, whether the ship is entering or leaving the port and the current amount of delay. In our problem, in each state we have to decide how much buffer time to allocate and which recovery action to perform. The probability distribution on which the transition depends corresponds to the additional delays that can be incurred. When the allocation of the buffer times is fixed, the remaining problem of determining the optimal recovery actions can be formulated as a linear programming problem. However, when we also want to optimize the buffer allocation, the problem becomes a mixed integer programming problem, which is in general hard to solve. Therefore, we developed some heuristic methods, which can be used to find a feasible solution to the problem in relatively little time. We can compute a lower bound on the costs by relaxing the mixed integer programming formulation. This lower bound can be compared to the solutions of the heuristic methods to get an indication of their performance.

Port of Rotterdam

The Port of Rotterdam wants to be the leading European hub for global and intra European cargo. Not only do they want to be a global hub, but they also aim to be leading on sustainable development. Efficient and reliable liner shipping route networks play an important role in this vision of the Port of Rotterdam. With efficient networks the transit time of containers can be reduced, which will make the port attractive to ship cargo from. Furthermore, maritime transport is a very carbon-efficient mode of transport. However, the carbon emissions increase rapidly with the sailing speed. When performing recovery actions to make routes more robust, the costs of the recovery actions can also be used to penalize emissions. In this way, container ships can also contribute to the sustainable development

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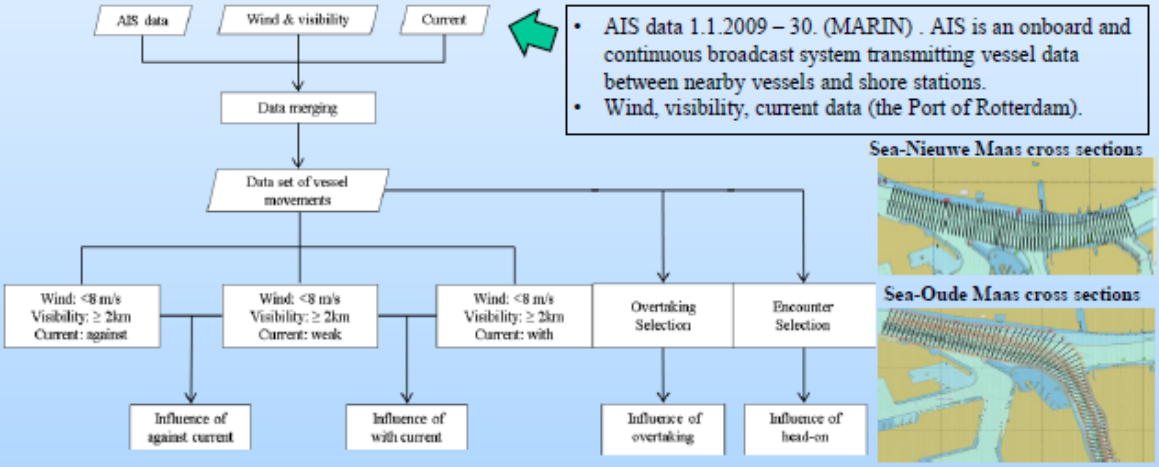
AIS data analysis for vessel behavior during strong current and during encounters in the Botlek area in the Port of Rotterdam

Introduction

Maritime traffic safety is an important issue, in particular in port areas. Though external factors are considered as parameters in some maritime traffic models, it is still not clear how these external factors affect vessel behavior individually. To develop a new maritime traffic model, which is used to predict vessel movements, an data analysis based on Automatic Identification System (AIS) is performed to investigate the influence of current and encounters on vessel behavior. Cross sections are used in this analysis to extract and analyze AIS data, as well as wind, visibility and current data provided by the Port of Rotterdam.

Methodology



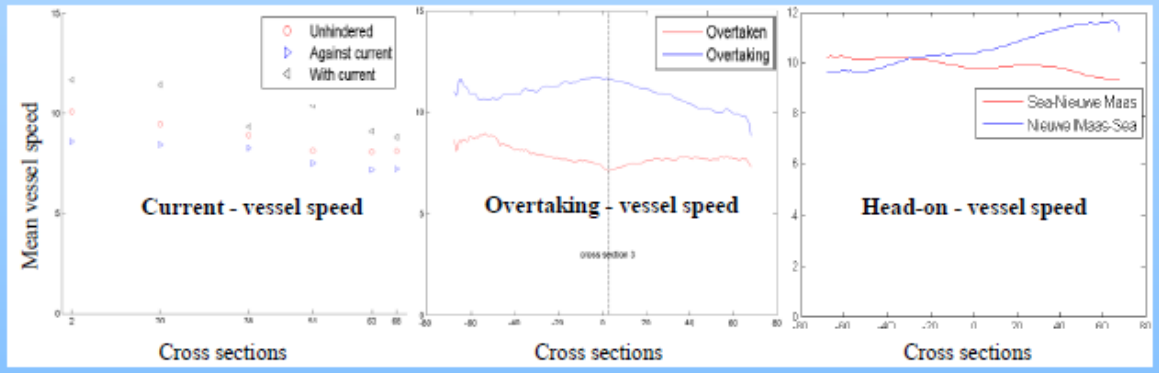
- AIS data 1.1.2009 – 30. (MARIN) . AIS is an onboard and continuous broadcast system transmitting vessel data between nearby vessels and shore stations.
- Wind, visibility, current data (the Port of Rotterdam).

Sea-Nieuwe Maas cross sections

Sea-Oude Maas cross sections

Results

Influence of different current and encounters (overtaking and head-on) on vessel behavior including vessel speed, course and lateral position are investigated. Influences on vessel speed are shown in following figures.



Findings

1. Current influences vessel speed.
2. Vessels change speed during encounters.
3. Vessels deviate to the bank during encounters.

Future research

In the future research, the new maritime traffic model will be developed to predict vessel movements in ports and inland waterways. In this way, the safety and capacity of ports can be assessed as well. On the other hand, the model can be used to improve maritime traffic management, such as VTS.

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AIS data analysis for vessel behavior during strong current and during encounters in the Botlek area in the Port of Rotterdam

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I am a PhD student from Delft University of Technology. My PhD started from October 2010. This PhD project is focused on developing a maritime traffic model which could be used for prediction of individual vessel behavior including vessel's interaction, external conditions and human factors. Furthermore, the new model will be integrated into the assessment of the safety and capacity in the design and management of ports and waterways. Prof. Serge Hoogendoorn from the section of Transport & Planning and Prof. Han Ligteringen from the section of Hydraulic Engineering are my promoters. Winnie Daamen is my daily supervisor. She specialized in pedestrian behavior, which is similar as vessel behavior in waterways. Using the game theory and optimal control method, which is successfully applied in pedestrian behavior, we want to develop new maritime traffic model. The model could be used in assessment of safety and capacity of ports and waterways. On the other hand, maritime traffic management, such as Vessel Traffic Service (VTS), could be improved by using the model. Our research is based on Netherlands Organization for Scientific Research (NWO) project 'Simulation model to improve safety and efficiency of port traffic'. The joint project is part of a program coordinated by the (NWO) and its Chinese counterpart the NSFC (National Natural Science Foundation of China) to promote international cooperation between researchers.

There is a growing need for a model that can effectively simulate the maritime traffic in ports and inland waterways. This is because ships are increasing in size and number. However, existing simulation models do not accurately describe interactions between ships. They also fail to correctly predict the course variations of individual ships caused by human factors and changing external conditions, such as fog and wind. In terms of safety (and preventing collisions), it is extremely important to take account of the human factor.

In the development of the maritime traffic model, the researchers will take advantage of previous experience acquired at TU Delft with models that simulate normal traffic, for example for flows of pedestrians. This is an area in which Dr Winnie Daamen already specializes. 'Although their method of propulsion is completely different, just like pedestrians ships have a great deal of flexibility in terms of the route they can select and how they interact with other ships.' In addition, research at TU Delft and the MARIN research institute has shown that detailed data from the ships' on-board Automatic Identification System (AIS) is ideal for studying the navigation of ships under varying conditions.

By using an innovative approach based on game theory, the model will accurately predict the behavior of individual ships and their interactions under varying conditions (wind, current and visibility). The cooperation between the Dutch and Chinese will also make it possible for the

practical application of the model to be extensively tested using data both from the port of Rotterdam and from the port of Shanghai.

This poster shows an AIS data analysis on the influence of currents and encounters on vessel behavior in the Port of Rotterdam, the Netherlands. AIS data is provided by Maritime Research Institute Netherlands (MARIN). Wind, visibility and current data are supported by the Port of Rotterdam. Together with our other data analysis, such as analysis of unhindered vessel behavior (planned behavior) and influence of wind and visibility on vessel behavior, we get insight into vessel behavior under different external conditions. In future research, more factors influencing vessel behavior will be included in the model to enhance its accuracy, such as mechanical failures and human error. Furthermore, the model will be tested for different areas, such as ports in other parts of the world and inland waterways. These will form the basis of the new maritime traffic model and support for the model calibration and validation.

Nowadays, the Port of Rotterdam is one of the biggest ports in the world. It is certain that the vessel traffic in port's area will be increased before 2030. Then, safety and capacity of the ports and waterways will increasingly important in the future. VTS is the monitoring system established by port authorities. The new maritime traffic model could be used to predict vessels movements in the port area. In this way, the model can be used for assessment the safety and capacity of ports and waterways under different external conditions. On the other hand, the model can be used to improve VTS, as well as predict dangerous traffic situation

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Consolidation Analysis Considering Large Deformations and Dynamic Loading

Research Training Group "Ports for Container Ships of Future Generations" of the German Research Foundation

Motivation

Aim of the research work is the numerical modeling of fully saturated soil considering partially drained conditions and dynamic loading behavior. The influence of partially drained conditions on the process of pile-driving should be investigated using this approach since foregoing research work was restricted to fully drained or fully undrained soil conditions.

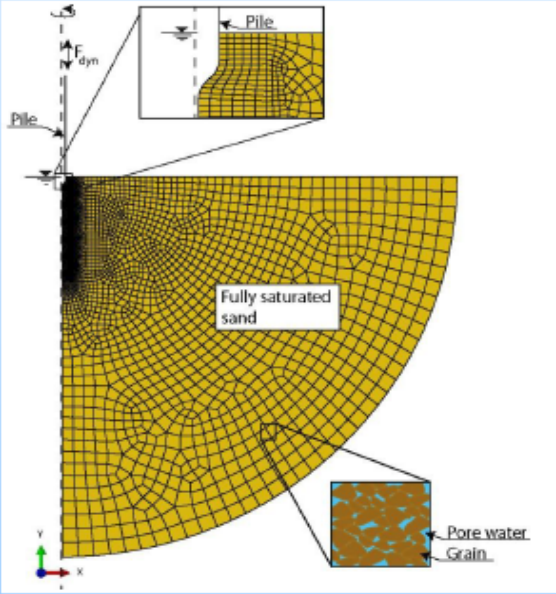

Fig. 2 Numerical model for the investigation of the process of pile installation considering partially drained soil conditions

Verification and Application

After verification of the implemented approach on simple problems (Fig. 1), it will be applied on the simulation of the installation process of piles (Fig. 2). Effects such as the development of excess pore pressure or a temporary soil liquefaction will be analysed (e.g. Fig. 3). The influence of the pile-driving method, the hydraulic conductivity as well as the relative density of the soil will be investigated.

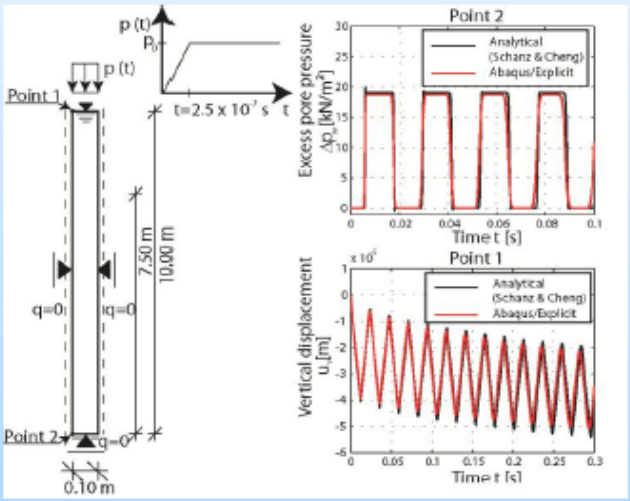

Fig. 1 One-dimensional wave propagation in a fully saturated soil column, comparison numerical and analytical solution

Method

The dynamic analysis procedure of the finite element software Abaqus/Explicit employs an explicit time integration rule and is used to perform a total stress analysis. The governing equations (u-p formulation) are implemented in the framework of a user-subroutine for constitutive models which is included in the analysis procedure to model the soil as a two-phase material.

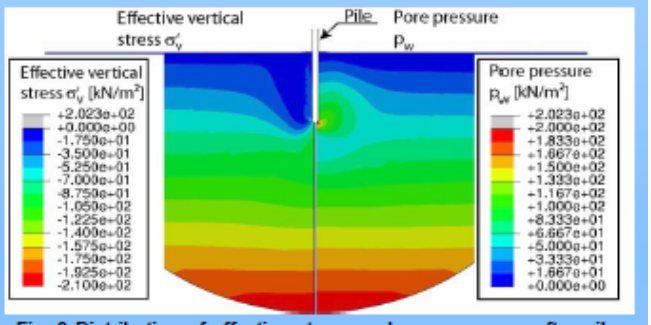

Fig. 3 Distribution of effective stress and pore pressure after pile jacking

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Consolidation analysis considering large deformations and dynamic loading

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Thorsten Hamann is a PhD student at the Hamburg University of Technology (scholarship holders of the Research Training Group "Ports for Container Ships of Future Generations" of the German Research Foundation (DFG)). The topic of his research training group is research on the field of interaction of ship, fluid, structure and soil with respect to the worldwide challenges for port construction for container ships of future generations.

Consolidation analysis considering large deformations and dynamic loading

Dynamic loading conditions occur for many geotechnical applications, e.g. pile driving, soil compaction by vibratory roller or dynamic pile testing. Numerical methods, e.g. the finite element method can be a helpful tool to analyse the mechanical processes in the soil. Simulations of this geotechnical problem using the finite element method lead to a deeper insight and understanding of the mechanical processes. In case of drained soil conditions appropriate numerical investigations on the installation process of piles as well as soil compaction by vibratory rollers have been done by Kelm (2003), Mahutka (2007) and Henke (2008). The influence of partially drained conditions on the mechanical processes in the soil has been neglected since common commercial software codes allowing for partially drained conditions e.g. Abaqus are restricted to static or quasi-static loading conditions. Accounting for effects as the temporary development of excess pore pressure or soil liquefaction was not possible. In harbor areas the ground water level is usually near the ground level and thereby soil is usually fully saturated. Thus, accounting for partially drained conditions in numerical simulations of geotechnical applications inducing dynamic loading is of importance for a realistic modeling of the mechanical processes in the soil.

Aim of the present research work is to investigate the mechanical processes during pile installation under partially drained conditions. Therefore, the installation process is simulated numerically using the commercial FE-code Abaqus/Explicit. The dynamic analysis procedure of Abaqus/Explicit uses an explicit time integration rule and allows to include user-defined constitutive models. A total stress analysis is conducted. A so-called u-p formulation is used to model the soil as a multiphase material.

The additional governing equations to describe the mechanical behavior of the soil in case of partially drained conditions as well as the interaction of the solid and fluid phase are implemented in the framework of a user-subroutine for constitutive models. Therefore, a mass balance equation of the fluid phase, Darcy's flow model and a hypoplastic constitutive model for the behavior of the solid skeleton are implemented.

In a first step the implemented approach is applied on simple boundary value problems. The solution is compared to analytical solutions or in case of static or quasi-static loading compared to solution obtained by existing software codes. In future the approach should be validated

against in-situ measurements of the evolution of excess pore pressure and total stresses during pile driving. Applying this approach the installation process of pile driving should be investigated. Especially the influence of partially drained conditions e.g. development of excess pore pressure, a temporary soil liquefaction or the propagation of waves in the soil are analysed. Further parameters such as the hydraulic conductivity or the relative density of the soil on the installation process should be studied.

Relation to the Port Development Plan to 2025 of the Port of Hamburg

The presented research work provides a method to model fully saturated soil under dynamic loading conditions numerically. The time-depending development of excess pore pressure induced by static, quasi-static or dynamic loading can be simulated. Since the soil behavior can be influenced strongly by the behavior of the pore water and the interaction of solid and water, accounting for the pore water is of great importance for a realistic modeling of fully saturated soil conditions as they usually exist in harbor areas.

The installation process of piles, e.g. pile jacking, pile drilling, vibratory driving or impact driving can be studied regarding the influence of pore water. Sometimes a temporary locally limited liquefaction of the soil in the near-field around the soil can occur. This phenomenon can have a negative influence on the behavior of neighboring structures. A numerical simulation of the installation process can help to predict the interaction to existing structures. Furthermore, the propagation of waves in the soil can be modeled in a more realistic way. Ground motions induced by dynamic loading can be simulated and predicted. This can be a helpful tool to prevent damages, since many buildings or production areas are restricted regarding high ground motions.

Kelm, M. (2003): Numerische Simulation der Verdichtung rolliger Böden mittels Vibrationswalzen, PhD Thesis, Veröffentlichungen des Instituts für Geotechnik und Baubetrieb, Hamburg University of Technology.

Mahutka, K.-P. (2007): Zur Verdichtung von rolligen Böden infolge dynamischer Pfahleinbringung und durch Oberflächenrüttler. PhD Thesis, Veröffentlichungen des Instituts für Geotechnik und Baubetrieb, Hamburg University of Technology.

Henke, S. (2008): Herstellungseinflüsse aus Pfahlrammung im Kaimauerbau, PhD Thesis, Veröffentlichungen des Instituts für Geotechnik und Baubetrieb, Hamburg University of Technology.

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Maximising the worth of nascent networks

P.W. Heijnen, A. Ligtvoet, R.M. Stikkelman, P.M. Herder

Introduction

Networked infrastructures (gas pipes, water pipes, electricity cables, glass fibre,(rail) roads) form the backbone of our society as they provide essential utilities and services. In a densely built and highly urbanised environment, such as the Netherlands, the roll-out of new networks encounters physical or legal boundaries that make the planning of such networks a difficult task. Furthermore, if several independent organisations are to be connected to these networks, the actual commitment of these parties and the capacities they require from the network can remain uncertain for a long time. This makes the planning process cumbersome and requires tools that can deal with this uncertainty.

Research goal

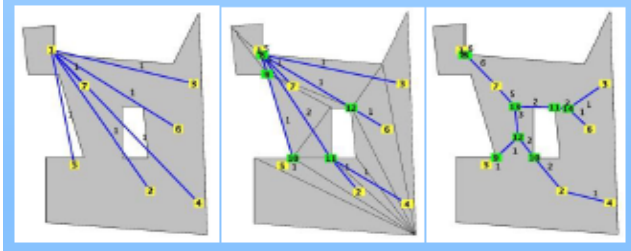
The design of networks has had ample attention. Most of the relevant literature, however, focuses on one specific application (e.g. telephone networks) and defines heuristics and algorithms that search for an optimal solution. Our goal is to develop a practical method that can support decision-making that deals with the kinds of uncertainties that occur in real projects.

Approach/research method

The algorithm we developed builds on graph theoretical concepts of minimal spanning trees, Steiner trees, and Gilbert networks, and adds notions of expected worth , a combination that we have not yet seen in existing literature.

The algorithm consists of two phases:

1. Find the **minimal cost network** for all possible sets of participants, starting from an initial network. Repeat the following steps till no cost improvement could be made
    1. Reroute network to allowed region
    2. Add splitting point if angle between connections is too small
    3. Find optimal location of new and earlier splitting points
2. Among these networks, find the one with the highest **expected present worth ratio**



Characteristics

One sink/source: Networks transport a commodity from one or several sources to one or several sinks. Examples are the collection of biogas or CO2 and the distribution of heat or natural gas.

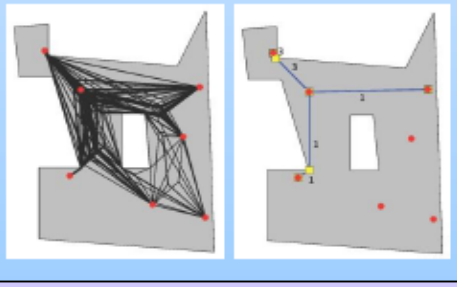
Length and capacity costs: The building costs depend to a large extent on the pipeline length (e.g. due to digging costs), but also on the pipeline capacities (e.g. due to materials costs).

Limitations on the routing: The networks need to be built in areas that pose limitations on the possible routing of pipelines due to existing buildings, obstacles like rivers or mountains, or zoning rules (e.g. protected natural areas).

Uncertainty: In the exploratory or design phase of the project, not all participants nor the capacities they require are fully known: they may still need to be convinced to invest or partake in such a venture.

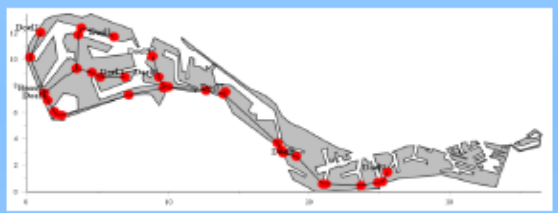
Deliverable

The deliverable of the study is a planning tool that allows for the assessment of low-regret options and the quick re-assessment of these options, should new information arrive that either narrows down or expands these options.



Future research

Further steps in this research entail many-to-many networks. Furthermore, one could imagine that certain geographical features, such as lakes, rivers, swamps, or mountains, would lead to higher construction costs. Differentiation of the costs is therefore a further extension that we think of. We also consider allowing for the analysis of already existing networks that need to be expanded.



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The development and greening of a synthesis gas infrastructure

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Petra Heijnen studied Applied Mathematics at Delft University of Technology. From 1994 to 1998 she did a four year PhD-research in coding theory at the faculty Applied Mathematics at the Eindhoven University of Technology. In 1998 she worked as a research member at the National Institute Statistics Netherlands. Since 1999 she is working at the faculty Technology, Policy and Management at Delft University of Technology, first as a project member of the E.E.T.-project Batch Processes: Cleaner and more efficient. Initially she worked at the subproject 'Improving batch scheduling and planning', where she studied, among other things, scheduling and planning software that can be used in the batch operating industry. After that she worked at the subproject 'Improving integrated batch-plant management', where she developed an integrated batch-plant management support method. Currently, she works at the faculty as an assistant professor in the Energy & Industry group.

The development and greening of a synthesis gas infrastructure

Several studies show the increasing potential of syngas, a mix of H_2 and CO gas, as a strategic intermediate mass and energy carrier in large industrial clusters. Fossil fuels, like crude oil, coal, natural gas, and biofuels are converted into syngas, which is subsequently used in the production of bulk products, like electricity, automotive fuels,petrochemicals and iron. The flexibility towards the feed stock portfolio and the multi usability of the syngas result in a robust and commercial attractive industrial cluster.

A serious threat for the realization of a syngas infrastructure is the complexity of tailoring the syngas flows between producers and consumers. In a standalone situation, each producer will produce its specific quality and quantity of syngas and each consumer will demand its specific quality and quantity ranges. As the number of producers and consumers of the infrastructure increases, the combinatorial complexity will explode. Producers, consumers and system & infrastructure operators have to negotiate on product flows, on product quality, on who will invest in technological installations for quality adjustment, on who will invest in the overarching infrastructure that falls outside the span of control of individual companies, on the topology of the connecting infrastructure, etc.

Scientific procedures for creating infrastructures are rare. The reason for this is the combinatorial and dynamic character of the solution space. For example: During the development of an infrastructure, producers and consumers may decide to join or leave the system. However, every combination of producers and consumers has its specific optimal lay-out. Solving this problem is a scientific challenge. In this poster we take up the gauntlet to develop procedures/tools that cut this combinatorial Gordian knot.

In 2014 the port of Rotterdam will finalize the first phase of the expansion of its port, the so-called Maasvlakte 2 project. Thousands of hectares of newly created land will trigger industrial activities and

thus create a demand for utilities like natural gas. Since 2011, Gate Terminal imports Liquefied Natural Gas. This terminal is located adjacent to the Maasvlakte 2 and may function as a source of natural gas. However, at this moment Maasvlakte 2 lacks infrastructures for gas distribution and industrial production. This marks the Maasvlakte 2 state of affairs as a realistic but fictive case for testing our approach.

Figure 2 Source and potential consumers of the LNG network

Figure 1 shows a map of Maasvlakte 2. The region is divided into several functional areas distinguished by colours. The green dot on the upper right is the LNG terminal, the source of the network. All other dots show potential customers. Red dots show customers. that would almost certainly participate, orange dots indicate more uncertain customers and yellow dots display very uncertain customers. The assumption is made that gas pipelines will go over land and will not cross water barriers. Node 1 is the LNG terminal, the source node. Nodes 3, 7, 8, and 9 have a high probability to participate, quantified as 80\% and are expected to be large consumers. Nodes 2 and 6 have a mediate probability to participate, quantified as 50\% and nodes 4 and 5 are not very likely to participate, quantified as only 20\%. Nodes 2, 4, 5, and 6 are defined as small consumers. The large consumers are expected to ask 10 times more capacity from the network than the small consumers.

Figure 2 (left) shows the pipeline density graph which depicts the combination of the edge-weighted Steiner minimal trees of all different configurations with the thickness of the pipelines relative to their likelihood and capacity.

Figure 3 Pipeline density graph for the LNG network (left) and expected worth maximising LNG network (right)

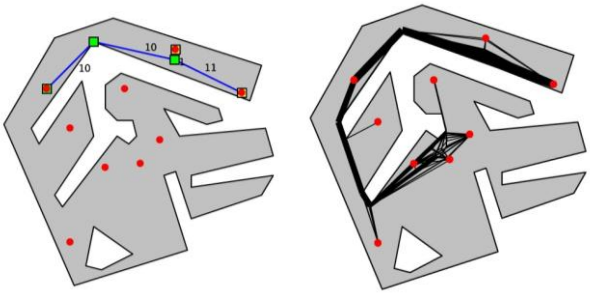

Figure 2 (right) shows the network that, from all these configurations, has the highest expected Present Worth Ratio. This ratio specifies the cost-effectiveness of a network. For
the fictive case, we focussed on natural gas. The development method is not limited to natural gas only. It may be applied for Carbon Capture and Storage infrastructures, large scale heat networks, etc.

Stacking Area Operations: Mathematical Models and Insights

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Co-authors: R de Koster[1], Y Yu[1], L Kroon[1], G Laporte[2], JT Udding[3]
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Stacking area planning

- **Our basic problem**:
  - A single block of containers with a single automated stacking crane (ASC),
  - *N* storage and retrieval requests,
  - The ASC moves a storage container from a given input/output (I/O) point to a given storage location in the block,
  - A retrieval container must be delivered to either a seaside or a landside I/O point depending on whether it is to be transported by ship or truck/train,
- **Objective**: minimizing the travel time of the ASC.
- **Decision**: in which sequence requests should be performed.
- **Model**: asymmetric traveling salesman problem.
- **Extenstion 1**:
  - Storage locations: selected from sets of available open locations.
- **Extension 2**:
  - Containers have different priorities,
  - Two ASCs: cannot pass each other and have to keep a safety distance.

Theoretical relevance

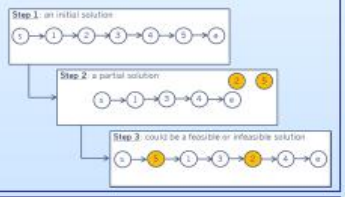
- PhD thesis, Institute: Rotterdam School of Management, Erasmus University, defense date: 27.11.12, Supervisors: R de Koster, Y Yu.
- Chapters of the PhD dissertation are submitted to highly scientific journals including Transportation Science and European Journal of Operational Research.

Port vision relevance

- The overall efficiency of a container terminal highly depends on the efficiency at the stacking area:
  - Almost all containers have to spend a period of time in the stacking area.
  - In 2010, more than 10 million TEU (135 million tonnes) are handled in the port.
  - In 2030, this will increase to more than 300 million tonnes.
  - In 2030, the hinterland and deep-sea terminals will be integrated.
  - The number of containers forwarded to the hinterland will increase significantly.
  - This will put a pressure on the stacking operations of small hinterland terminals.

Solution method

- Adaptive large neighborhood search (ALNS):
  - Use a constructive heuristic to generate an initial solution,
  - Apply an operator to remove some of the requests,
  - Apply an operator to insert the removed requests,
  - Repeat the 2nd and 3rd steps until the stop criterion is met.



Practical relevance

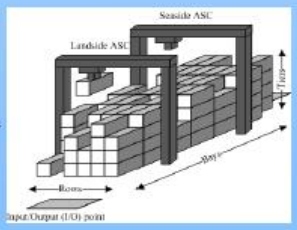
- The proposed models and methods are promising and can be plugged into the terminal operating system (TOS) software to improve the terminal efficiency.
- To put theories into practice in the Ultimate project (financially supported by Dinalog).
- The results of a case study before implementing:
  - A terminal uses a score-based heuristic available in the TOS to sort requests.
  - The score points given to each container are determined by the due-time and the transport mode to deliver it or pick it up.
  - Our calculations show that the improvement of the ALNS over the score-based heuristic is 8.45%.

Table 15 A snapshot of the terminal database of storage and retrieval requests

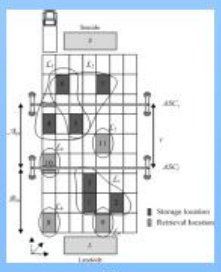
Container	ISO	Weight	Request	Transport mode	Travel Info.	Position
UNRL 123458 7	20GP	25000	Retrieval	Barge	121402-ANDREAS-I	20.01.3
UNRL 457874 0	20GP	25000	Retrieval	Barge	121402-ANDREAS-I	34.08.2
UNRL 544867 4	20GP	25000	Retrieval	Barge	121402-ANDREAS-I	37.06.3
UNRL 545668 5	20GP	25000	Retrieval	Barge	121402-ANDREAS-I	20.05.2
UNRL 125485 0	20GP	25000	Retrieval	Barge	121402-ANDREAS-I	38.09.4
IKEA 040846 3	20GP	2500	Storage	Barge	121399-ALVERNA-I	21±4.03±4.1–4
IKEA 101010 9	20GP	2500	Storage	Barge	121399-ALVERNA-I	21±4.03±4.1–4
IKEA 111111 0	20GP	2500	Storage	Barge	121399-ALVERNA-I	21±4.03±4.1–4
IKEA 135448 6	20GP	2500	Storage	Barge	121399-ALVERNA-I	21±4.03±4.1–4
IKEA 154886 1	20GP	2500	Storage	Barge	121399-ALVERNA-I	21±4.03±4.1–4
POCU 104202 3	42GP	2646	Retrieval	Train	121385-ELCH-O	14.07.2
UESU 426699 8	42GP	14747	Retrieval	Train	121385-ELCH-O	16.06.2
APZU 438508 2	42GP	15218	Retrieval	Train	121385-ELCH-O	08.08.3
APZU 451722 2	42GP	3958	Retrieval	Train	121385-ELCH-O	13.05.4
CCLU 419140 0	42GP	14630	Retrieval	Train	121385-ELCH-O	09.08.2
CPSU 645973 2	45GP	10318	Retrieval	Train	121385-ELCH-O	12.02.1
CPSU 646551 7	45GP	10572	Retrieval	Train	121385-ELCH-O	15.09.2
ECMU 466231 6	42GP	20330	Retrieval	Train	121385-ELCH-O	14.07.1
EVER 081201 0	20GP	10000	Storage	Truck	NA	18±4.06±4.1–4
TCKU 925916 4	45GP	17223	Storage	Truck	NA	18±4.06±4.1–4

Schematic representation

The focus of our studies



(a)



(b)

Fig. (a) A block of containers, (b) a top view of the block with problem specifications

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Stacking Area Operations: Mathematical Models and Insights

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Methods and findings of the dissertation

This dissertation proposes, develops, and tests optimization methods to support the decisions of container terminal operators in the stacking area of a terminal. We focus on operational stacking problems, which are treated in four chapters. The first three chapters focus on sequencing a given set of container storage and retrieval requests in a single block. All three problems are complex and modeled as continuous time integer programming models. The objective is to minimize the makespan to carry out all requests. We try to optimally solve the problems as long as the complexity allows it. Otherwise, heuristic algorithms are developed to obtain near-optimal solutions. The last chapter links indirectly to the first three and will be discussed later. the models described in this thesis are new and have the ability to improve container stacking operations in practice. In the meantime, the model of chapter 4 has been applied to a real container terminal, where reductions of about 8% in makespan were obtained, compared to algorithms currently used in the Terminal Operating System (see the next Section).

In Chapter 2, we study an ASC, stacking and retrieving containers from a single block of containers. We formulate the problem as an asymmetrical traveling salesman problem

(ATSP) and propose a two-phase solution method to optimally solve it. In the first phase, using the I/O points, we develop a new merging algorithm to patch subtours of an optimal solution of the assignment problem (AP) relaxation of the problem. We show that the first phase runs in a polynomial time, and often finds an optimal solution. Otherwise, a branch-and-bound (B&B) algorithm is used in the second phase to find an optimal solution of the problem.

In Chapter 3, we extend the problem by considering sets of open locations for stacking storage containers. We formulate the problem as a generalized ATSP (GATSP). In this problem, locations in the intersection of multiple sets make the problem more complex. Extra constraints are necessary to stack at most one container in such a location. We propose a three-phase solution method to optimally solve the problem. The main idea of the algorithm is to simplify the problem to an ATSP, by redefining the original travel time matrix. An optimal ATSP solution can be quickly obtained using the solution method studied in Chapter 2. An optimal ATSP solution provides an optimal GATSP solution either directly or through a B&B algorithm.

In Chapter 4, we extend the problem further. In this problem, two ASCs carry out the requests, which have different priorities. We model the problem as a multiple GATSP with precedence constraints (mGATSP-PC). Several extra practical constraints are considered: (1) the ASCs cannot pass each other and, for safety reasons, the ASCs must be separated by a safety distance; (2) each storage container must be stacked in a location selected from a set of available open locations; and (3) containers have different priorities. We develop an adaptive large neighborhood search

(ALNS) heuristic capable of solving instances of realistic sizes.

In Chapter 5, we study a different problem which is indirectly related to the previous ones. The problem is how to stack incoming containers in a real-size container block shared by containers of multiple ships, one at a time. The objective is to minimize the expected number of reshuffles. We use a stochastic dynamic programming (DP) model and develop a decision-tree (DT) heuristic. The heuristic uses the results of the DP model for small-scale problems to generate generalized decision trees that can solve large-scale problems.

Practical relevance

The results obtained in this dissertation using Monto Carlo simulation are promising and show that the proposed methods can be plugged into the terminal operating system (TOS) software to improve the terminal efficiency. The author is currently involved in the Ultimate project (financially supported by Dinalog, the Dutch Institute for Advanced Logistics) in which he intends to put his theories into practice. In this project, he closely collaborates with other universities, deep-sea and hinterland terminals, barge operators, and software companies. The purpose of the project is to integrate supply chain and transportation by extending the sea terminal gate into the hinterland - the land space over which the port sells its services and interacts with its clients. The result is a huge number of containers directly forwarded to hinterland terminals. This requires hinterland terminals to improve their stacking operations to keep the same efficiency. The method developed in Chapter 4 is currently being tested using the real data of one of the hinterland terminals provided by a software company. The results show that we can obtain better results compared to the heuristic algorithm developed by the software company for the TOS software. The next step is to plug the model and solution method into the existing TOS software. Convincing the software company and participants of usefulness of such a method is a second issue, as implementation in practice is not straightforward, due to the many additional constraints that play a role there.

Waterborne AGVs for Inter Terminal Transport

Huarong Zheng, Rudy R. Negenborn, Gabriel Lodewijks

Complex spatial layout like Maasvlakte 2 with limited land utilization and increasing Inter Terminal Transport (ITT) volume demands a novel way to meet higher standards on safety, efficiency and sustainability. A closed transport route for ITT could offer the lowest costs for transport movements. We propose waterborne AGVs in coordination with landside AGVs for ITT in a smart port to reduce the heavy road traffic and to enable a complete automated cycle of a smart port.

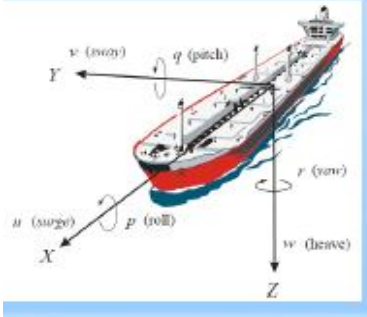
Scientific Challenge

Challenge for efficient control because of complex ship and disturbance dynamics

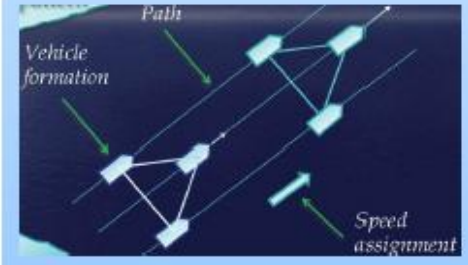
Scientific Challenge

Optimal cooperative routing in complex traffic situations considering multi-source port information

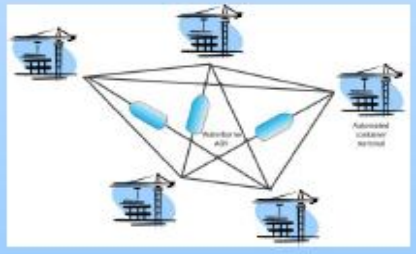
Individual vessel



Vessel formation



ITT scheduling and routing



Approach

- Distributed nonlinear model predictive control based on ship and disturbance models
- Efficient path generation model (pedestrian dynamics) considering collision avoidance, vessel scheduling constraints

NWO

STW

Enabling new technology

Research Goal

An innovative and efficient waterborne AGV system for Inter Terminal Transport, contributing to a closed automated transport route for a smart port.

TU Delft Delft University of Technology

Port Research Centre TU Delft

Erasmus Universiteit Rotterdam SMARTPORT

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Waterborne AGVs for Inter Terminal Transport

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Brief CV

Huarong Zheng majored in logistics engineering for bachelor degree and intelligent transportation system for master degree in the same university at Wuhan University of Technology, China. From January, 2013, she is PhD candidate at the Section of Transport and Logistics Engineering, Department of Marine and Transport Technology, Faculty of Mechanical, Maritime and Materials Engineering, Delft University of Technology, the Netherlands under financial support from China Scholarship Council. The research topic of her PhD project involves nonlinear model predictive control with applications to vessel motion control and vessel formation control. Her more fundamental research interests are in the areas of model predictive control, optimization and autonomous vehicles. Related theories will be used to address problems of a Smart Port, in particular, for the design of waterborne AGVs in coordination with landside AGVs for Inter Terminal Transport (ITT).

Research Contents

Research Problem

Fiercer competition is envisioned in North Europe with considerable capacity expansion in the container sector. The new port area, Maasvlakte 2, together with three big terminals in use at Maasvlakte 1, will realize a global container hub complex, expected to handle more than 30 million TEU (Twenty-foot Equivalent Unit) per year towards 2035. Consequently, there will be an increased need for container transport between the various terminals and various modalities (rail, road, barge, sea), which is also known as inter-terminal transport (ITT) [1]. Modern automated container terminals have adopted AGVs (Automated Guided Vehicles) to help solve the problems like long operation time due to larger and wider vessels, high personnel expenses, lack of qualified manpower and low efficiency of land utilization on the landside area of the port. However, traffic flow on land has already been heavy considering the limited land; further, for complex spatial layout like Maasvlakte 2, the distance between some terminals would be much longer by land than by water, as can be seen from Figure 1. On the other hand, government and port authorities have put a higher standard on transportation efficiency, sustainability and safety. Expanding the existing physical transportation infrastructure could help to relieve the issues, although at extremely high costs. As an alternative, improving the intelligence of infrastructures can have more efficient capacity management, improved reliability of service, increased sustainability, and enhanced infrastructure security [2].

It became clear that a closed transport route for ITT offered the lowest costs for the handling of containers, transport movements and infrastructure [3]. We propose waterborne AGVs in coordination with landside AGVs [4] for ITT between automated container terminals in a smart port. A waterborne AGV is essentially an unmanned surface vehicle which will be

used in the port area on the seaside to reduce the heavy traffic on the landside and at the same time, to enable an closed automated transport route for a smart port.

Individual waterborne AGVs can follow a reference route with collision avoidance capability, which is of significant importance in busy waterways like large ports. The International Regulations for Preventing Collisions at Sea (COLREGs) are the navigation rules to be followed by ships at sea, on inland and coastal waterways to prevent collisions and will be incorporated for safe routing of the waterborne AGVs. Furthermore, for multiple waterborne AGVs, optimal task scheduling, dispatching and cooperation should be considered.

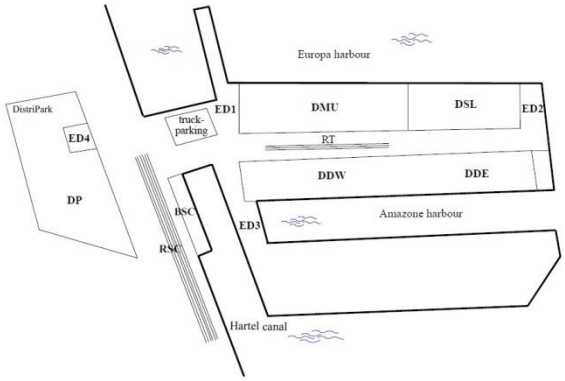

Figure 1: General layout of the Maasvlakte

Research Approaches

Model predictive control (MPC) has been successfully applied to control complex systems in industrial settings and is one of the most popularly used advanced control techniques [5]. The control technique is based on the pre- diction of the future behavior estimated by an explicit model of the system with its constraint. Advantages of MPC are that in principle it can take into account all information available and that it can therefore anticipate undesirable situations in the future at an early stage [6]. This could be very effective when it comes to ship motion control since the ship control system is a typical strong nonlinear system which is susceptible to varying parameters and environmental disturbances, and whose maneuverability is not good enough to respond timely when an emergency happens. Furthermore, for the limits on dynamics as well as safe, economical and environmental reasons, there could be various constraints on actions, states, and outputs; MPC can handle those constraints in an explicit way. For multiple cooperative vessel control, coordination among a group of ships following reference paths, speeds while holding a desired inter-ship formation pattern has to be achieved. This can be done in a distributed MPC configuration, in which there are multiple controllers, each of them using MPC to control its own subsystem [7].

Routing of waterborne AGVs is the process of determining routes for a set of autonomous ships to fulfill their respective transportation tasks with safety, efficiency and sustainability in mind. In most existing landside AGV systems in automated container terminals or automated logistics warehouses, AGVs follow predefined, fixed paths with the aid of either magnetic or visual marks. Such systems lack flexibility, leading to low efficiency while dynamic free ranging has high potential in terms of transport capacity of the resulting system [8]. Except for that, it could be difficult to provide waterborne AGVs those magnetic or visual guide, especially in heavy traffic port areas. Therefore, waterborne AGVs actually are not guided vehicles but free ranging ones, having some analogies with pedestrian manoeuvres in a public transport terminal [9]. In such a case, route choice takes place at two levels, namely the tactical level with route choice model which determines the total route from the origin (or current position), via intermediate destinations, such as activity

areas, to the destination and the operational level which provides a detailed spatial description of the infrastructure in two dimensions. A route consists of a series of subsequent trajectories, each of which indicates the exact spatial path pedestrians follow within a specific area. Pedestrians conduct behaviors like walking, waiting, navigation or performing an activity between different service nodes such as ticket offices, ticket machines, entrance/exit or platforms. Similarly, waterborne AGVs complete transportation tasks by sailing, waiting, navigation or being loaded/unloaded between different terminals. It is not always possible to move in a straight line from the origin to the destination due to the presence of both static and dynamic obstacles, other pedestrians/vessels for example. However, while there is only one criteria for pedestrians, which is minimizing time, waterborne AGVs should have multiple objectives taking safety, efficiency and emissions into consideration, costs for speed of movement, time pressure (arrival on time is important for ITT), collision avoidance, to name a few. Moreover, at the operational level, ship dynamics models and disturbance models need to be considered, based on which different ship maneuvers/activities can be executed by efficient control algorithms while pedestrians whose dynamics are too complex to be modeled, are often simplified to a point in simulations.

Research Goal

Based on the ship mathematical dynamics model and port disturbance model, an effective controller should be designed to follow the path updated from the routing model, which takes into account safety, economical and environmental objectives for ITT in particular.

Relation with Port Vision 2030

Key words for the development of the Port of Rotterdam are flexibility, efficiency and sustainability. Port Vision 2030 (Port of Rotterdam) [10], highlights on innovative concepts and more commonplace use of ICT (Information, Computer and Technology) within the logistics chain putting shipping as one of its success factors. However, the increasing volume of transport flows between continents, combined with all kinds of offshore activities, is resulting in increasing shipping intensity in coastal waters and ports, which brings about safety issues. Furthermore, there is pressure from society to make the shipping industry “greener”. Development of new port infrastructure in times of crises demands a smart approach to build a more efficient, sustainable and competitive port processes.

AGVs (Automated Guided Vehicles), as an important equipment in modern automated container terminals, have effectively improved the port’s throughput, and thus boosting efficiency and competence. However, with the expansion of the port, newly finished Maasvlakte 2 for example, there will be an increasing need for ITT. Corresponding to the landside AGVs, waterborne AGVs are then proposed to help relieve the heavy road traffic in port and at the same time, form a closed automated transport route for a smart port.

Individual waterborne AGVs can follow a reference route with collision avoidance capability, which is of significant importance in busy waterway like large ports. The International Regulations for Preventing Collisions at Sea (COLREGs), are the navigation rules to be followed by ships at sea, on inland and coastal waterways to pre- vent collisions and will be incorporated for safe routing of the waterborne AGV. Further, for multiple

waterborne AGVs, optimal task scheduling, dispatching and cooperation should be considered. Based on the ship mathematical dynamics model and port disturbance model, a effective controller using nonlinear model predictive control should be designed to follow the path updated from the routing model, which takes into account of safety, economical and environmental reasons for ITT in particular. The waterborne AGVs would be free ranging without actually being guided vehicles and both the performance of ITT system in terms of throughput and flexibility might be improved.

It is currently the captain who integrates all kinds of information to make decisions based on nothing but experience. This decision process is affected by the unexpected weather, water-level, other vessels' behaviors, potential obstacles and also messages from a control center (e.g., VTS) and thus can be extremely complicated for a human.

Whether to steer, speed-up or slow-down depends totally on the captain who is expected to be familiar with sailing and the environment. However, environment changes and human makes mistakes. Therefore, we need the machine with intelligence to help in this process. An intelligent vessel would do by employing the technologies mentioned in this paper. By all kinds of sensors installed on board, the dynamic environment information can be gathered to deter- mine the optimal route and speed, which then can be realized by the intelligent controller. Benefits of a waterborne AGVs for at least the following five parties can be foreseen:

1. For the crew: the workload will be significantly reduced and the sailing will be safer and more pleasant.
2. For a shipper: fewer seamen will be employed, less fuel will be consumed because of the optimal route and speed. (Fuel and labor are the two main expenditures for a shipper).
3. For the port: if the ship completes certain ITT task punctually, the waiting time at the port will be reduced, the traffic flow will be lower and the management will be easier and the cost will be reduced as well.
4. For the citizen: harmful gas emissions will be reduced.
5. For the government: fewer accidents, lower emissions and more advanced technologies will all contribute to a more sustainable society.

The aim of this research is to develop and evaluate an innovative ITT modality for a smart port, contributing to the port's safety, flexibility, efifciency and sustainability, which is in accordance with the vision of the Port of Rotterdam.

This research is supported by the China Scholarship Council under Grant 201206950021 and the VENI project "Intelligent multi-agent control for flexible coordination of transport hubs" (project 11210) of the Dutch Technology Foundation STW, a subdivision of the Netherlands Organization for Scientific Research (NWO).

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The 2nd Erasmus Smart Port Rotterdam/Port Research Centre Poster Session, Rotterdam, June 27, 2013

Hierarchical Control of Equipment in Automated Container Terminals

Jianbin Xin, Rudy Negenborn, Gabriel Lodewijks

Challenges for container terminal operators

- Increase the throughput of the existing container terminal
- Improve sustainability of automated container terminals

Research goal

Achieve the autonomous operational control of equipment to improve the throughput in an energy-efficient way

Scientific questions

- How to handle the trade-off between time and energy ?
- How to identify complex behaviors and uncertainties of equipment?
- How to build up the link between the scheduling problem and operational control of each individual ?

Approach

- Propose a hierarchical architecture in terms of two interactive levels to decompose control complexity
- Solve a scheduling problem to achieve the minimal makespan at the higher level (Mixed Integer Linear Programing)
- Solve time-optimal and energy-optimal control problems at the lower level (Model Predictive Control, Distributed Optimization)

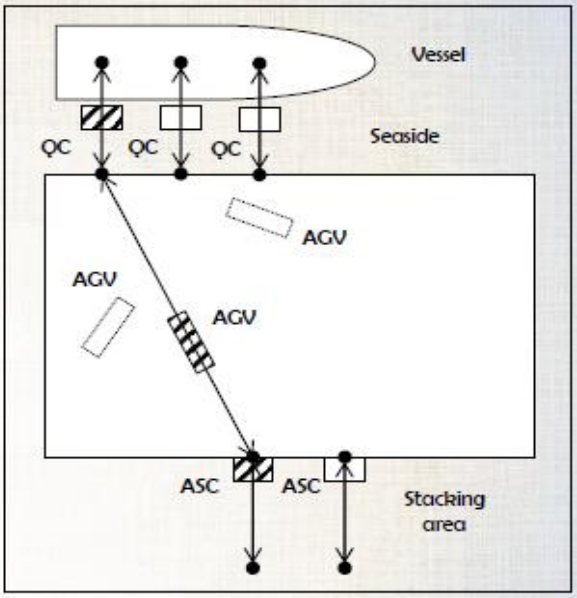

Fig 1. The layout of a container terminal.

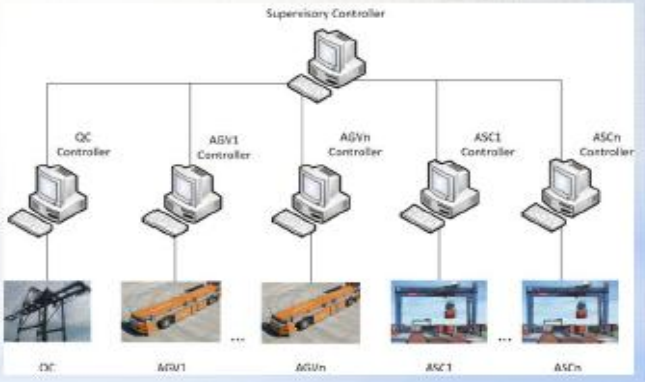

Fig 2. The hierarchical control architecture.

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Hierarchical control of equipment in automated container terminals

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Curriculum Vitae

In June 2010, Jianbin Xin received the MSc degree in Control Science and Engineering from Xi'an Jiaotong University in Xi'an, China. From September 2010 until August 2011, Jianbin worked on dynamic control of electric vehicles at the Delft Center for Systems and Control, Delft University of Technology. Since September 2011, Jianbin is working at the Department of Marine and Transport Technology, Section of Transport Engineering and Logistics of TU Delft on his PhD project "Hierarchical control of equipment in automated container terminals". In his research project, he is focusing on the operational control of equipment inside the container terminal. His main interests are in modeling and control of container terminals and intelligent control of transportation systems, using hybrid systems, model predictive control, and optimization.

Research Project

Research Question

The increasing amount of containers that arrive and depart with container ships provides much pressure for terminal operators [1]. The throughput, i.e., the number of containers handled per hour, should be increased. Meanwhile, energy consumption needs to be reduced to adapt sustainability. In contrast to building new terminal infrastructures, terminal management can be improved in order to maximize the performance of the existing infrastructure, possibly in an economical way. This motivates the research question:

"*How to improve the throughput of an automated container terminal in an energy-efficient way?*"

Research Goal

This research project aims to achieve real-time optimal control of equipment of automated container terminals to improve the throughput in an energy-efficient way.

Methodology

The objective of this research project is to achieve the minimal makespan in an energy-efficient way at the operational level.

1) Multi-level Control

An container terminal has both discrete-event dynamics and continuous-time dynamics when container are transported. Previous work [2] considered a hybrid model predictive control approach. The integration of throughput and energy consumption leads to a mixed-integer quadratic programming program, which is a NP-hard problem. To handle the trade-off between time and energy consumption, a hierarchical control architecture [3] is proposed to achieve operational control of equipment inside an automated container terminal. The behaviors of equipment are modeled as a higher level and a lower level representing discrete-event dynamics and continuous-time dynamics, respectively. These dynamics need to be controlled.

2) Higher level Controller
At the higher level a scheduling problem is formulated to achieve the minimal makespan. For this, the minimal time required for carrying out a task at the lower level is needed. This scheduling will integrate the operation of quay cranes, AGVs and automated stacking crane. This scheduling problem can be solved as a mixed integer linear programming problem. In particular, decomposition technologies will be applied to achieve tractable computational time when the number of equipment increase significantly.

3) Lower level Controller
The minimal time for carrying out a task by each piece of equipment is obtained by the lower level. The actual operation time, allowed by the higher level for completing a task by one piece of equipment at the lower level, is determined by the scheduling algorithm at the higher level. Optimal control at the lower level is subsequently proposed to achieve the minimal energy consumption when the operation time allowed is given. In particular, Distributed Model Predictive Control will be proposed to achieve real-time control of multiple AGVs taking into account of collisions. In contrast to work of AGVs [4], the lower-level controller of AGVs will focus on developing real-time control strategies and the interaction between AGVs and other piece of equipment (e.g. quay cranes and automated stacking crane) .

Relevance to the strategy of the port of Rotterdam
This research project is relevant to the strategy of the port of Rotterdam [5] in the following way.

1) *Accessibility*
Further globalization and development of the world economy are expected to trigger growth in global freight transport. The port of Rotterdam plays a crucial role in the transshipment of global freight transport due to its geographical location. This means cargo shipments via Rotterdam are expected to increase and a growing number of multinationals from emerging economies will want a presence in the port. As a whole, the throughput of the port of Rotterdam needs to be increased to handle the growth of cargo volume. For each existing container terminal, the throughput should be maximized such that the port of Rotterdam can have a certain high handling capacity. This research aims to increase the throughput of an automated container terminal in terms of operational control of equipment inside. Traditional scheduling does not take the dynamics and its constraints into account, in particular the complex behaviors of AGVs. The operation of each piece of equipment in practice cannot guarantee the traditional scheduling of interconnected pieces of equipment. Each piece of equipment can be controlled in a more realistic way by the proposed methodology to guarantee the expected throughput. Once the expected makespan cannot be achieved, delays will influence the handling of the following container ships to attenuate the accessibility of the container cargo in the port of Rotterdam. Therefore the accessibility can be improved by the proposed methodology.

2) *Sustainability*
In the future, climate change will stimulate more and more consumers take sustainability into account when choosing products. More and more companies use sustainability to distinguish themselves from their rivals. This trend offers opportunities for the port of Rotterdam to

distinguish itself as a sustainable port. But the port of Rotterdam must first become sustainable. The port of Rotterdam should focus on energy efficiency to reduce the amount of carbon oxygen. As an important transport hub in the port of Rotterdam, container terminals should implement sustainable energy technologies for each piece of equipment, as well as energy-efficient management of equipment for the whole terminal. This research project focuses on the energy-efficient management of container terminals when multiple pieces of equipment involve transporting of containers. Considering the transport time and energy consumption are conflicting, this research project first guarantees to achieve the minimal makespan and then apply energy-optimal control to equipment when the minimal makespan is minimized.

3) *ICT applications*

Information technology has a growing influence on everyday life. Exchanging data between devices, networks and systems will become even more commonplace in the future. This has major implications for the way companies are organized in port of Rotterdam. Data exchange and smarter IT systems will also have a major impact on freight transport. Tests are already under way with automated guided vehicles which greatly improve both traffic safety and infrastructural capacity. By linking logistics systems, it is possible to eliminate unnecessary (empty) transport and then improve the usage of existing infrastructure. In an automated container terminal, a large number of containers will be handled by unmanned equipment. The automation of all piece of equipment requires an efficient algorithm for the operator of an automated container terminal. This research project provides a solution to the management of an automated container in which the maximal throughput can be achieved in an energy-efficient way.

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A NEXT GENERATION CONTAINER PORT

Nima Zaerpour, René de Koster, Bart Kuipers
Rotterdam School of Management, Erasmus University
&
Casanova + Hernandez Architecten

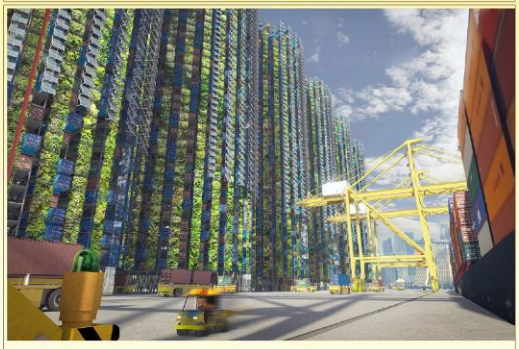
Port vision 2030: Port Compass

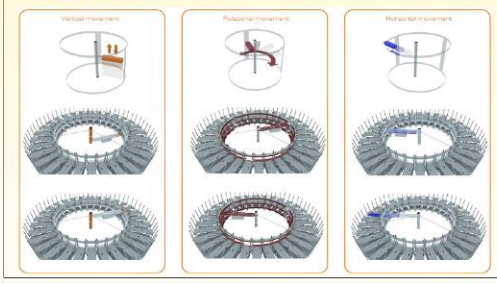
- Intensifying land use
- Reducing environmental footprint
- Improving the utilization of capacity
- Investments in infrastructure
- ICT, coordination and efficient logistics
- Excellent recreational facilities and quality of life
- Innovation

Objective

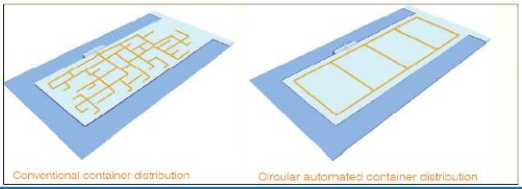
To seek **revolutionary concepts** in the planning, design and operations of the next generation of container ports that will achieve high **efficiency and productivity** to support future shipping in an economically and environmentally **sustainable** manner

A Container Tower



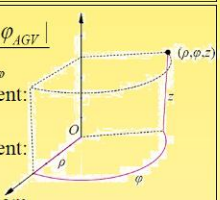


Circular Automated Container Distribution



Performance

$$RT(\rho,\varphi,z)=\frac{\rho\varphi}{v_\varphi}+\frac{z}{v_z}+\frac{2\rho}{v_\rho}+\frac{z}{v'_z}+\frac{\rho|\varphi-\varphi_{AGV}|}{v_\varphi}$$



- Throughput for *vertical* movement: **91** TEU/hour (53 transaction/hour)
- Throughput for *horizontal* movement: **23** TEU/hour (14 transactions/hour)
- The quay cranes are fed with upstream modules with higher capacity (creating a push flow of containers to quay cranes)

Cost Analysis

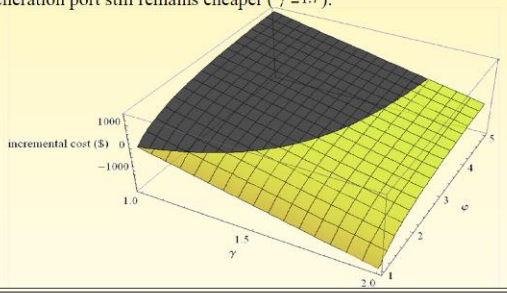
- Investment cost comparison:

$$c_{inc}=c_{ave}-c'_{ave}=c_l\varepsilon(1-\frac{1}{\varphi})+c_t(1-\gamma)$$

- Operational cost comparison:

$$NPV(i,\tau_{\max})=\sum_{t=0}^{\tau_{\max}}\frac{s_{inc}}{(1+i)^t}$$

- Container storage towers can reduce the required footprint about 66%, i.e. $\varphi=2.9$. With 1.7 times more investment per location, next generation port still remains cheaper ($\gamma\leq1.7$).



Sustainability

- Vertical movement: Electrically powered lifts
- Horizontal movement: Electric AGVs
- **59%** reduction in energy consumption and CO2 emissions
- A hybrid urban solution combining a green container port and city areas.

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A Next Generation Container Port

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About the author

Nima Zaerpour (1983) is a postdoctoral fellow at Rotterdam School of Management, Erasmus University Rotterdam. He received his B.Sc. in Industrial Engineering from Sharif University of Technology in 2005 and his M.Sc. in Industrial Engineering from University of Tehran in 2008 both in Tehran, Iran. In September 2008, he joined Rotterdam School of Management, Erasmus University Rotterdam. His research interests are next generation storage systems, e-commerce order fulfillment systems, sustainable warehouse operations, facility logistics, distribution logistics, etc. In 2012, he was a visiting scholar at School of Industrial and Systems Engineering at Georgia Tech, where he attended Global Supply Chain Scholars Program. Moreover, in 2011, he was a visiting scholar in the Department of Information Management and Decision Science, University of Science and Technology of China. His research findings has been presented in many international conferences including INFORMS Annual Meetings (2009, 2010, 2011, 2012), POMS (2012) and EURO (2009, 2010). He defended his

PhD thesis in February 2013. He is currently involved in the Dinalog project, 'Cargo Driven Intermodal Transportation' with focus on managing cross-dock operations at the cargo level.

About the Next Generation Container Port

The proposed next generation high-density container tower system is mainly introduced to increase the footprint and space utilization in order to achieve high throughput within a given land profile. For such systems the use of footprint is much smaller than the footprint required for traditional container ports. Therefore, the saving obtained from the smaller land area might offset high cost of technology. Our proposed next generation container port can increase the storage density significantly. By storing containers in towers of 150 meters, containers can be stored up to 45 levels high, reducing the required land and footprint. Additionally, in a container tower each container is individually accessible as no reshuffling is required.

Supply chain visibility aims to improve supply chain performance by providing reliable data to different nodes in the supply chain including port terminals. In our analysis for the proposed design we answer the following questions:

1. What is the cost of a next generation port compared to traditional ports?
2. Is a next generation port better (in terms of environment) than a traditional system?
3. What is the performance of our proposed next generation port of a given storage capacity?

To investigate the cost feasibility of our proposed system, we compare our proposed next generation container port with the real data obtained from a traditional container terminal. According to our analysis, container storage towers can reduce the required footprint about 66%. Our analysis shows that if the investment in technology and building for the next generation port is up to 1.7 times larger than the traditional port, next generation port still remains cheaper in terms of investment. Based on our results, the investment cost of a next generation port will be increased up to 50%. In addition, use of fully automated container towers results in significant reduction of direct labor cost and energy costs (fuel and electricity). Although these new container towers might require higher maintenance costs, our results show that in total 16% of operational costs can be reduced by using our proposed container towers instead of conventional container terminals. Thus, our next generation port design will be completely financially feasible compared to current conventional port terminals.

The use of the latest technologies in our next generation port terminal makes it a relatively 'green' terminal. For vertical movements, container storage towers operate with electrically powered lifts, which lead to significantly reduced fossil fuel and energy consumption, and CO2 emissions compared to traditional straddle carrier crane-based storage systems. For horizontal transport, diesel-electric automated guided vehicles (AGVs) are used which consume 30% less fuel and consequently cause less CO2 emissions compared to their earlier generations. The average storage and retrieval time of a container can be obtained based on tower dimensions and speed of the lift. By using average storage and retrieval time and engine power, the average energy consumption for each tower can be calculated. In addition, the energy consumption for horizontal movement can be calculated based on the average distance traveled by an AGV and the engine power of an AGV. The total energy consumption can be obtained based on annual throughput of the terminal. CO2 emissions can be obtained by using life cycle analysis based on energy generated by different types of power plants. The results show that in a next generation container port, although the lifts for vertical movements require powerful engines to hoist heavy containers, the travel distance of AGVs will be decreased significantly in horizontal direction. Hence, the energy saving from AGV movements can offset additional energy consumption by the lifts. Comparing the total energy consumption of our proposed next generation port with real data of the total energy consumption of a container terminal shows that in total 59% reduction in energy consumption and as a consequence CO2 emissions can be achieved. This reduction is even more significant for CO2 emissions if electricity is provided by a fossil-fuel power plant.

Our computational model and analysis is based on little transparency and visibility within the supply chain (worst case scenario). For instance, we consider a random storage assignment policy as the control policy for the container towers.

This means receiving containers are randomly assigned to storage locations. However, storage assignment of container based on their duration of stay (DOS) can improve the performance of such systems significantly. A two-class-based storage policy can simply be implemented in practice by classifying containers in high turnover and low turnover classes based on their duration of stay. The high-turnover containers are then assigned to locations closer to the pick-up/drop-off point. The results show that such a storage policy can reduce the response time up to 50% compared to a random storage policy.

The 2nd Erasmus Smart Port / Port Research Centre Rotterdam-Delft / Next Generation Infra
Poster Session, Rotterdam, June 27, 2013

Land Use & Performance Benchmarking of Seaport Terminals

An ANP based benchmark approach

ITMMA INSTITUTE OF TRANSPORT AND MARITIME MANAGEMENT ANTWERP

Port of Antwerp

Universiteit Antwerpen

1 Research Questions

How do we define land use and terminal performance?

Are we allowed to compare the performance of different terminals and ports worldwide regarding land use?

What is the role of the surrounding operating environment (e.g. ports) how do they foster or limit performance?

2 Methodology

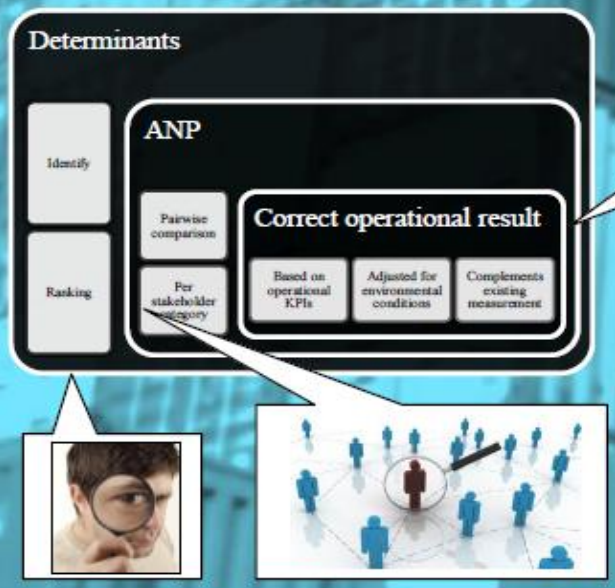
First step: obtain which quantitative and qualitative determinants matter by means of expert survey

Second step: identify which external determinants influence seaport terminal land productivity

Third step: simulate how terminal operations are affected

Fourth step: assign relative weights (ANP)

Fifth step: benchmark



3 Results

Terminal land use performance should be based on stakeholder weights and...

Experts confirm that external determinants do matter, traditional KPIs do not suffice - a shortlist of 10 determinants was obtained

Comparing different terminals and ports is possible IF the external environment is being included and considered

Analytic Networks Process (ANP) is suitable to assign relative weights, since it enables feedback effects

Research Background

Most benchmarks tackling land productivity are based upon opertional and industry KPIs. It is argued that overall seaport terminal performance should be based on stakeholders appraisal. It is assumed that the external environment limits on site terminal capacity and performance

Researcher Info

Dries Verbraeken M.Sc is holder of the Port of Antwerp Scholarship for his research on land productivity of seaport terminals supervised by Prof. Dr. T. E. Notteboom (ITMMA – Uni.Antwerp – Antwerp Nautical Academy)
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Dries Verbraeken, University of Antwerp (ITTMA)

Land Use & Performance Benchmarking of Seaport Terminals

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Dries Verbraeken is a research associate at ITMMA. He has been granted a four year scholarship by the Antwerp Port Authority; his Ph.D will comprise land productivity performance and benchmarking guided by prof.dr. Theo E. Notteboom.
When joining ITMMA, Dries worked on a one-year project for the province of Antwerp. The results of the project were presented to the province council, press and broad public in march 2010. Dries is holding two master degrees (MS.c), one in Political Sciences (2005) and one in International Relations and Diplomacy (2006) of the University of Antwerp. In 2010 he completed his MS.c in Maritime Sciences at the University of Antwerp. His scientific interest is focussed on logistics, port concession agreements, port productivity; European railway policy and history of the city of Antwerp in general.

Research and Topic Relevance

Land use in ports have been an important research topic since a large number of ports are so called “landlord ports” who balance public interest with private investments. Therefore the port area and available lands are considered to be a scarce resource. In order to safeguard public stakeholders and monitor private performance in many cases concession agreements are agreed upon. Land use and productivity measures are viewed as the major of the cornerstones of benchmarks. In recent years environmental and sustainability concerns have gained momentum when discussing concession agreements. Throughput guarantees and modal split requirements, treatment of waste are amongst the most common examples.
It should be noted however that land productivity measures are by no means to be considered “neutral” benchmarks. Since they stress particular interest a deeper inquiry is required. Quite often industry benchmarks are hallmarked because they are relatively easy to compute and in part because they stem from operational KPIs. In academic literature several noteworthy contributions can be found when evaluating port seaport terminal performance. One should note that different approaches yield different results as the selection of indicators more or less defines the resulting benchmark view. In addition to methodological considerations a persistent lack of operational data is key to the fact that most studies only offer partial analysis.

To tackle some of the drawbacks of current benchmarking one should consider what definition of land productivity should be used. From an operational point of view this offers a straightforward point of view but only for a select number of stakeholders. When other views are taken into account other KPI’s should be added. Although a number of multi-criteria benchmark offer both qualitative and quantitative elements a synthesis remains quite difficult. More over concession agreements offer only limited degrees of flexibility. Since they are the result of negotiations and the product of future prospects at that time one they fall short when larger environmental conditions change.

This research argues that the basic state of analysis should not entail perpetual stability. Instead flexibility should be the starting point. It is argued that operational performance of terminals is capped by what is achievable within a certain economic, political, social and technological environment. A first step in this research flow aims to confirm that environmental (external) determinants are able to influence operational results. Next a list of identified determinants should be ranked by both internal (port authorities, terminal operator) stakeholders as external ones. When the different stakeholders assign relative weights using Analytic Network Process the stage is set for a benchmark. This benchmark can be used to assess terminal performance in view of current condition and offers insight in to stakeholder's preferences. It can also be used to evaluate current land use and offer different scenarios. When fully implemented it can improve operational results by identifying drivers beyond the terminal operator's control offering a path for other stakeholders to improve conditions.

The 2nd Erasmus Smartport / Port Research Centre Rotterdam-Delft / Next Generation Infra
Poster Session, Rotterdam, June 27, 2013

Simulation of cluster development of MV2

Dr. Chris Davis, M.Sc. .Industrial Ecology

Introduction

In order to explore possible development options for the MV2, an Agent Based Model has been created. This model simulates the investment decision behavior of simulated individual companies. Once companies have started operation, they form trading networks among themselves and larger aggregated markets. Based on this, we are able to track the flow of money and goods between agents, and consequently between the Port and the world market. Further data is collected on how this influences the amount of port dues collected.

Relevance and Implementation

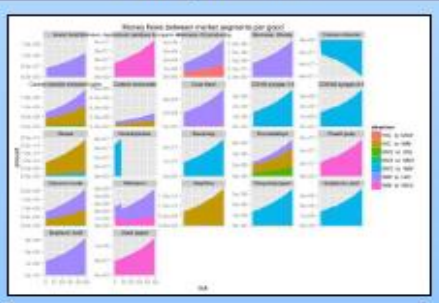
The deliverable of the study is an ABM simulation tool that can be used by employees of the PoR to elucidate influences of scenarios and decisions made by the PoR on the long term development of industrial clusters at Maasvlakte 2.
The simulation is run via a user interface that is able to download the latest data from the wiki. The user is then free to modify this data and test out different scenarios involving various combinations of companies and price trends for different types of goods.

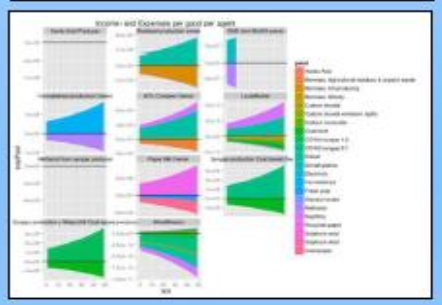
Data Management

To help manage data used for the model, a semantic wiki has been set up. Every company, facility and product has a dedicated wiki page describing the facts collected for each object. Different visualizations are employed to show the state and completeness of the current data. The structured data on the wiki is used as a database which is directly fed into the model.

Agent Based Model

Example Results





Definition of Flows

Identification of Possible Trading Networks

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Digital evolution of the MV2 cluster

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"Prediction is very difficult, especially of the future."
Niels Bohr

If the future would be predictable, the development of the Maasvlakte 2 would become much easier. Unfortunately, the future is unpredictable. A possible strategy is to use a set of scenarios to develop clusters for the MV2. The project "Digital evolution of the MV2 cluster" makes it possible to calculate and consider the combination of future possibilities. The simulation tool to be developed should support the Port of Rotterdam in taking strategic decisions. For example, the Port of Rotterdam can gain insight into the effects of the settlement of a large-scale container storage or a coal/biomass burner on MV2 in 2014 on the performance of the MV2 over a period of decades.

The Port of Rotterdam (PoR) has gained excellent expertise for the development of harbour industrial clusters. The PoR will be facing strategic decisions as with the future development of the industry in an uncertain environment. The PoR already has a number of options for the MV2. Working out these options will be depending both on the policy of the PoR and developments in the market, sustainability criteria, technology, laws and rules and just pure coincidence. At the same time these options can influence each other either positively of negatively. The choices made today may have enormous effects on uncertain future developments. To manage the development of the MV2 both on a short and a long term is very complex.

At Next Generation Infrastructures (NGInfra) much research strongly related to harbours has been done to understand socio-technical systems. Frequently Agent-Based Modelling (ABM) has been used. After the description of input, output and rules of behaviour of relevant agents, the ABM technique will let the virtual actors make and break structures over a period of time. This technique is especially useful in studying the development of complex systems. However, this technique is still not often used in practice.

The challenge for this project is to integrate knowledge and expertise from the researchers- and users environment related to industrial cluster development. The knowledge of NGInfra can contribute highly to gaining insight in possible industrial development scenarios of the MV2/PoR and at the same time the expertise of the PoR can strongly stimulate research to the clustering and creation of infrastructures.

The objective of this project is:

To develop a simulation tool that can be used by employees of the PoR, which provides insight with valid/accepted performance indicators into the scenarios and decisions of the PoR to the evolutionary

development of industrial clusters on the MV2.

In an agent-based model all relevant parties are described as digital actors: the so-called agents. The description of an agent includes individual data/properties, the interaction rules of agents with other agents, along with factors external to the simulated agents. Examples of agents are: owners of a not yet settled biomass company, an already settled electricity plant, a transport infrastructure for CO_2, an oil trader on the world market or the PoR itself. Examples of interactions are the buying of (raw) materials, the mutual exchange of intermediate products, the coupling to a utility or settling on a certain location.

A model simulation starts with determining for example the start configuration, the list of candidates for settling and a scenario (with for example rising prices for fossil materials, dropping prices for sustainable materials and unchanging CO_2 rights). For a period of decades agents will determine on fixed times if the conditions are interesting enough for settling, (de)coupling with other agents, the creation of new infrastructures, etc. They even consider leaving the cluster. This is how a digital harbour industrial cluster develops. The quality development of a cluster over decades will be shown by performance indicators, like harbour dues, lease, capital value, added value and emissions.

The simulation tool will give long-term appreciations of dynamic developing industrial clusters for different trends. The simulation tool does not give a future forecast but it explores possible futures.

The agents behave mainly autonomous in the model; however they can influenced by the policy of the PoR. It will be possible for example to gain insights into the long-term effects of the short-term stimulation of biobased chemical industry. The simulation tool is intended to support the PoR for many years concerning the development of the harbour.

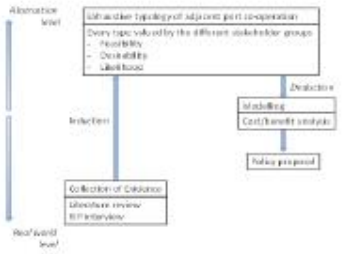
Christopher Bryan Davis graduated in 2001 with a Bachelor of Engineering degree from Vanderbilt University with a double major in Computer Science and Electrical Engineering. For several years he worked as an engineer at Dell. In 2005 he began the master's program in Industrial Ecology at Leiden University and Delft University of Technology. In 2007, he graduated with a thesis entitled ``Integration of Life Cycle Analysis within Agent Based Modelling using a Case Study on Bio-Electricity''. This work received the Stans Prize from the Institute of Environmental Sciences (CML) at Leiden University for the best M.Sc. thesis. In 2008, he began a Ph.D. position at the Energy and Industry group, Faculty of Technology, Policy and Management, Delft University of Technology. His research focused on exploring how the social and technical revolution emerging around the World Wide Web could enable us to gain a better understanding of the complex socio-technical systems that surround us.

Currently, he is a postdoctoral researcher in the same group and is continuing to explore the topics elaborated on in this thesis.

The 2nd Erasmus Smart Port Rotterdam/Port Research Centre Poster Session, Rotterdam, June 27, 2013

Societal cost benefit analysis of co-operation between adjacent seaports authorities

PhD research by Joost Hintjens



Take a post-it and add your suggestions

Joost Hintjens (*1962) got his master degree in Commercial Engineering at the University of Antwerp in 1986 and started a career in the industry while getting his Master in Management at the University of Ghent in 1993. He worked for several mid-sized European industrial companies with a focus on international marketing and logistics. He started teaching in 2002, first part-time at the Atheneum in Antwerp but from 2006 full-time as lecturer Logistics at the Artesis University College. He started his PhD research at the end of 2012 with the co-operation between adjacent seaport authorities as subject.

Motivation

+ Increased scale of maritime shipping
+ Increased concentration of market players
+ Increased containerisation
+ Reduced captive hinterland
+ Increased contested hinterland
+ Footloose customers
+ Reduction of bargaining power of PA
+ Use of scarce land resources
+ Use of scarce financial resources
+ Need for efficiënt hinterland connections
+ CO_2 reductions
+ Greening of the economy

==========

∑ = Co-operation between adjacent seaport authorities

Hypothesis

H1 The societal effects of co-operation between adjacent seaport authorities are quantifiable

H2 The net value of these effects depends on the time frame

H3 The net present value of these effects are positive

Effects

Endogenous

Cost	Benefits
Diseconomies of scale	Purchase/selling power
- Increased management cost	Common products
- Inefficiencies	Added services
- Loss of traffic	Add:
Add :	

Exogenous

Cost	Benefits
Loss in servicequality	Improved connections
Increase in price	Optimal use of public resources
Add:	Reduced external costs
	Add:

Methodology (to be developped)

Supply side :

E.g.: An effect of co-operation could lie in increased efficiencies, economies of scale and reduction of costs. This would allow the PA to offer more services for the same price or improve the profitability.
A merged PA might be serviced by more terminal operators, this increased operator competition might lead to a lower price.
The co-operating PA would strengthen their negotiating position for concession negotiations this would increase shareholder value.
The port dues might increase thus reducing the consumer surplus but the relative importance of these dues in the global supply chain is minimal.

Demand side :

E.g.: Co-operation between adjacent seaports could lead to an increased attractiveness of the co-operating ports. Co-operating PA might offer an improved connectivity thus extending their hinterland and increasing the services offered.
The increased competition between TO's might improve the service level thus increasing the demand.

Societal effects

E.g.: More efficient use of factor goods would lead to a better use of scarce land resources.
The modal shift and the bunding of flows would result in lower external costs.
More efficient ports would result in more competitive exporting industries and lower importing costs.
The introduction of new, green technologies might accelerate through the critical mass of the co-operation.
Through a common internalisation of external costs the quality of the choices will improve.

Question

How to quantify these effects?

Please take a post-it and add your suggestions

Erasmus Universiteit Rotterdam SMARTPORT
Port Research Centre TUDelft

Joost Hintjens

I learn more by listening than by talking

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Universiteit Antwerpen
TPR DEPARTMENT OF TRANSPORT AND REGIONAL ECONOMICS

Joost Hintjens, University of Antwerp

Societal cost benefit analysis of co-operation between adjacent seaports authorities

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Supervisors: Dr. Thierry Vanelslander , dr. Eddy Van De Voorde

Curriculum vitae

Joost Hintjens (°1962) got his master degree in Commercial Engineering at the University of Antwerp in 1986 and started a career in the industry while getting his Master in Management at the University of Ghent in 1993. He worked for several mid-sized European industrial companies with a focus on international marketing and logistics. He was general manager of companies in Belgium, Holland and Czech Republic for a French industrial group when he switched to teaching in 2002. First part-time at the Atheneum in Antwerp but from 2006 full-time as lecturer Logistics at the Artesis University College. He is currently chair of the course group Logistics at Artesis and researcher at the University of Antwerp where he is focusing on the role of ports in the supply chain. His interest goes mainly to the role of logistics at mid-sized companies and the relations with their clients and suppliers in controlling the supply chain. He started his PhD research at the end of 2012 with the co-operation between adjacent seaport authorities as subject.

Research

Societal cost benefit analysis of co-operation between adjacent seaports authorities.

PhD studies started October 2012.

Introduction

Adjacent ports should co-operate, this is often stated, but many disagree. If they should co-operate then the benefits should be quantifiable. Ports are important links in the global supply chains. They play a decisive role in the competitiveness of exporting industries and in the efficient availability of imports. Due to containerisation and the resulting scale increases in shipping, the hinterland of ports has radically increased. Thus the captive hinterland has shrunk and the contested hinterland reaches across continents. The scale increases led to bigger shipping lines and shippers. Ports changed from nodes to links. Containerisation made customers footloose giving them much lower switching costs. All this has led to a weaker position of the port vis-à-vis its users.

Co-operation can take place between many players in the port industry. Research has been published on intra-port co-operation. Co-operation between ports on the same supply chain is also well documented. It exists between ports on different sides of the maritime divide and between seaports and hinterland ports, inland or feeder. But the reduced captive hinterland leads to the opportunity or

even necessity for ports to co-operate on competing supply chains. This topic is much more contentious, it supposes that organisations which have fought ferociously for generations, share resources and trade secrets, it also brings fear for reduction of service levels and price increases.

Many actors besides the port authority are concerned: shipping lines, shippers, stevedores; they fear that co-operation will diminish competition and thus reduce service levels and increase prices. Policy makers, employees are afraid they might lose control over their local port and the employment it brings. The public at large who is not keen on the use of scarce space that a port has might actually encourage co-operation if it makes a better use of land and reduces environmental pressure.

Many opportunities for and forms of co-operation are possible. Not all are as likely or desirable but some might bring a real competitive advantage, cost saving or economies of scale. Many forms of inter-port co-operation are already in place today: adjacent ports are already working together on projects where they can reinforce each other such as lobbying with supranational organisations.

Objective

The objective of the research is to prove whether co-operation between adjacent seaport authorities brings a net positive contribution to society. To this end a typology that describes the different forms and aspects of co-operation between adjacent port authorities needs to be established. Based on a theoretical paradigm to quantify the societal costs and benefits of co-operation a realistic, actual, factual case will be solved.

Problem description

Budgetary, environmental and spatial limits bring policy makers to the conclusion that adjacent seaports should co-operate. The port authorities are reluctant, the port users suspicious. The effects of co-operation can be far reaching and some might be unsought. The benefits are vague and ill-defined. The business case for co-operation is unproven, so far.

Relation with the strategies of the port of Antwerp and Rotterdam

Both ports aim for a modal shift and at the same time want to extend their hinterland as far as possible. They also want to reduce the ecological footprint of the logistic operations related to the ports. To do so in dialogue will have an increased benefit. Some examples are given below.

Firstly, it will not disturb the competitive position. It will maintain a level playing field between competitors. It would be hard for one port authority to deliberately handicap its commercial position by installing costly environmental requirements while its nearby competitors would not follow suit.

Secondly, some policies would require a critical mass which one port, alone, might not realise. Long distance rail hinterland connections could only be successful if they had a high frequency but to reach this frequency a high volume would be required. Two ports could more easily, in combination, reach a high volume then when they would do so separately.

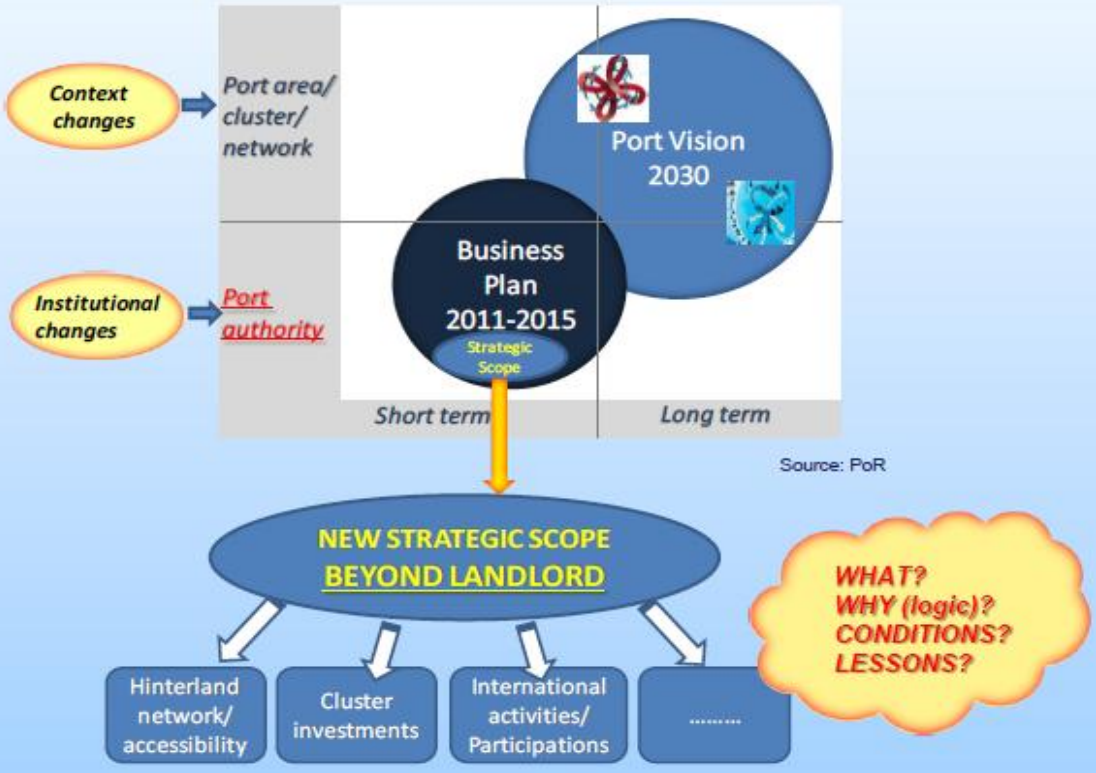
Thirdly, some policies, like cold ironing, require technical standards. If the two

biggest ports of Europe can agree between them, then the other European ports will be obliged to follow.

Lastly, Europe wants to increase its power over port policies, environmental and other. In the lobbying process that this require from the ports a unified front of neighbouring ports will have more impact and will have a higher success probability to get its interest on the agenda.

These are just a few examples of how the long term strategies of neighbouring port authorities have a reciprocal influence.

BEYOND THE LANDLORD
An analysis into the strategic scope of the port authority



RESEARCH GOAL

TO GET AN UNDERSTANDING OF THE STRATEGIC SCOPE DEVELOPMENT OF PORT AUTHORITIES

QUESTIONS TO BE ANSWERED

What are port authorities doing 'beyond the landlord'?
What is the logic behind it?
What conditions apply?
What lessons can be learned?

METHODS

THEORETICAL CONSTRUCT BUILD UPON:
Concepts from Strategy Research
Institutional Theory
Business Model approach

EMPIRICAL RESEARCH:
Worldwide Survey (91 responses)
Statistical Analysis
Case-studies

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RESEARCH SETTING

PROMOTORS
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FINANCIAL SUPPORT
Dinalog (Ultimate project)
Port of Rotterdam

Larissa van der Lugt, Erasmus University Rotterdam

BEYOND THE LANDLORD: An analysis into the strategic scope of the port authority

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Supervisors: Lorike Hagdorn (VU) , Peter de Langen (TU/e)

PROFILE

I'm driven by the ambition to support the economic development of ports and ports' actors by providing grounded insights and new thoughts on economic and strategic improvements. At the same time I'm driven by the ambition to educate academic students at the highest level and to develop their commitment to the ports' and logistics sector.

To realize these ambitions I've chosen a research position at the crossroad of science and applied practical research and consultancy. As senior researcher and project coordinator at the department of Regional, Port and transport Economics I am involved in research projects, both academic and practical, on port and maritime economics, port management and port related logistics development. Within that field I specialize in economics organization, governance and strategic management: my PhD project is on the Strategic Scope of Port Authorities. I am

course coordinator and teacher in the various Master Programs on Logistics and Port Economics and Management.

The good connections I've build up with other research institutes, both within the Netherlands as abroad, with the ports' industry, and with the world leading academics in the field of port economics and management are crucial for me in the development and spread of the knowledge and insights I develop together with colleagues sharing the same ambitions.

RESEARCH

In the Port vision 2030 many challenges for the port are outlined, combining in the two main visions for the future: to develop Europe's Industrial Cluster and to develop Rotterdam into a Global Hub. The actual Port vision document distinguishes from earlier vision documents mainly in its shift from focus at expansion and physical development towards efficient and effective exploitation and exploration of existing assets and resources, covering all companies belonging to the ports' cluster and networks. This especially requires changes in behavior of all port related actors, asking for new ways of economic organization and interaction between actors.

This Port Vision 2030, carefully developed by PoR in discussion with all stakeholders and yet widely accepted by the port community, in principle sets the directions

for the port as a whole. Next question, evenly important once it comes to implementation, is which actor takes what role and has which responsibilities in bringing this Port Vision to realization. And related to this question: what role does the Port Authority itself has in this process? This question is a very actual and relevant question continuously addressed within PoR management.

Overall, over the last decade strategic thinking has gained a stronger foothold within PoR. A quick scan into the annual reports from 2000 to 2011 shows that the number of times that the words "strategy" and "strategic" are explicitly mentioned, has increased substantially over this period. It starts from zero in 2000 and increases sharply after 2008 up to around 40 times for each of the two words in the annual report of 2011. Assuming that corporate communication reflects firm behavior, this evolution demonstrates the increased focus at strategic issues at the PoR organization level.

This is also key to the PhD Research, that aims to provide an understanding of the nature and the drivers of the changes in the *strategic scope* of port authorities. At a global scale, most port authorities act as landlords, responsible for the development and management of the seaport. In the landlord model the private sector undertakes the port operations. However, this landlord model is an increasingly incomplete and inaccurate description of the role of the port authority. In the last two decades many PAs have changed from rather public administrative organizations embedded in local or national governments into autonomous and commercially operating organizations. Changes in the commercial and operational environment; e.g. globalization of port actors, increased importance of network integration by ports and port actors, pressure from environmental side and increased pressure on the accountability of the port authority, have resulted in a changed perspective on the role, position and functions of port authorities. The missions and goals have changed accordingly. This has also had an effect on strategies (how to reach these goals) of port authorities and their *scope of activities:* port authorities, across institutional structures and regions in the world, increasingly engage in activities beyond the landlord function. Recent literature also shows the increasing importance of new PA functions, such as the role of community or cluster managers, on top of traditional functions such as infrastructure manager (also referred to as the landlord function), regulator and operator. Furthermore, besides the enlargement of the scope of activities, the geographic space within which these activities take place is also extended from the local level (the port area) to the regional and even the global level (as evidenced by e.g., PAs like Rotterdam and Antwerp taking financial participations in inland platforms in their hinterland or investing in port projects in emerging economies). As a result PAs are

facing strategic decisions on investments within their port areas, within their foreland and hinterland and on their strategic positioning and acting towards the private companies located in the port.

The strategic view/perspective of the port authority (PA) has been approached from different analytical lenses. In fact, management discipline areas such as strategic management, human resources management (HRM), environmental management and information and knowledge management appeared in the picture of port research, having an important influence on theory transfer and application. However, most contributions are rather conceptual and based on cases of specific ports or specific regions. There seemingly is an increasing need to apply theories, concepts and research models used in business and management related disciplines to capture the more complicated and behavioral aspects of PAs such as collaboration, integration, internationalization, network management and cluster management. In this research we start adding to this emerging research stream by first investigating the strategic scope of port authorities and by exploring factors that influence this strategic scope, based on a structured survey send to all major port authorities worldwide. More specifically, we investigate whether recurring configurations of strategic scope exist and to what extent these relates to contextual factors of PAs. This provides a basis for further theory development and empirical analysis of strategies of port authorities, based on specific issues and specific cases:

- Hinterland strategies from a co-evolutionary perspective
- Internationalization strategies
- Financial performance of port authorities
- Strategic cognition of port authority managers

Together this results in a set of papers approaching the strategic scope issue of port authorities from different angles.

The 2nd Erasmus Smart Port Rotterdam/Port Research Centre Poster Session, Rotterdam, June 27, 2013

Rick M.A. Hollen MScBA, PhD Candidate

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Promoters: Prof. Dr. Frans A.J. Van Den Bosch & Prof. Dr. Henk W. Volberda

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THE ROLE OF MANAGEMENT INNOVATION IN ENABLING TECHNOLOGICAL PROCESS INNOVATION IN PORT-INDUSTRIAL COMPLEXES: THE CASE OF *Plant One*

Port Vision 2030, Port Compass *(Port of Rotterdam Authority, 2011)*

"In 2030, Rotterdam's industrial and energy complex […] is the largest, **most modern and sustainable petrochemical and energy complex in Europe**." (p. 5)

"Attracting new technologies and innovative activities requires **facilities for testing and expanding innovations**. […] The port already has a number of these facilities in place, such as **Plant One**." (p. 75)

RESEARCH GAP: **In order to become a highly modern and sustainable petrochemical and energy complex, sustainable technological process innovation of constituting established process manufacturing firms becomes of pivotal importance. As these firms often face intra-organizational tensions to reconcile pressures for exploration and exploitation across subsequent phases of technological process innovation *(e.g., Burgers et al., 2008; March, 1991; Russo & Vurro, 2010)*, they may need to perform the development phase – being the most sensitive to these tensions – in the (underexplored) inter-organizational context of an external test facility such as Plant One. This requires management innovation, i.e. new-to-the-firm management practices, processes, structures and techniques *(Birkinshaw et al., 2008)*.**

New-to-the-firm management activities associated with **SETTING OBJECTIVES**, focused on legitimizing and enforcing the involvement of other organizations

(*Example:* setting the objective that pilot installations should be built fit-for-purpose)

New-to-the-firm management activities associated with **COORDINATING ACTIVITIES** regarding knowledge creation outside the firm's boundaries and integration of externally acquired knowledge.

(*Example:* more entrepreneurial, ambidextrous type of project manager in place)

Intra-organizational perspective on technological process innovation: three phases

Process manufacturing firm

Discovery phase: creating new technological knowledge *(exploration focus)* → *Development phase*: developing from laboratory scale and testing towards industrial scale *(exploration and exploitation)* → *Deployment phase*: adopting in full-scale production operations *(exploitation focus)*

Technological process innovation with the development phase performed in the interorganizational context

Focal firm (established process manufacturing firm) *(Intraorganizational context)*

Discovery phase *(focal firm)* → Development phase *(focal firm)* → Deployment phase *(focal firm)*

Development phase *(beyond boundaries focal firm)*

PLANT one

Interorganizational context used by the focal firm for the development phase of technological process innovation (e.g., interorganizational context of an external test facility)

New-to-the-firm management activities associated with **MOTIVATING EMPLOYEES** involved in the inter-organizational context.

(*Example:* project leaders are valued internally for what they accomplish externally: "no harm to career")

New-to-the-firm management activities associated with **DECISION MAKING** about resource allocation, taking inter-organizational relations and intra-organizational tensions into account.

(*Example:* decision-making inter-organizational context less hierarchically structured)

Various (both large and small) firms/organizations have started pilot projects within Plant One, including *ECN*, *Huntsman*, *N.R. Koeling* and *TNO*.

The Port of Rotterdam Authority, being focused on facilitating port-related innovation, is one of the initiators of Plant One.

Part of this research has been published in the scientific international journal ***European Management Review*** (2013, Vol. 10, Issue 1, pp. 35-50, Wiley Online Library). The paper is entitled "The Role of Management Innovation in Enabling Technological Process Innovation: An Inter-Organizational Perspective" – authors: Rick M.A. Hollen, Frans A.J. Van Den Bosch and Henk W. Volberda. Earlier drafts of this paper were presented at the **INSCOPE Annual Conference** in Rotterdam (Netherlands, November 23rd, 2012) and at the **Strategic Management Society (SMS) Lake Geneva Special Conference** in Lausanne (Switzerland, March 22nd, 2013).

Rick M.A. Hollen, Erasmus University Rotterdam

Strategies to increase innovation: Fueling the Port Vision 2030 agenda

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Supervisors: Prof. Dr. Frans A.J. Van Den Bosch & Prof. Dr. Henk W. Volberda (RSM Erasmus University)

Short CV

Rick M.A. Hollen is a PhD Candidate / Research Associate in Strategic Port Management at the Department of Strategic Management and Entrepreneurship of the Rotterdam School of Management, Erasmus University. Prior to his current position, he obtained a Master's degree (2009) in Strategic Management (cum laude) and a Bachelor's degree in Business Administration at the same university. As part of his studies he participated in international semester exchange programs at the Copenhagen Business School in Denmark (2005), HEC Montréal in Canada (2007) and the Pontificia Universidad Católica in Chile (2008). Before starting his PhD trajectory, he worked as a Project Manager Business Development for a global technology and services company.

His PhD research, funded by the Port of Rotterdam Authority, mainly focuses on managerial and organizational factors that increase and sustain the international competitiveness of port-related firms/ organizations and of ports as a whole, and in particular on how port authorities can contribute to this challenge. Key topics in his research include management innovation (as part of social innovation), exploration/ exploitation, inter-organizational cooperation, industrial eco-systems and strategic value creation in and between leading ports (i.e. port-industrial complexes). He co-chaired the EURAM Conference 2012 Track 'Strategies to Increase Innovation in Ports' in Rotterdam.

One of his papers, which examines the role of management innovation in enabling technological process innovation, recently appeared in the international scientific journal European Management Review (EMR), while other papers have been/will be presented at international conferences including the Strategic Management Society (SMS) 2013 Special Conference in Lausanne/Geneva, the International Association of Maritime Economists (IAME) Conference 2013 in Marseille, the Academy of Management Annual Meeting 2013 in Orlando and the SMS 2013 Annual International Conference in Atlanta.

Overall PhD research area

The co-authored research report "The strategic value of the Port of Rotterdam for the international competitiveness of the Netherlands: A first exploration" (2011) has explored various interrelated topics within the field of strategic port management that are of interest for port authorities and other port-related organizations and stakeholders. The report provided direct

input to the Port Vision 2030 (Port Compass) of the Port of Rotterdam Authority. Many of the explored topics, which are largely related to the paradox of how to increase innovation (i.e., exploration) in largely efficiency-driven (i.e., exploitation-driven) ports, require a deeper understanding. The dissertation research aims to provide such understanding by means of further theoretical support and empirical research through, among others, case studies. Based on the outcomes of the research, strategies for port authorities and firms involved are developed. Below, three main topics that are currently researched are highlighted, all largely focused on how to balance exploration and exploitation. In order for the Port of Rotterdam to remain internationally competitive in 2030, such a balance – referred to in the strategy literature as *ambidexterity* – is highly important.

Research into how to assess, monitor and increase the strategic value of ports for their country

Up till now, research on the value of ports for their country focuses primarily on their economic importance in terms of value added, employment and other quantitative measures. These measures, however, do not take into account the contribution of ports to the international competitiveness of their country. Assessing this neglected qualitative contribution becomes more important for ports and port authorities to maintain their 'license to operate and grow' and to strengthen their strategic positioning, often requiring governmental permits and funding. To address this gap, we developed a methodology and related conceptual framework aimed at determining the strategic value of ports for the international competitiveness of their country. Strategic value creation is highlighted in the Port Vision 2030 (p. 8/31/47) as a key performance indicator of future port activities. The contribution of the Port of Rotterdam to the international innovation-driven competitive advantage of the Netherlands is estimated to be at least 6 billion euro of added value for firms located elsewhere in the Netherlands (Van Den Bosch et al., 2011). Departing from Porter's (1990) Diamond model and introducing the concept of strategic connectivity in the context of ports, qualitative indicators of strategic value are developed and illustrated in a case study of the port of Rotterdam. We argue and illustrate that ports can create strategic value in three ways: (1) through contributing to the determinants of international competitiveness of their county; (2) through strategic cooperation (i.e. aimed at specialization, innovation and productivity improvements) with ports and other logistic hubs in the country; and (3) through strategic cooperation with foreign ports and other logistic hubs abroad. We subsequently develop a strategic balance that can be used by port authorities to monitor (i.e. by evaluating current projects and activities) and to increase (i.e. by choosing an option from a set of strategically comparable alternative options) the strategic value of ports for their country.

How to increase technological process innovation in ports by using external test facilities like Plant One

Firms in leading port-industrial complexes are required to become increasingly more innovative and flexible by engaging in continuous strategic renewal, anticipating customer demands and taking into account the challenges regarding the natural environment in order to keep their 'license to operate and grow'. Established (petro)chemical firms, for instance, need to come up with technological process innovations to switch to more sustainable and efficient modes of production that allow for a higher degree of reduction, reuse and recycling of raw materials, energy and residual streams. Sustainable technological process innovations are important to achieve the Port Vision 2030 objective of being the "most modern and sustainable petrochemical and energy complex in Europe" (p. 34). As established firms often face intra-organizational tensions to reconcile pressures for exploration and exploitation across subsequent phases of technological process innovation, they may need to perform the development phase – being the most sensitive to these tensions – in the inter-organizational context of an external test facility. This requires, however, new-to-the-firm management practices, processes, structures and techniques, i.e., management innovation. The role of management innovation in this context has remained largely unexplored. We address this research gap by developing a conceptual framework that is illustrated by a case study of Plant One in the Port of Rotterdam, being mentioned in the Port Vision 2030 (p. 75) as a supporting and developing innovation facility. Based on theory and case evidence, we provide insights – both for managers of the firms involved and for port authorities – into how technological innovation in port-industrial complexes can be fostered through management innovation.

Managing interorganizational reciprocal interdependence for enhanced resource productivity in integrated port-industrial complexes

The Port Vision 2030 highlights the aim of developing a fully-integrated industrial complex (p. 34/ 49). This will lead to a higher extent of physical interconnected-ness and resulting process integration among legally autonomous firms that exchange heterogeneously distributed materials, energy, water and by-products as a collaborative approach to sustainably enhance their resource productivity. Due to the resulting contingencies, firms in these co-called 'industrial ecosystems' are challenged with managing increased mutual interdependence for enhanced resource productivity. The role of new interorganizational management practices of these firms in addressing this challenge remains largely unexplored in the strategy literature. By addressing this research gap, we aim to contribute to the literature on interorganizational relationships, management innovation and industrial ecology. Based on a literature review, propositions are developed and then illustrated by a longitudinal case study of an industrial ecosystem of three leading global process manufacturing firms in the Port of Rotterdam. Illustrated examples of new interorganizational management practices to improve resource productivity in this context include interorganizational meetings at different hierarchical levels,

measurement of joint resource productivity, disclosure of sensitive information, and a jointly developed emergency procedure. We discuss implications for the proposed transition process from a focus on protecting firm-centric competitive advantage (transactional view) towards a main focus on achieving interorganizational competitive advantage (relational view), implying business model innovation. We also discuss managerial implications for port authorities.

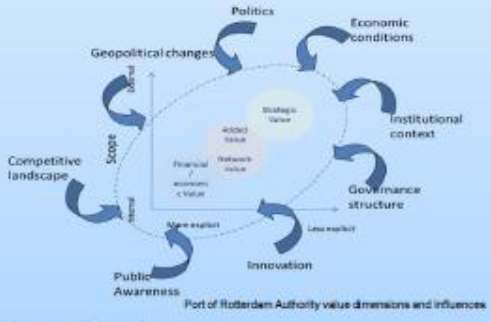
The 2nd Erasmus Smart Port Rotterdam/Port Research Centre Poster Session, Rotterdam, June 27, 2013

Value and uncertainty management in seaports

"To develop an integrated method for value capture and preservation of port infrastructure investments, applicable to Rotterdam seaport and allowing for future uncertainty"

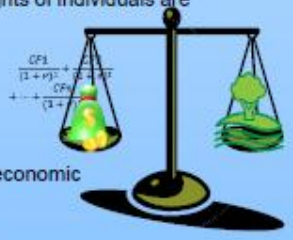
Background:

Ports are important national assets and investments in them add value in multiple ways. Not all of these are expressible in economic terms. Value can be seen from different perspectives and are subjective.
Port managers have limited insight into what can happen in the future. The drive to make sustainable investment decisions is gaining momentum. What is considered valuable now can be different in some years' time. A tool or method is required to make more robust decisions for port investments.
This PhD research aims to arrive at such method.



Requirements

- Applicable to infrastructure investments by Port of Rotterdam Authority
- Produce ordinal decision results
- Satisfy the requirements of business and society, while ensuring that basic human rights of individuals are safeguarded
- Robust for input bias
- Tested on cases



Issues:

- Balancing value types e.g. economic versus non-use
- Value incommensurability
- Impact of monetising value
- Non-revealed value, role of emotions in eliciting value
- Analysis inclusion and exclusion of value factors
- Distribution of value
- Limitations of discounting
- Long term effects, intergenerational carry-over

And: future uncertainty…

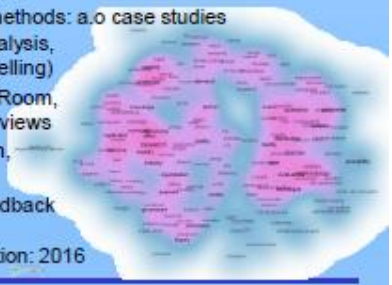
- Complexity
- Many approaches and insights

Research Questions

- Which concepts, tools and mechanisms for value and uncertainty management of ports are currently applied in comparable sectors?
- How do trends in society influence choice of value and uncertainty tools ?
- How will the relevance of types of values and uncertainties be determined ?
- Which practical issues would need addressing in the implementation of a theoretical value and uncertainty management framework ?

Approach

- Literature research
- Exploration of methods: a.o case studies (Cost Benefit Analysis, Exploratory Modelling)
- Group Decision Room, (structured) interviews
- Method selection, model building
- Expert panel feedback



Expected completion: 2016

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Value and uncertainty management of investments in port infrastructure

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Steve Sol graduated as a Chemical Engineer from Delft University of Technology in 1995. Upon graduation he was offered to take a PhD position on a topic related to catalysts physics. Instead he chose to join Air Products and Chemicals, where he was enrolled in an international management development programme. During multiple years assignments in the UK he gained experience in engineering, operations and commerce. Upon his return to the Netherlands, he was sponsored to take on an executive MBA at Rotterdam School of Management. Graduating from the programme with Deans Honours he was hired by Port of Rotterdam (PoR) in 2002. After an initial role in marketing & strategy, performing business development activities to attract more chemical industry to the Port industrial zone, he was asked to manage an asset management unit. In 2008 he took a role at PoR's joint venture in Sohar, Oman (SIPC), being operationally responsible for the JV's daily activities. After returning to the Netherlands he joined PoR international development department, taking up port development projects in Eastern Europe, Far East and West-Africa. With an ambition to expand his knowledge base and to still obtain his PhD, he chose to return to university in 2012 to research wider impact and implications of investments in port infrastructure. His work is sponsored by Port Research Centre, which is cooperation between PoR and TU Delft.

Contents of research

Value, uncertainty and complexity Ports are important national infrastructural assets requiring significant investments to construct, maintain and operate. These assets add value in multiple ways. Port Authorities responsible to operate, develop and maintain the port have to balance their resources and investments between private and public objectives. Value is a subjective notion, given different perspectives of parties operating (in) ports as well as those affected by it. On a high level a difference can be found between those approaches originating from economics, sociology or ethics. Port project valuation from an economic perspective can be done on the basis of discounted cash flow analysis. Value contribution to the society is not or hardly accounted for. For such evaluations (Social) Cost Benefit Analyses (CBA) are widely used. This requires so-called non-use values (such as cost or benefits to the environment) to be monetized. There are a number of objections against CBA stemming from philosophical/ethical point of view: not every effect can or should be monetized; values may change over time; outcomes can vary greatly, depending on whom is doing the analysis; it does not take the distribution of cost or welfare

over society into account. Different approaches lead to different insights as to which values should be relevant for Port Authority managers that are making investment decisions in port infrastructure.

Economic value calculations are sensitive to the forecast of costs and income. Future economic situation and competitive situation of the port needs to be taken into account. Too often forecasts of the returns are based upon some form of trend extrapolation or some simplified scenario. The uncertainty in assessing future situations may lead to a wrong investment decisions.

The development of a port has a profound, sometimes irreversible impact on its surroundings. Infrastructure is built within months or years and in general will be there for a number of decades, and could serve multiple generations. The recovery time of the environment can take decades as well. In the meantime the business environment of a port can change drastically. Some could include: changing global economy (trade patterns, investment climate), changing public opinion (about the function of the port and the impact a port has on the environment), changes in institutional settings, national and international rules and regulations, politics, legal framework. Timescale is therefore an important factor to take into consideration when addressing uncertainty regarding future values, that are being used to base investment decisions upon. Currently, (financial) uncertainty is captured in a project discount rate. However, discounting has its limitations. E.g. long term (and intergenerational) effects are hardly accounted for. Or it is simply not quite understood how to capture unknown effects in discount rates.

The world of the Port Authority is complex. Their managers has to balance between various factors: changing port business, changing demands of stakeholders, potentially changing organizational setup and institutional environment. A set of business decision tools which is primarily based on economic criteria which is currently the case, may not suffice. Changing values need to be taken into account. However, in order to assess uncertainties surrounding these values and in order to make sensible decisions about an uncertain future, a multi-disciplinary approach is required.

Goal

Policy makers and executives in Port of Rotterdam that are responsible for managing the ports' infrastructure require new insights into dealing with value and uncertainty when making (investment) decisions. From a scientific point of view there is a knowledge gap as to which approaches to value and uncertainty management related to ports and waterways exist and how they may be applied.

The goal of the PhD research project is to come up with a contemporary integrated, scientific method as to how value and uncertainty in Port of Rotterdam can be managed, in view of the many approaches and insights that currently exists but which do not give decision-makers a uniform framework. The method should do justice to a broad range of the Ports' stakeholders

and should robust for the input or preferences of those persons using it.

Approach

In this research the different aspects of value and uncertainty theory related to port business are explored. Scientific literature analysis and bibliographic mapping provide research directions. We will seek to understand how creation of value is dependent on ones perspective of the ports (business) environment through qualitative (interviews) and quantitative (Group Decision Room) research. The environment, in which authorities responsible for ports and waterways operate in, is changing, adding to the uncertainty surrounding investment decisions.

We will seek to understand the potential impact of changes using exploratory modeling techniques.

Other case studies in which we will analyse and test various scientific methods should provide clues as to the applicability of the methods found. A decision model is to be built on the basis of these insights. We will test the applicability of the model found on selected cases and using the input of expert panels.

Relation with Port of Rotterdams' strategy

The decision models applied by PoR provide insights into how the companies' executives currently manage the value of their investments and activities. The ports' authority value management models are impacted by changes in the ports' business environment. PoR is nowadays operating in a global corporatised, highly competitive environment.

PoR has to be agile in its decision making processes, corporate financing and human resources, putting more emphasis on commercial results and financial control. This also means that in the companies "Home-base & Show-case" strategic initiative, public values such as the ports' safe nautical operations and caring for a sustainable environment of the port may have to compete for resources against private values PoR has laid out in its Port Strategy such as attracting best-in-class customers from selected market segments, entrepreneurial development of new projects, investments' in logistical chains, accessibility or growth markets overseas.

Nowadays the focus on sustainability of port activities is increasing. Values driven by sustainability demands of stakeholders and society, are assuming greater importance. A larger public scrutiny, perhaps fuelled by the current economic crisis, requires PoR to become much more aware of those, and perhaps other intangible values. In its Port Vision 2030, the company has laid out a number of challenges and objectives. The mix of public-private business objective gives rise to the question whether or not the existing tools of the PA for managing value are still valid. Investments may contribute in different ways to creation of value and, as intimated before, this value cannot always be expressed solely in financial terms.

Value to business of investments and activities undertaken used to be based on contribution to PoR' safe nautical operations, cargo throughput or to leasing/selling land to the port tenants. Public projects were often coined as "strategic". Also it is often unclear who benefits from the Port Authorities'

investments: the company itself, the port operators, the local community, society as a whole, or a combination of these? PoR seeks to make their value contribution explicit, in terms of added-value reporting ("Havenmonitor") or network value assessment.

It remains unclear how *non-use* values (such as the PoR current drive for sustainability, emission control, energy reduction) should translate in the existing value framework. Though from an intuitive point of view these non-use values seem important, and the company has publicly committed to many of them, PoR requires a way to assess the merits of various types of values whilst deciding on their investments.

PoR decision makers need to balance between focusing on specific strategic directions and retaining sufficient degrees of freedom in their decision making to cope with changing circumstances. How robust is PoR decision framework for circumstances as they develop that are not captured in their Port Vision? Current value calculation methodologies based on discounted cash flows and corporate risk management frameworks may not always provide sufficient decision information to fully encompass potential unplanned & unknown effects, besides those arising out of stakeholder and societal concerns. This may well lead to rethinking business models, performance indicators and business decisions in the future. This research aims to provide a decision framework encompassing the latest insights in value and uncertainty management theories, so that various decision alternatives, encompassing the dimensions described herein, can be weighed against each other.

Acknowledgements

This research is supervised by Tiedo Vellinga (1st promotor), Paulien Herder (2nd promotor) and Poonam Taneja, all from TU Delft. Funding is provided through Port Research Centre, which is cooperation between Port of Rotterdam and TU Delft. All contributors are thanked for their support.

ROTTERDAM SCHOOL OF MANAGEMENT
ERASMUS UNIVERSITY

PhD Candidate: Irina Romochkina
Supervisors: Dr. Peter van Baalen
Prof. dr. Rob Zuidwijk
Promoter: Prof. dr. Eric van Heck

INTEREST ALIGNMENT IN THE DEVELOPMENT OF PORT INTER-ORGANIZATIONAL INFORMATION SYSTEMS

The 2nd Erasmus Smart Port Rotterdam/Port Research Centre Poster Session, Rotterdam, June 27, 2013

Rotterdam Port Vision

The port of Rotterdam has the ambition to be the leading European hub for global and intra-European cargo flows in 2030 (Port Vision 2030, 2011). To reach this goal is planned through 1) significant improvements in supply chain efficiency; 2) expansion of the European network of inland hubs as well as rail and inland shipping infrastructures. Both of these actions require further development of port inter-organizational information systems. This is acknowledged by the association Deltalinqs which states that the state of the art information networks are required to support hinterland connections and turn the port into the North-West European synchromodal hub. **The information flow between port community members needs to be improved to support the smooth flow of goods through the port.**

Research Problem

Inter-organizational information systems (IOS) have a great potential in improving the efficiency of port operations (Wrigley et al., 1994; Van Baalen et al., 2008). The majority of innovative supply chain concepts like synchromodality, closed loop supply chains require intensive data exchange supported by the inter-organizational information systems. The existing research shows, however, that the direct operational benefits from IOS implementation are not enough to ensure the IOS adoption by target user groups (Giuliano et al., 2008). In my PhD project I focus on the process of IOS development during which the interests of various potential users are to be taken into account. The overarching question of my PhD study is "**How to align the interests of different parties in IOS development to ensure its successful adoption by the target user groups?**"

Research Project and Its value for Rotterdam port

The research project is divided into three parts. In the first part I analyze the existing IOS landscapes in four ports: Rotterdam, Antwerp, Singapore, and Los Angeles. The high level of analysis facilitates understanding what influence the network structure has on the development of IOS. The second part reviews existing IOS research with an aim to outline the instruments that are available for IOS developers to make the IOS attractive for the users if the operational benefits are not sufficient enough. Finally, in the last part of the project I work on the pricing model which can be implemented to incentivize the use of port IOS via rewards for data contribution. The size of the reward can be assessed based on the Shapley value principle which accounts for the relevant importance of a party for a given logistics application.

This research can be of interest for Portbase, the core of Rotterdam port information structure. The system is still expanding and keeps offering new functionalities to the port community member. Thus, Portbase constantly has to deal with the problem of interest alignment addressed in my research.

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Interest Alignment in the Development of Port Inter-Organizational Information Systems

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Supervisors: Prof.dr. Rob Zuidwijk, Dr. Peter van Baalen, Prof.dr. Eric van Heck

Curriculum Vitae

Since October, 2011 I am a PhD candidate at the Department of Decision and Information Sciences of Rotterdam School of Management (Erasmus University of Rotterdam). I got my Master of Philosophy Degree in Logistics and Information Sciences from the same university in September, 2011. I have been living in Rotterdam for three and a half years now. Originally I am from Russia where I got my Bachelor of Science Degree in Economics at Lomonosov Moscow State University.

I decided to pursue a PhD track for many reasons but the most important is that I like the challenges and independence that comes along with carrying out a research project. My topic of interest is Port Inter-Organizational Information Systems on which I focused in my master thesis and on which I continue working on now in my PhD project. The great advantage of this topic for me is that it rests in the intersection between supply chain management and information systems disciplines. I find it an exciting area of research which contributes to the advancement of real-life business practices. It is of great importance for me that my PhD research would be interesting and useful for both academics and practitioners. Therefore I pay a lot of attention not only to academic research on my topic but also to the opinions of practitioners who are working in this field.

Research project

Inter-organizational information systems (IOS) have a great potential in improving the efficiency of port operations (Wrigley et al., 1994; Van Baalen et al., 2008). The majority of innovative supply chain concepts like synchromodality, closed loop supply chains require intensive data exchange supported by the inter-organizational information systems. The existing research shows, however, that the direct operational benefits from IOS implementation are not enough to ensure the IOS adoption by target user group (Giuliano et al., 2008). In my PhD project I focus on the process of IOS development during which the interests of various potential users are to be taken into account. The overarching question of my PhD study is “How to align the interests of different parties in IOS development to ensure its successful adoption by the target user groups?”

The research project is divided into three parts. In the first part I analyze the existing IOS landscapes in four ports: Rotterdam, Antwerp, Singapore, and Los Angeles. The high level of analysis facilitates understanding what influence the network structure has on the development of IOS. The second part reviews existing IOS

research with an aim to outline the instruments that are available for IOS developers to make the IOS attractive for the users if the operational benefits are not sufficient enough. The examples of such instruments are monetary incentives, legal enforcement etc. The available instruments are to be categorized in accordance with IOS developer type and the network structure in which the developer functions because the success of certain incentives in one context does not guarantee its success in another one. Finally, in the last part of the project I work on the pricing model which can be implemented to incentivize the use of port IOS via rewards for data contribution. The size of the reward can be assessed based on the Shapley value principle which accounts for the relevant importance of a party for a given logistics application.

Relation to the strategies of ports of Rotterdam and Antwerp

The port of Rotterdam has the ambition to be the leading European hub for global and intra-European cargo flows in 2030 (Port Vision 2030, 2011). In order to reach this goal the port authority acknowledges the importance of the following actions: 1) significant improvements in supply chain efficiency; 2) expansion of the European network of inland hubs as well as rail and inland shipping infrastructures. Both of these actions require further development of inter-organizational information systems. This is acknowledged by the association Deltalinqs which states that the state of the art information networks are required to support hinterland connections and turn the port into the North-West European synchromodal hub.

At present Portbase system is at the heart of inter-organizational information exchange of the port. However, the network structure of the port will be changing with the introduction of the Second Maasvlakte. This might influence the existing status quo with respect to the use of Portbase services. New terminal operators might decide in favor of using alternative systems to support information exchange with their partners. Furthermore, the expansion to the hinterland will require the development of a separate system for communication with the inland terminals or addition of new functionalities on Portbase platform. In any case Portbase will have to work on attracting new target users and incorporating their interests into the common IOS. My research will inform Portbase on the different incentives that could be used depending on which situation the company will be working on. Moreover, my last project considers new pricing options that Portbase could use to make the use of the system attractive for the port companies.

The port of Antwerp in its vision also stresses the importance for the port community to organize the flow of goods as efficient as possible (Sustainability Report Port of Antwerp, 2010). They see the digital management of the flow of goods as one of the ways to reduce the environmental impact of hinterland transport. Thus, the port of Antwerp similarly acknowledges the importance of inter-organizational information systems for its future development. Currently Antwerp Port Community System (APCS) is the core of information infrastructure of

the port of Antwerp. The system is still expanding and keeps offering new functionalities to the port community member. Thus, APCS constantly has to deal with the problem of interest alignment addressed in my research. Hopefully the outcome of my research project will be able to inform APCS on the ways to improve their practices as well.

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The 2nd Erasmus Smart Port Rotterdam/Port Research Centre Poster Session, Rotterdam, June 27, 2013

THE VERY LONG TERM DEVELOPMENT OF THE DUTCH INLAND WATERWAY SYSTEM

Shipping Scenarios for the Delta Programme

Cornelis van Dorsser, Han Ligteringen (1st promoter) , Bert van Wee (2nd promoter), Milou Wolters (RWS)

Background

Rijkswaterstaat aims to develop a state-of-the-art proactive integrated very long term replacement strategy for its hydraulic infrastructures. The hydraulic infrastructures tend to have a very long lifetime of about 50 to 100 years. It is therefore necessary to gain basic insights in the very long term developments that can be expected on the inland waterways. For this reason we started a PhD project on the very long term development of the Dutch inland waterway transport system. The project started in 2009 and will be completed by the first quarter of 2014.

Spin-off

By 2007 the Dutch Government also launched another much larger project now referred to as the Second Delta Programme. This programme has the following two primary aims: (1) Safeguard the Netherlands against flooding (due to higher future river discharges and raised sea water levels caused by the effects of climate change); and (2) Guarantee sufficient fresh water supply. In addition to these primary aims it also needs to take into account the effects of the Proposed Delta Measures on (inland) shipping, but by the end of 2012 hardly any efforts had been put into the development of shipping scenarios.

As our main project is almost completely devoted to the development of insight in the development of transport demand on the inland waterways – and as we had already been working on a very long term probabilistic prediction for the overall port throughput in the Le Havre – Hamburg Range we have been asked to contribute to the Delta Programme by writing a full background document on the shipping scenarios for both the ports and inland waterways up to the year 2100. These scenarios have functioned as basic input to the delta programme.

The paper on: *"A Very Long Term Forecast of the Port Throughput in the Le Havre – Hamburg Range up to 2100"* is available on the website of the EJTIR: http://www.ejtir.tbm.tudelft.nl/issues/2012_01/pdf/2012_01_05.pdf

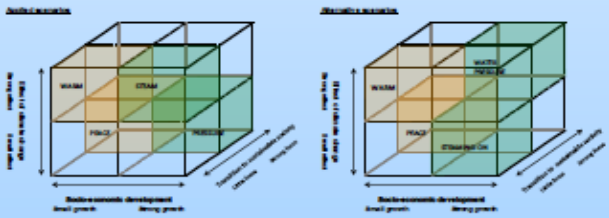
The (Dutch) background document on the Shipping scenarios: "Scheepvaartscenario's voor Deltaprogramma, 100 jaar later…" is available on the Deltaweb: https://deltaprogramma.pleio.nl/file/download/15938322

The main scenarios document in which the Shipping Scenarios are incorporated will be published soon. It will be reffered to as: *Deltares et al. (2013) Deltascenario's voor 2050 en 2100 Nadere uitwerking 2012-2013".*

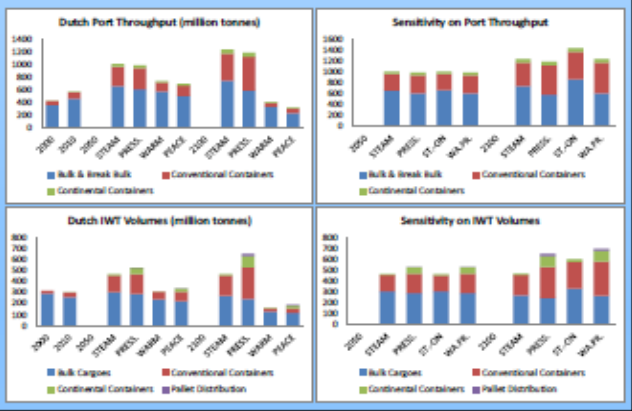
Delta Scenarios

The Dutch Delta Scenarios were developed along two main dimensions being (1) the level of socio-economic growth and (2) the effects of climate change. The level of economic growth has been linked to the extended WLO-Scenarios for 2050 of the Regional Communities (RC) and Global Economy (GE) scenarios. The effects of climate change have been linked to the KNMI-06 moderate (G) and extreme (W and W+) scenarios.

The scenarios were further developed around a third implicit driver. We will refer to this driver as the transition towards a sustainable society. In all the scenarios it was implicitly assumed that a strong focus on sustainable development will lead towards a smaller effect of climate change (this is indicated at the left side cube in the figure below.



We are nevertheless of the opinion that in case of high economic growth and strong effects of climate change the inverse causal relation may be even more likely. If strong effects of climate change are combined with high economic growth this will trigger an increased focus on sustainability. We therefore suggested an alternative set of scenarios of which the results have been presented as a sensitivity analysis. The sensitivity analysis shows that the alternative scenarios are slightly more extreme.



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Research on the Very Long Term Development of the Dutch Inland Waterway System: Shipping Scenarios for the Delta Programme

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Cornelis van Dorsser studied at two universities simultaneously. In 2004 he graduated as an Economist specialised in the field of transport economy and logistics. In 2005 he graduated as a naval architect specialised in the field of shipping. During his graduation period he worked for Vos Logistics (a trucking company) and the Mercurius Shipping Group (an inland shipping company). In 2005 he joined Royal Haskoning. The first year of his assignment he mainly worked on the development of the South Zone Industrial Port in Aqaba (Jordan) as an industrial zone and port planner. Thereafter he worked as port consultant, transport economist, and inland waterway transport (IWT) specialist on many interesting port development and IWT Projects. Mr. van Dorsser worked in various projects all over the world such as Nigeria, Gambia, Guinea, Egypt, Jordan, Thailand, Trinidad, and Costa-Rica. In 2009 he started his PhD project at the Technical University of Delft on *"The Very Long Term Development of the Dutch Inland Waterway System up to the year 2100"*. At the same time he remained working at Royal Haskoning. In 2011 he re-joined the Mercurius Shipping Group where he now works as a research and business developer and provides strategic advice to the management. In his new function he is amongst others responsible for expanding the services of two innovative inland container crane barges inside the Port of Rotterdam. In the meanwhile he remains working on his PhD.

His research project is funded by Rijkswaterstaat (RWS). RWS is responsible for the development and maintenance of the Dutch inland waterway system. Most hydraulic infrastructures have an expected lifetime of about 50 to 100 years. In the near future many of those infrastructures will have to be replaced. Current practice is to replace structures one by one, but one by one substitution is like: *"Replacing all parts of an old car and obtaining a good as new old timer"*. Rijkswaterstaat therefore desires to develop an more proactive integrated replacement strategy that considers the replacement of hydraulic structures as an opportunity for reorganising the network at a systems level. Such a strategy should be able to answer questions like: *"is it sensible to replace all seven weirs in the river Meuse individually or should we restructure the system into 5 weirs"*. Planning processes related to changes of the system take a long time (say up to about 20 years) and methods to look more than a few decades into the future are often lacking. The development of a very long term proactive replacement

strategy does however require insight in very long term developments of (and on) the main inland waterways. This research project therefore aims to develop the means required to look far into the future of IWT on the Dutch Waterways. It thereby addresses the direct needs of the asset managers of Rijkswaterstaat.

The results of the project are not only relevant for the asset managers of Rijkswaterstaat. They can also contribute to the needs of other stakeholders that deal with other very long term issues such as port authorities that want to look beyond the scope of the current long term visions (e.g. beyond the horizon of the port vision 2030 recently published by the Rotterdam Port Authority) and the Delta Project. In order to support West-European port authorities we have published a very long term probabilistic prediction of the overall port throughput in the Le Havre – Hamburg range. The paper is referred to as:

- Van Dorsser, J.C.M., M. Wolters, B. van Wee (2012) *A Very Long Term Forecast of the Port Throughput in the Le Havre – Hamburg Range up to 2100*, European Journal of Transport and Infrastructure Research , Vol. 12, No. 1, pp. 88-110.

The Second Delta Programme was launched after the publication of the Delta report by the Delta Committee in 2008. The primary aim of the Delta Program is to safeguard the Netherlands against flooding and to guarantee sufficient fresh water supply. With respect to flooding the project deals with both the effects of changing precipitation levels on high river discharge volumes as well as the effects of the raising sea level. In addition to these primary aims the Delta Programme also need to take into account the effects of the proposed measures on logistical users in the affected areas. However, by the end of 2012 hardly any efforts had been put into the development of shipping scenarios. Given the background of our research project we were asked to contribute to the development of the Shipping Scenarios of the Delta Programme. In response we were able to provide the Delta Committee with a full background report in which all relevant preliminary results of our very long term research project have been discussed. Based on these insights we also provided a detailed qualitative description of the scenarios as well as a full quantitative ramification for the most relevant commodity groups (Bulk and Break Bulk, Conventional Containers, Continental Containers, and Pallet Shipments). The last two items refer to new types of transport that have not yet been fully materialised but for which there are sufficient indications that they may develop into an important future transport category. The Dutch report is available on the Deltaweb (https://deltaprogramma.pleio.nl/file/download/15938322) and referred to as:

- Van Dorsser, J.C.M. (2012) *Scheepvaart Scenario's voor Deltaprogramma, 100 jaar later…*, Rijkswaterstaat.

The main scenario document in which the Shipping Scenarios are incorporated will be published soon as:

- Deltares et al. (2013) *Deltascenario's voor 2050 en 2100 Nadere uitwerking 2012-2013*.

The aim of the Dutch Delta Scenarios is to investigate the corner points of likely future scenarios. For this reason they were developed along two main dimensions being: (1) the level of socio-economic growth and (2) the effects of climate change. The level of economic growth has been linked to the extended WLO-Scenarios for 2050 of the Regional Communities (RC) and Global Economy (GE) scenarios. The effects of climate change have been linked to the KNMI-06 moderate (G) and extreme (W and W+) scenarios.

We argue that that the scenarios were also developed around a third implicit driver which we will refer to as: (3) the transition towards a sustainable society. In all currently developed Delta Scenarios (Warm, Pressure, Peace, and Steam) it is implicitly assumed that a strong focus on sustainable development will lead towards a reduced effect of climate change. This view is indicated by the left side cubical in the Figure 1

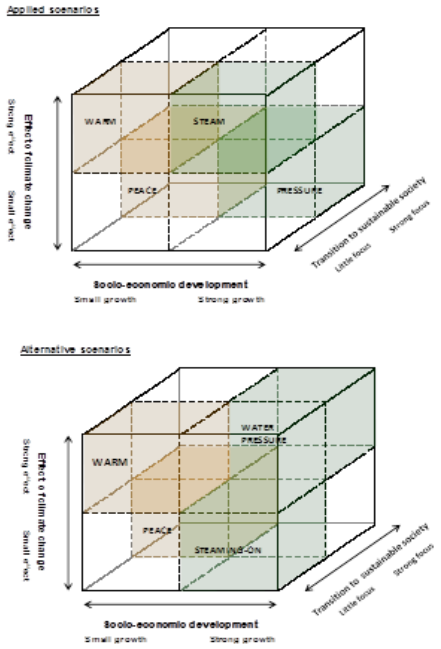


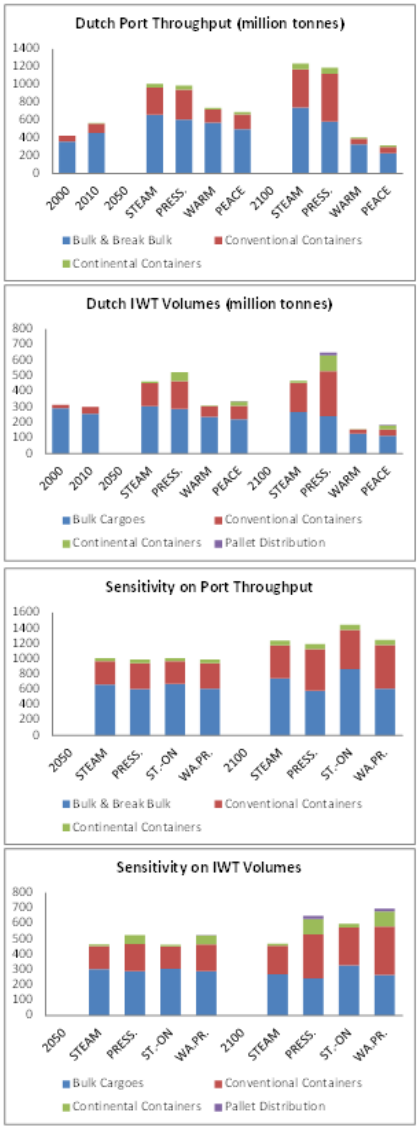
Figure 4: Applied and suggested choice of Scenarios

We are nevertheless of the opinion that in case of high economic growth and strong effects of climate change the inverse causal relation may be more likely. If strong effects of climate change are combined with high economic growth this will trigger an increased focus on sustainability. We therefore suggest an alternative set of scenarios for which the results have been presented as a sensitivity analysis in the background study report (refer Figure 1, right). These scenarios will be referred to as (Steaming-on, and Water Pressure).

For each of these six scenarios an extensive qualitative and quantitative ramification was made and the output was discussed amongst certain stake holders such as the Port of Rotterdam. The expectations turned out to be in line with the long term vision of the Port of Rotterdam and may also help to think of developments beyond the year 2030 port

vision (e.g. questions like should we ever need a third Maasvlakte?). In addition they are likely to be used for the evaluation of measures proposed in the framework of the Delta Programme.

The results of the four scenarios developed on behalf of the Delta Programme are presented in Figure 2.



A comparison with the alternative scenarios shows that the alternative scenarios are slightly more extreme than the standard scenarios (refer Figure 2). One can therefore question if the Delta Scenarios sufficiently address the variation in possible futures as they were intended to. We still see some room for improvement.

Acknowledgement: This PhD project is supervised by Han Ligteringen (1st promoter), Bert van Wee (2nd promoter), and Milou Wolters (daily supervisor from Rijkswaterstaat). We thank Rijkswaterstaat for providing the funding.

Joint Design and Pricing in Intermodal Port-Hinterland Network Services: The Extended Gate Operator Perspective

Authors: Panagiotis Ypsilantis & Prof. Rob A. Zuidwijk

Introduction

The extended gate concept is introduced from deep sea Container Terminals to increase their competitive position by enhancing the connectivity of the ports with close and distant contestable hinterland.
A set of inland terminals act as extended gates of the port, where a customer can pick up or drop of a container as if directly to a seaport, and are connected with the seaport terminals with high capacity, sustainable frequent connections(barge, train).

ECT's Extended Gates Hinterland Network

Problem Definition

The TOC implementing the extended gate concept has to design an optimal hinterland network by determining:
•The locations of the extended gates (existing inland terminals or new inland terminals)
•The capacity of the corridors
•The frequency of connections in each corridor
•The tariffs for containers passing through the extended gates
The above design factors can affect the profitability of the TOC in several ways:
•Total costs structure is dominated by economies of scale
•The Tariffs and Frequency of connections affects flows passing through the extended gates.

Model Formulation

We formulate this problem as a bi-level mathematical problem.
•In the first level, the net revenues of the TOC implementing the extended gate concept are maximized.(Revenues – Fixed and Variable Costs of Operating Connections)
•In the second level, the total logistics costs faced by the users of the network are minimized.(Transportation Costs, Handling Costs)
•Demand in Commodities (OD, Amount of Flows, Total Time requirements)
•Total transport time: dependent on frequency of Connections
•Cost of Corridors: Economies of Scale

Solution Methodology

•NP hard Problem
•MIP equivalent formulation solved by CPLEX
High Calculation times even for medium instances
•Novel Algorithm Development
Solve a series of "easy" linear and MIP problems
•Algorithm Evaluation
Instances: (30 Nodes – 60 Commodities)
Computation Time:
CPLEX: Mean=481sec, St.D. =526sec
Algorithm: Mean=5.35 sec, St.D.=0.4 sec
Obj. Value Average Gap=2%

Main Results

Modelling Contributions:
•Capture trade-offs among revenue management, Economies of Scale and user time constraints.
•Extension current models which assign each commodity to only one route in the network.
•Algorithm provides high quality solutions in considerably less calculation time with low variability.
Managerial Contributions:
• Differences in Network Design when assuming port to port vs port to door services.
•Impact of considering service time constraints in network design at the tactical level.

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Joint Design and Pricing in Intermodal Port-Hinterland Network Services: The Extended Gate Operator Perspective

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Resume

Panagiotis Ypsilantis is a doctoral candidate at the Rotterdam School of Management (RSM) of Erasmus University of Rotterdam (EUR) since January 2011. My Ph.D. topic is titled, "The Design, Planning and Execution of Sustainable Container Transport Networks: Information as an Enabler", and it is part of the ULTIMATE project funded by DINALOG. His research is focused on the quantitative modeling of several aspects of the extended gate concept, ranging from hinterland network design to optimal container bundling policies and is performed with close cooperation with ECT and Brabant Intermodal; companies that are also enabled in the ULTIMATE project. He obtained my MSc degree on October 2010 on OR&QL at the Econometrics Department of Erasmus University of Rotterdam. In his MSc thesis he investigated the impact of Chassis Exchange Terminals (CET) on the overall performance of container terminals, with the use of simulation and analytical models. In 2008, he obtained a 5-year master equivalent degree in Mechanical Engineering with two year specialization in Industrial Engineering from the Aristotle's University of Thessaloniki (AUTH), in Greece. His general research interests are in modeling maritime logistics, container transport networks and reverse logistics.

Abstract

Maritime container terminal operating companies have extended their role from node operators to that of multimodal transport network operators. They have extended the gates of their seaport terminals to the gates of inland terminals in their network by means of frequent services of high capacity transport modes such as river vessels (barges) and trains. These network operators face the following three interrelated decisions: (1) Determine which inland terminals act as extended gates of the seaport terminal, (2) determine capacities of the network transport links, i.e. capacity of the transport means and frequency of service, and (3) set the prices for the transport services on the network. We propose a bi-level programming model to jointly design and price extended gate network services for revenue maximization.

The network operator does so while anticipating the decisions of the customers who choose minimum cost paths to their final destinations, and who always have the option to choose direct trucking offered by the competition. The model in this paper extends existing models by including service time constraints and economies of scale. Considering the special structure of our problem we propose a heuristic that provides near optimal solutions to our

problem in substantially less time. Through experimental results in some realistic instances, we study optimal network designs while comparing sea port to door and sea port to inland port services and situations where transit time requirements do and do not apply. Our results show that when demand is relatively low, there are significant differences in the optimal network design for port to door versus port to port services. In the case of port to door services, the prices of services are determined by the competition and not by the design of the network, so the network is designed against minimum costs, and economies of scale are achieved by consolidating flows through a limited number of extended gates. The case of port to port services is different, i.e. revenues are enhanced not so much by reducing costs through the exploitation of economies of scale, but by exploiting the possibilities to dedicate extended gates to market segments for which the competition leaves room for higher port to port tariffs.

Managerial relevance

Nowadays, container terminals compete based on their hinterland connectivity and other supply chain actors put efforts in vertically integrating their businesses; these advancements lead to business formulations that are near the definition of network (Extended Gate) operator. Such corporations must be in line with their customer's and society's needs and provide cost effective, reliable and sustainable solutions in container transport. The management of such corporations strives for answers to questions that relate to how to design and expand their hinterland networks, what would be the benefits of operating in such networks, what should be the information infrastructures to support these networks and how to execute efficiently in the proposed networks. This study is close to industry's related issues, since as part of the Efficient Multimodal Hinterland Networks (ULTIMATE) project, funded by DINALOG, there is close cooperation with some of the leader companies in the field like ECT, Brabant Intermodal, Port of Amsterdam, NV Regio Venlo, Port of Rotterdam, NV, Modality Software Solutions BV, PORTBASE BV and KEYRAIL BV. The work we present in this poster session is mostly related to a company like ECT, which acts as an Extended Gate operator, and would like to answer questions on how to design, expand and execute its hinterland network.

The management of intermodal container transport is being challenged by a number of important developments. The dynamics of emerging and declining markets have a large impact on transport demand. Moreover, customers have extended their expectations with regard to operational excellence, while other shareholders are concerned with the environmental impacts of container transport. Providers of services need to develop innovative concepts to meet these challenges. New concepts such as Extended Gate need to address these challenges by the design of an intermodal network and services on the network, but also by the development of value propositions to customers and

other shareholders. An important aspect of value propositions that could be made to shippers and other stakeholders such as customs authorities and governments is the fact that containers are different in many aspects. They contain different types of cargo, require different logistics services, represent different levels of value, and entail different security and social risks. As a result, the transport market is segmented not only in terms of origin and destination, but also in terms of additional service requirements. A concrete research avenue could focus on the Extended Gate concept and be concerned with the question how decision tools can support the development of differentiated services on the network that incorporate the diversity of containers in terms of cargo and service requirements, while using physical and information resources, in such a way that economic, environmental, and social performance are improved.

The 2nd Erasmus Smart Port Rotterdam/Port Research Centre Poster Session, Rotterdam, June 27, 2013

Intermodal Freight Transport - A Model Predictive Control Approach

Delft University of Technology
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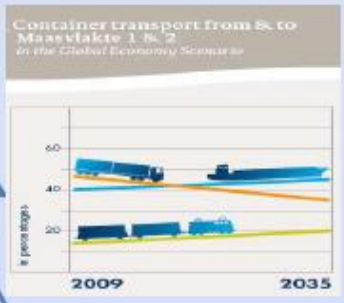
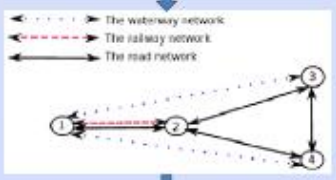
This work is carried out within the framework of the NWO/STW VENI project: "Intelligent multi-agent control for flexible coordination of transport hubs"





Research problem

How can containers be transported over intermodal freight transport networks among Port of Rotterdam and hinterland terminals in a cost and time efficient way while achieving the set modal split target?

Research goal

We are working on *a decision-making support tool*, which is capable of determining the optimal intermodal freight flow assignments taking into account freight flow dynamics over intermodal freight transport networks.

The proposed approach

We propose to improve *the operational performance* of the intermodal freight transport network via *better real-time coordination*. To implement this approach, the task consists of two parts:

- The modeling part: *dynamic intermodal freight transport network models*;
- The control part: *real-time and coordinated intermodal freight flow assignment methods.*

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Intermodal Freight Transport - A Model Predictive Control Approach

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Supervisors: Rudy Negenborn, Bart de Schutter

Curriculum Vitae

Le Li is a PhD candidate at Delft Center for Systems and Control (DCSC), Delft University of Technology, Delft, The Netherlands. He started his PhD project Multi-level and multi-agent control of intermodal freight transport network in December 2011. He obtained his bachelor degree in Automation (July, 2008) and his master degree in Control Theory and Control Engineering (May, 2011) both from Northwestern Polytechnical University in Xi'an, China. Now, his research interests are in applying distributed and coordinated model predictive control methodology and optimization techniques to model and control intermodal freight transport networks between deep-sea ports and inland terminals in the hinterlands.

Research problem

Due to the increasing demand for freight transport in national and international trade, hinterland haulage among major deep-sea ports and the cargos' original/final inland locations has become an important component in modern logistic systems. Intermodal freight transport integrates the use of different modalities (e.g., trucks, trains, barges, etc.) during the freight delivery process to maintain the efficiency and sustainability of hinterland haulage. One crucial challenge for hinterland haulage is to provide reliable transport services in a cost and time efficient way with the existing transport infrastructures while considering other related physical capacities and environmental regulations. Our research problem is to investigate *how containers can be transported over intermodal freight transport networks among the Port of Rotterdam and hinterland terminals in a cost and time efficient way while achieving the modal split target?.*

The proposed research approach

We propose to improve the operational performance of the intermodal freight transport network via better real-time coordination. To implement the proposed approach, the task consists of two parts: the modeling part and the control part.

The modeling part

In the modeling part, dynamic intermodal freight transport network models need to be developed. The models should capture the characteristics of intermodal container transport, e.g., modality changes at intermodal terminals, time-dependent hinterland connection travel times, load-dependent vehicle transport costs, due time requirement for container transport, capacity constraints, etc. Some work had been done on modeling dynamics of intermodal transport networks, which represent the modality

change phenomena in intermodal freight transport [1, 2, 9]. But there are still some limitations, e.g., withourt considering the dynamic behavior of unloading/loading/storing containers at terminals, the container entering and transport capacity of transport connections, etc. A generic intermodal freight transport network model has been developed in our previous work [4]. Further efforts will be taken on model extensions to obtain a good representation of intermodal freight transport dynamics.

The Control Part

In the control part, the main work is to develop *real-time and coordinated intermodal freight flow assignment methods*. The distributed and coordinated model predictive control methodology will be applied for real-time and coordinated freight flow assignments over intermodal freight transport networks while considering model split targets, information privacy, etc. To be specific, this sub-task will be done in two steps:

1. *model predictive control for intermodal freight flow assignments*. The model predictive control methodology [3] enables the prediction of container flow evolutions
over intermodal freight transport networks considering the current and future traffic conditions, the future (possibly estimated) transport demand in the network, network capacity constraints, etc. Therefore, freight flow assignments can be determined to take actions in advance so as to reduce or even release the effects of possible uncertainties in the network.

2. *multi-agent coordinated intermodal freight flow assignments*. Intermodal freight networks are naturally complex and large-scale systems, which consists of a large number of interconnected and interacted components, e.g., deep-sea terminals, inland terminals, transport connections with different modalities, etc. Centralized model predictive control approach can only be applied for networks with small size, for the huge computational complexity of the corresponding freight flow assignment problems. In addition, typically these components distribute in a wide range of areas and are associated with their particular behaviors and objectives. They can participate in the coordination with other components in order to obtain a better objective, but still insist on keeping their own independencies by limiting the private information exchange. Therefore, in case of real-time freight flow assignments over a larger network, distributed and coordinated control approach is necessary [5, 7].

Relation with the strategy of the port of Rotterdam

Increasing cargo transport demands have been forecasted by the Rotterdam Port Authority for the coming twenty years[1]. These upcoming demands will bring challenges for both the deep-see port and its hinterland freight transport networks. With the construction of Maasvlakte 2, Port of Rotterdam will undergo a large increase in the capacities of cargo handling and storage [6, 8, 10]. Therefore,

more and more attention is being paid to improve the operational efficiency of the hinterland freight transport systems that connect the deep-see port to the hinterland and that have been suffering from frequent road traffic congestion, traffic pollution, etc.

In Port vision 2030, Port Compass, a modal split target (more transport by water and rail, less by road) for 2030 is set to achieve a maximum 35% of containers transported to and from the Maasvlakte by road. Currently, this figure still stands at 47% [8]. Aside from building new transport infrastructures, there is also a cheaper and faster way that contributes to the achievement of the set modal split target. That is to operate and use the existing transport infrastructures in a more efficient way by applying modern communication and computation technologies and modern systems and control theory in the field of freight transport.

Intermodal freight transport has been proposed by the industry and academic researchers as a potential solution for achieving efficient and sustainable freight transport systems. In particular, intermodal freight transport provides the possibility to increase the market share of trains and barges that are considered to be more environmentally friendly than trucks, by utilizing cargo transport and performing modal transfers in an appropriate manner during the freight delivery process. Hence, intermodal freight transport will contribute to the achievement of modal split targets set for the coming years that result from the concerns regarding the sustainable development of freight transport systems.

The container is one prevailing form of a loading unit for freight transport in the modern logistics system. In the Port of Rotterdam, container handling accounted for 25% of throughput, while in 2030 it will possibly represent 42% of total freight [8]. To make sure containers are transported efficiently through intermodal freight transport networks, appropriate routes need to be selected. However, it is too complicated to investigate each container's delivery process when studying a large-scale intermodal freight transport network. Therefore, we consider the movement of containers as a flow at a more aggregated level [4]. From the container flow perspective, one primary task in intermodal freight transport is to assign freight (container) flows from their origins to destinations over the network in an optimal way such that the total transport time and the total delivery cost are minimized subject to related network constraints. In this project, the optimal freight flow assignment will be determined with dynamic intermodal transport network models and through the distributed and coordinated model predictive control approach.

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The 2nd Erasmus Smart Port Rotterdam/Port Research Centre Poster Session, Rotterdam, June 27, 2013

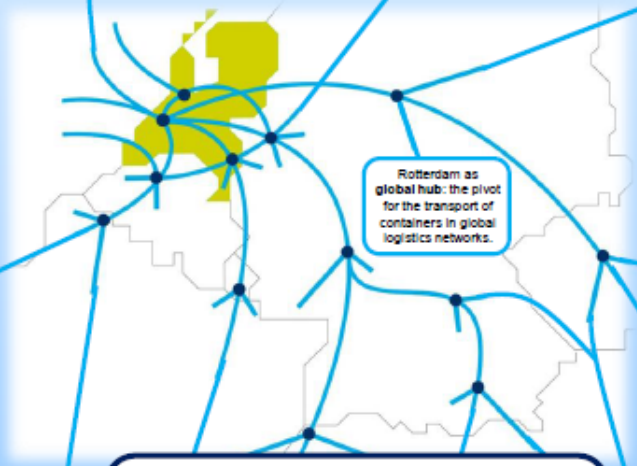
Business model innovations in intermodal hinterland networks

Researcher: Roy van den Berg

Problem statement
North West Europe is a highly competitive market for container transport. What can both port authorities and businesses within the logistics chain do to improve their hinterland connectivity?

Goal research
To understand business models and to identify and analyze (possible) business model innovations in port-hinterland container transport.

Relevance to the port community
Companies normally only focus on their own operations. This research provides learnings from others and identifies opportunities for the future.



Relation with Port Vision 2030
The challenge to realize the global hub as defined in the port vision of Rotterdam depends for a large part on the intermodal connectivity with the hinterland. This challenge can only be faced by the companies operating in, and through, the port of Rotterdam.

The existing business models give insight in what these companies can do, or could do in the future, to strengthen their hinterland connections. A deeper understanding of these companies is important to be able to facilitate the realization of the port vision. It also gives insight in how the companies can operationalize the port vision.

The port authority itself is also one of companies analyzed. The outcome helps to identify possibile ways for realizing the port vision by the port authority itself.

First results
1. Participation by a port authority in the hinterland can result in increased accessibilty and modal shift.
2. Impact modal split obligations ranges from impact on terminal design to an effect on the business model.
3. Opportunities exists for an inland terminal centered value proposition provided by shipping lines.

Logistics department Port of Rotterdam Authority
The research is related to the work of the logistics department at the Port of Rotterdam Authority. The focus of this department is on improving accessibility, facilitating modal shift and increasing market share in the hinterland. Through:
- Optimalisation of logistics processes within the port (e.g. project Nextlogic)
- Promoting intermodal transport (e.g. www.inlandlinks.eu)
- Investing in new rail connections (e.g. project Rail Incubator)

Part of a DINALOG project
DINALOG supports the research project ULTIMATE (Efficient Multimodal Hinterland Networks – new concepts for design and operations) within the research theme: Transport Hubs in Control. The project addresses topics in the domain of integrated multimodal hinterland networks. The research presented on this poster is part of work package 2: Governance and business models innovations in the hinterland

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Business model innovations in intermodal hinterland networks

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Curriculum Vitae

Roy van den Berg (1983, Dutch) is business manager logistics at the Port of Rotterdam Authority. He started his career at the port authority in October 2008 after graduating in June 2008 as MSc at the RSM Erasmus University, master Supply Chain Management. In June 2004 he graduated as BBA at the Hogeschool Rotterdam (University of Applied Sciences), bachelor program Small Business and Retail Management.

In his position as business manager logistics at the Port of Rotterdam Authority he was responsible for developing the hinterland strategy and marketing plan. Currently, his main focus is on the development of InlandLinks (www.inlandlinks.eu), a website to stimulate intermodal transport by making the hinterland network of Rotterdam transparent, especially for shippers and forwarders. Furthermore, he is the contact person for shippers with the aim to facilitate trade via Rotterdam and increase the share of intermodal transport.

At the Port of Rotterdam Authority he is also working part time as an external PhD student. He already published two papers on the hinterland strategy of port authorities and recently published an expert article on Logistiek.nl

In his spare time he is an active runner and likes to play some golf. Furthermore, he volunteers as treasurer at Unicef Rotterdam and is engaged in projects to generate new revenue streams for Unicef.

Contents of my research

A multitude of companies is active in intermodal transport in port hinterlands. These intermodal networks are of increasing importance to the competitiveness of sea ports. My research deals with business model innovations in intermodal hinterland networks with the aim of realizing a better understanding of existing business models and innovations to realize stronger intermodal networks.

The research focusses on the players which are closest to the port authority. First, the port authority itself has been studied. In general, port authorities play a minor role in the development of port hinterlands although the hinterlands are vital to the development of the port. Several academics have argued for a larger role for port authorities in the hinterland but limited empirical evidence existed. To fill this gap I executed a case study on the hinterland strategy and subsequent actions of the Port of Barcelona Authority. The results indicate that an active involvement in the hinterland can have a

significant impact on attracting container volumes from distant hinterlands and improving the accessibility of the port. The second player studied is the terminal operating company. The Port of Rotterdam Authority has been the first to incorporate modal split obligations in concession contracts of the terminal operation companies. Through in-depth interviews with the three major terminal operating companies in Rotterdam, the effects of modal split obligations have been explored. The impact of modal split obligations in concession contracts ranges from an impact solely on terminal design to an effect on the business model that terminal operating companies apply in a specific port. As a visitor of the port the shipping line is the third player which has been studied. The existing main value propositions of shipping lines are 'port-to-port' services and 'door-to-door' services. In port-to-port services, buyers 'just' purchase maritime transport from a shipping line. Door-to-door services comprise of the total transport chain and include land based transport. Carriers as well as forwarders offer these door-to-door services. A third value proposition centered around inland terminals is emerging. Such a value proposition consists of transport up to the inland terminal, and may have advantages over port-to-port services, such as better leverage of scale economies, better repositioning of empty containers and better alignment with the business model of forwarders and requirements of shippers. The research includes a qualitative assessment of this third value proposition and a survey among customers (i.e. shippers and forwarders) in The Netherlands to study their attitude towards the third value proposition and the service offering of shipping lines in general. Differences are found between shippers and forwarders with respect to their position towards shipping lines. Furthermore, differentiation possibilities exist through providing an intermodal value proposition.

The final part of my research will focus on the shippers and their demand for sustainable transport operations and the impact on business models in the port industry. In addition, the business model of the port authority will be studied again by analyzing the port as platform in a two-sided market.

Relation of my research with the Port Vision 2030 of Port of Rotterdam

The Port Vision 2030 of the Port of Rotterdam indicates that there are enormous growth opportunities for container throughput with the development of the second Maasvlakte. However, several weaknesses of the Port of Rotterdam have been identified like road congestion, the service level of the rail market compared to the German ports and the efficiency of the hinterland connections in general. These weaknesses could hamper the realization of the growth opportunities. Furthermore, the overcapacity of deep sea container terminals in North West Europe and the delay of the development of the third rail track which connects Rotterdam via the Betuwe route with Germany threaten the position of Rotterdam. On the other hand

the trend of increasing scale in transport (for example the introduction of the Ultra Large Container Carriers) and the fact that Rotterdam is connected to all modes of inland transport creates opportunities for Rotterdam.

The Port Vision indicates that the infrastructure at the sea side is in place and creates an important strength to capture opportunities resulting from the increasing scale of container vessels. The land side is still a challenge. Therefore, in the port vision a global hub has been defined in which Rotterdam will be the pivot for the transport of containers in global logistics networks. Within the global hub special attention is given to inland transport. For example, synchromodal transport is a feature of the integrated port networks in which Rotterdam plays a leading role with reliable transport as outcome. The defined targets are to strengthen the hinterland network and realize a modal shift through improving the interconnection with multimodal inland hubs and increasing the efficiency of logistics chains.

The Port Vision can only be realized through the activities of the different companies operating in the port. The question is what are the business models of the companies active in the port? How can they adjust their business model to become more competitive and strengthen their hinterland connections? My research deals with the business model the companies operating in the port which have a direct relation with the port authority (i.e. terminal operating companies and shipping lines). The main focus of these companies is still on the sea side and largely influence the port performance. On the land side these players can, and in some instances already do, play a role. A deeper understanding of these companies is important for the port authority to be able to facilitate realization of the Port Vision. It also gives insight in how the companies can operationalize the Port Vision.

The business model and role of the port authority is an important part of my research as well. The focus on hinterland connectivity is relevant as it is one of the main challenges for Rotterdam. The results of the research related to the port authority like hinterland strategies, the impact of the modal split obligations and approaching the business model from another perspective through a platform in two-sided market approach provides valuable input for the future actions of the port authority to be able realize the Port Vision.

"Intelligent Waterways" for Improving Performance of Transport Over Water

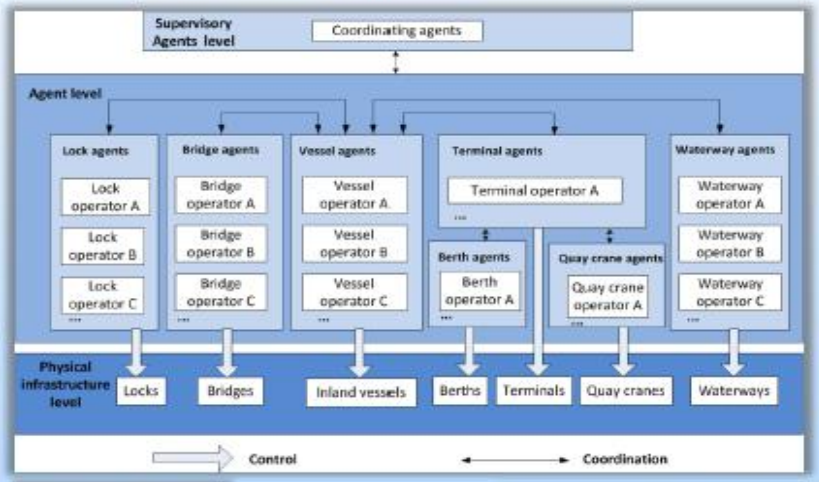
Shijie Li, Rudy R. Negenborn, Gabriel Lodewijks

Background

Scheduling in inland waterways has been done based on the operator's knowledge and experience. It happens frequently that appointments cannot be met due to the uncertainty in the alignment process. Thus, the collaborations and communication between inland waterway users needs to be enhanced.

Research Goal

Incorporating distributed constraint optimization algorithms to improve the collaboration and communication between inland waterway users, and make waterways "intelligent" so that every user can get optimal scheduling plans.



Approach

- The system model of this research will be based on **multi-agent system**, with each agent representing a different inland waterway user.
- **Distributed constraint optimization** algorithms will be proposed to solving a large class of multi-agent coordination and resource allocation problems.
- Case studies will be done for testing the performance of the algorithm proposed.

Research Content

- Vessel rotation planning between container terminals
- Route selection for inland vessels
- Coordination between water level control and freight distribution
- Application of distributed constraint optimization algorithms

Expected Results of Research

Decision support system for multiple users of inland waterways to obtain their optimal solutions, and help them schedule their operations and activities.

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"Intelligent waterways" for improving performance of transport over water

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1 About the author

Shijie Li was born on December 3, 1988, in Hubei Province, China. In 2010 she obtained the Bachelor's Degree of Engineering, majored in Detection, Guidance and Control Technology from Harbin Engineering University, China. In 2013, she obtained the Master's Degree of Engineering, majored in Control Theory and Control Engineering from the same university. From October 2012, she started as a Ph.D. student in the Department of Marine and Transport Technology at the Delft University of Technology. Her Ph.D. research focuses on the implementation of control and optimization algorithms to inland waterway transport. Her research interests include inland waterway transport, multi-agent system and distributed constraint optimization.

2 Research Content

2.1 Research Background

Inland waterway transport plays an important role for the transport of goods in Europe. More than 37,000 kilometers of waterways connect hundreds of cities and industrial regions. According to [1] and [2],
from the perspective of the European Commission, active support of inland waterway transport is required.

To improve the performance of inland waterway transport for its operators and users, innovations are needed.

So far, scheduling in inland waterway transport is mostly done through telephone, fax, and e-mail, based on the planner's knowledge and experience. Unfortunately, it happens frequently that appointments cannot be met by either the shipper or the terminal operator. For example, appointments are sometimes not even feasible at the time they are made. Disruptions at one waterway infrastructure can quickly propagate in the waterway and disturb the operations of other inland waterway operators, which results in uncertain waiting, handling at waterway infrastructure and vessel arrival times [3, 4]. The uncertainty in the alignment process leads to many undesirable effects. There have been some researchers working in these fields [5, 6], most of them have focused on the design of decision support systems to enhance interaction between terminals operators and shippers. On the one hand, the performance of these decision support systems can be improved in the future through the development of optimization algorithms and computer technology. On the other hand, collaborations with other actors in the inland waterway transport also need to be enhanced. More actors, such as lock operators, bridge operators, container

stevedore, can be added to the existing decision support system, and they can try to negotiate with each other and try to find the optimal solutions for every operator.

2.2 Research Objective

The previous section indicates that the collaboration of inland waterway transport needs to be improved to reduce the uncertainties of the operation process. First literature review on inland waterway transport in [7] showed that previous attempts to provide solutions to improve inland waterway transport have been focused on the optimization of operations inside container terminals, or the alignment of vessel operators and terminal operators, research on the overall control of inland waterway transport is rare. With overall control we mean the control which considers all the involved actors in inland waterway transport inside one system, including vessel operator, terminal operator, berth operator, quay crane operator, lock operator, bridge operator, as well as the characteristics of inland waterways. In this research, we plan to improve the inland waterway performance through the introduction of advanced control algorithms, and our research goal can be formulated as follows: *The objective of this research is to develop and evaluate a decision support system for the users of inland waterway, concerning the operations and interactions between involved users (terminal operators, vessel operators, lock operators, etc.), as well as physical characteristics of inland waterways, and incorporating advanced control algorithms to make the inland waterways "intelligent", in order to improve the overall performance of transport over water.*

2.3 Research Approach

A multi-agent system (MAS) is a system in which multiple agents
interact to achieve local or global goals [8]. Several applications of multi-agent systems can be found in transport logistics, but especially applications of agents in transport over water are scare and most papers have focused on the alignment of activities inside one terminal [5]. In addition, most papers stay at the level of a conceptual agent model and sometimes draw conclusions about the expected performance of the model without presenting experimental results. Among the literature on multi-agent based approaches in transport logistics, we found no similarity to the problem we consider.

There are many users, controllers, players, actors, and operator involved in the inland waterway transport networks. Each of these concepts refers to entities that directly or indirectly change the way commodity is flowing. Different users may have different objectives, these objectives may be conflicting. Depending on their objectives, the users choose different actions, resulting in a different operation of the network [9]. Since there are multiple actors involved in inland waterway transport, and each actor has its own consideration and objectives, it is difficult to formulate their behaviors. Thus, we use a multi-agent system to

model the process of inland waterway transport. In the design of the multi-agent system we aim to developa system that can be implemented in practice. Thus, it is necessary that the multi-agent system facilitates optimization of the operations of vessel, terminal, lock and bridge operators and is acceptable for them as well. Moreover, the system has to facilitate real-time planning to deal with the dynamic nature of the problem. In this model, different actors will be defined as different agents, their characteristics will be defined as the variables of each agent, and their relations with each other are defined as constraints. The performance of the inland waterway transport will be evaluated using key performance indicators (KPI). The KPIs we define will be objective functions of the model. Distributed constraint optimization (DCOP) is a theoretical model framework where several agents coordinate with each other to take on values so as to minimize the sum of the resulting constraint costs, which are dependent in the values of the agents [10]. This model is becoming popular for modeling a large class of multi-agent coordination and distributed resource allocation problems, in which a group of agents must choose values in a distributed way so that the cost of a set of constraints over the variables is either minimized or maximized [11]. Thus, the DCOP model has been used in formulating multi-agent problems such as the distributed scheduling of meetings, distributed coordination of sensors in a network, distributed management of power distribution networks,..., etc [12–14]. But DCOP model has been rarely used in the field of inland waterway transport. Thus, in this research, we introduce DCOP algorithms to the MAS model of inland waterway transport to find out the optimal solutions, in the form of scheduling plans for the involved inland waterway operators.

3 Relation with "Port Vision 2030"

According to the"Port Vision 2030" from the port of Rotterdam authority, in 2030, the port of Rotterdam will be the world leader in shipping sustainability, efficiency and safety. The improved handling of ships will result in faster turnaround times, reducing chain costs and making Rotterdam a more attractive hub. However, in 2011, both feeders and inland vessels frequently have to wait to be handled at the terminals.
Often they have to visit a number of different terminals, planning of the use of infrastructure and ships' visits must be therefore be improved.

According to the "Port Vision 2030", the best way to improve efficiency in handling ships is through extensive data exchange between ship owners, terminals, marine service providers and the Harbor Master.
This would minimize waiting time times and optimize cruising speeds. The "Port Vision 2030" is closely related with this research in two aspects:

Firstly, the research objective here is to enhance the collaboration and communication between inland waterway users through the implementation of control algorithms, based on the

assumption that we can implement the extensive data exchange between the users. For the port of Rotterdam, if the extensive data exchange in the ship handling process could be implemented, the optimization strategy proposed in my research can be used to improve the efficiency in handling ships. Secondly, the first step of the research will start from the port of Rotterdam as a case study. To reach our research goal, firstly we need to study the vessel rotation planning problem, which is to schedule vessels' visits to different terminals. Through better planning of vessels' visits to terminals, the following benefits can be obtained:

• financial benefits for ship owners who can reduce speeds to arrive at the terminals exactly on time (instead of arriving too early and having to wait);

• reduction of CO2, fine particles;

• financial benefits for marine service providers (pilots, tugs, boatmen) and terminals to be able to improve capacity planning.

Though our scope is focused on a bigger perspective, which is the inland waterway network, the Port of Rotterdam will be taken into consideration in this network. Because for the inland waterway transport in the Netherlands, the Port of Rotterdam will be crucial component in it, due to the amount of cargo transferred to the inland through Port of Rotterdam.

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The 2nd Erasmus Smartport / Port Research Centre Rotterdam-Delft / Next Generation Infra, Poster Session ,Rotterdam, June 27, 2013

Modeling European Freight Logistics Network: An aggregated approach

Main research question:

- How can we study the effect of changes in demands on freight flows in Europe or a continent from logistic perspective?

Freight logistics is an important element of freight transportation system which determines the routing patterns of commodities. In a situation where there is a change in the magnitude of freight demands in different regions of a continent/ a nation, a change in logistic structure is expected. The adaptation effort of the companies to minimize the costs of supplying the demands such as transport and inventory costs would result in changes in their distribution networks. Figure below depicts the Spatial pattern of consumptions in Europe where Eastern European countries have growth in consumption activities.

$$\min \quad z_1 = \sum_{i \in I} f_i y_i + \sum_{i \in I} \sum_{j \in J} c_{ij} x_{ij} \qquad (1)$$

$$\max \quad z_2 = \sum_{j \in J} d_j \sum_{i \in D_j} x_{ij} \qquad (2)$$

subject to,

$$\sum_{i \in I} x_{ij} = 1, \quad j \in J \qquad (3)$$

$$x_{ij} \le y_i; \quad i \in I, j \in J \qquad (4)$$

$$y_i \in \{0,1\}, \quad i \in I \qquad (5)$$

$$x_{ij} \in \{0,1\}; \quad i \in I, j \in J \qquad (6)$$

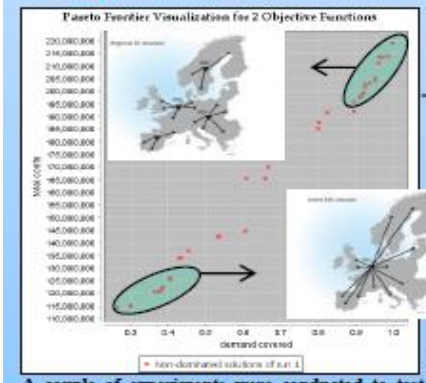
The model that's developed and used in this research is Bi-Objective Uncapacitated Facility Location Problem (BOUFLP). The objectives of the model are to minimize the total costs from establishing a hub/distribution center and transportation costs (z_1) and to maximize the coverage of the demand served by these distribution centers (z_2). Constraint (3) ensures that each of the customers is attended by 1 facility; constraint (4) ensures that flows of goods only occur from opened facilities; and constraints (5) and (6) form binary property of the decisions of opening facility i (y_i) and serving customer j from facility i (X_{ij}).

Aggregation technique:
Hub locations that occur with high frequency in the non-dominated solutions are considered to have higher probability to be the real hub locations.

$$P(h_i) = \frac{\sum_{n=1}^{N} y_{in}}{N} \times s_k$$

Cp =1056, H=200

$P(h_i)$= probability location-i is selected as a location for an aggregated hub.
N= total number of non-dominated solution
Y_{in}= binary variable for hub-i in non-dominated solution n, $Y_{in} = 1$ if hub-i is opened in non-dominated solution n
S_k = weighted share of sector-k in European freight transport flows.



A couple of experiments were conducted to test and validate the model described above. The figure above depicts the non-dominated solutions found for 1056 consumption points (Cp) and 200 potential hub locations (H) in Europe. The solutions depict a tradeoff that typical logistic operations have to make: trade-off between total costs and demand covered. The different optimum solutions presented here represent different logistic structures used by different companies which work in different sectors. The solutions on the left bottom corner represent distribution structures where centralized hubs are used while solutions on the right upper corner represent distribution structures where regional or local hubs are used.

Cp =200, H=42, concentration of consumption: South and Eastern Europe

Cp =200, H=42, concentration of consumption: Eastern Europe

Taking into account the general trend in international trade development, where we foresee increasing consumption activities in the Eastern European countries, there will be more distribution centers located in these countries. This may mean that Ports that are located in the South part of Europe may get more flows of freight and there is more freight transported via rail from countries like China or India to these countries.

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Modeling European Freight Logistics Network: An aggregated approach

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1. Curriculum Vitae

Ronald Apriliyanto Halim is a PhD candidate in the Transport & Logistic section of Technology Policy and Management faculty at Delft University of Technology. His research is focused on the development of a global freight logistics model which will be used to support policy makers to deal with uncertainty in the future. The model developed has special focus on reproducing the future spatial patterns of global production-consumption, global trade, global logistic system, and global transportation and global infrastructure services. As such, the model can be used to explore and analyse the impacts of changes in the aforementioned 5 elements to the relevant stakeholders such as Port of Rotterdam. As a response to the uncertainty problem, techniques such as simulation and optimization will be used to derive policies which are adaptive. This research project is supported by Port of Rotterdam and Ronald is working closely with Business Intelligence and Corporate Strategy department of the Port Authority.

Ronald graduated as an industrial engineer from Pelita Harapan University (Indonesia) in 2007 (magna cum laude). After working as a consultant for almost 1 year he continued his study in Systems Engineering, Policy Analysis, and Management (SEPAM) in 2008 in Delft University of Technology. He accomplished his master study with a scholarship from Shell (Shell Centenary Scholarship). Ronald is specialized in (TIL) transport, infrastructure, and logistics and (MSO) modeling, simulation and optimization. His research interests include evolutionary computation, simulation of freight logistics system, adaptive policy making, and simulation-based optimization. He can be reached at: R.A.Halim@tudelft.nl.

2. Modeling European freight logistics network

Freight logistics is an important element of freight transportation system which determines the routing patterns of commodities. In a situation where there is a change in the magnitude of freight demands in different regions of a continent/ a nation, a change in logistic structure is expected. The adaptation effort of the companies to minimize the costs of supplying the demands would result in changes in their distribution networks. While the need to include logistic model in freight transportation models has been acknowledged for assessing the extent the spatial pattern of international (European) freight logistics network would evolve, there hasn't been, unfortunately, many models developed to serve this purpose. One important problem that is addressed in this research is the approximation of European freight logistics network at an aggregate level. A multi-stage freight logistic chain network model is developed to: 1) approximate the locations of the distribution centers/hubs in Europe 2) approximate the routings of the freight from the distribution centers/hubs to the consumption site. The model is formulated based on a multi-objective optimization model in which the trade-off

between total transport costs and demand coverage is studied to derive an approximation on the (aggregated) European distribution network/hubs. The modeling exercise of this project is part of a bigger freight modeling framework which enables us to analyze the impacts of global trends to the routing patterns of freight flows to different region in the world. The framework has been presented in the first Port poster session.

2.1 Research problem

The main problem aimed to be solved in this research is the development of European freight Logistics Network model which we can use to answer the research questions defined below.

Main research question:

- How can we study the effect of changes in demands on freight flows in Europe from logistic perspective?

Sub research questions:

- What would be the impacts of a shift of demands to Eastern European countries on throughput of the Ports in north western Europe?
- What would be the impacts of changes of transport costs from certain Seaports to the logistic hubs in Europe?
- What would be the impacts of the development of the new ports in Europe to the transshipments market in Europe

2.2 Research Objective

The main research objective of this project is to develop a logistic model which is able to:

1. Support the understanding and analyses of the impacts induced by the changes in global logistic drivers such as: development of new ports, shift in economic growth and consumption patterns, and regulatory trends against the future formation of global logistic networks.
2. Support the analysis on the impact of the evolution of logistics network to the routing of freights of different commodities from seaports to the consumption sites.

2.3 First Results

The model that's developed and used in this research is Bi-Objective Uncapacitated Facility Location Problem (BOUFLP). The objectives of the model are to minimize the total costs from establishing a hub/distribution center and transportation costs (z_1) and to maximize the coverage of the demand served by these distribution centers (z_2). Constraint (3) ensures that each of the customers is attended by 1 facility; constraint (4) ensures that flows of goods only occur from opened facilities; and constraints (5) and (6) form binary property of the decisions of opening facility i (y_i) and serving customer j from facility I (X_{ij}).

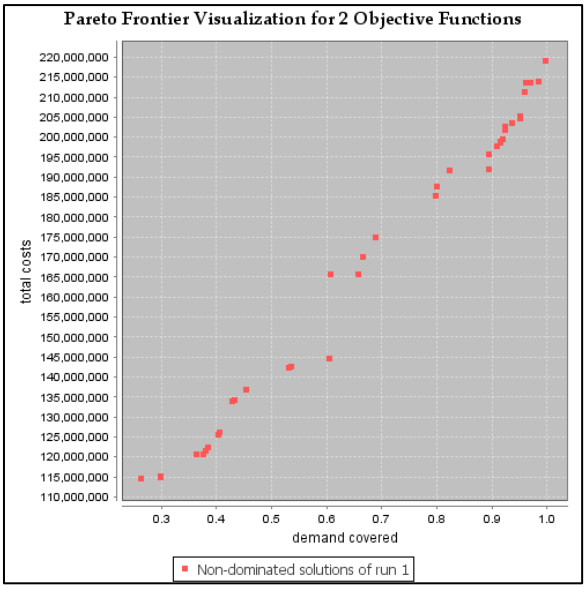

Figure 5 non-dominated solutions for bouflp with 1056 regions and 200 potential hubs

Since we are interested to investigate the general patterns of the freight flows in Europe an aggregation technique has to be used to approximate the locations of the hubs regardless of the commodities transported within Europe. The hubs are approximated based on their occurrences in the non-dominated solutions. Locations of hubs which occur above certain frequency in the solutions are selected to be the locations of approximated hubs.

$$P(h_i) = \frac{\sum_{n=1}^{N} y_{in}}{N} x\ s_k$$

P(h_i)= probability location-i is selected as a location for an aggregated hub.

N= total number of non-dominated solution

Y_{in}= binary variable for hub-i in non-dominated solution *n*, Y_{in} =*1* if hub-*i* is opened in non-dominated solution *n*

S_k = weighted share of sector-*k* in European freight transportation. Certain sectors have certain share which constitutes possible logistic structures in Europe.

- **Experimentation of the model to project the spatial pattern of European Logistic Network**

The following figure is produced by the European Logistic Network (ELON) model which depicts the approximated locations of hubs/ distribution centers within Europe. By using this model, analysis regarding the flows between hubs and regions where consumption takes place can be conducted. An important finding from the preliminary study is that taking into account the general trend in international trade development, where we foresee increasing consumption activities in the Eastern European countries, there will be more distribution centers located in these countries. This may mean that Ports that are located in the South part of Europe may get more flows of freight and there is more freight transported via rail from countries like China or India to these countries.

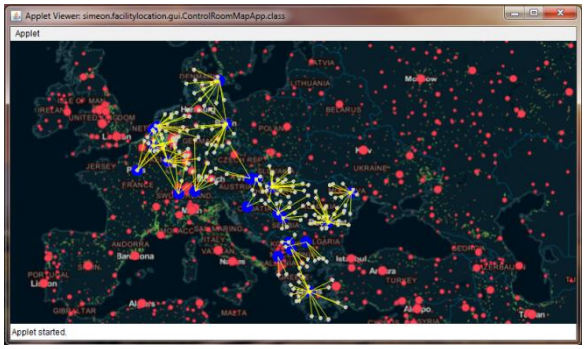

Figure 6 Spatial Pattern of freight flows for certain regions in Europe with 200 consumers and 42 distribution centers/ hubs.

3. Research relevance: Port of Rotterdam and real-world problems of strategic decision making

Looking at the important role that port of Rotterdam has been playing as a global hub during the past couple of decades, it is clear that strategic planning of the port authority is crucial in maintaining the competitiveness of the port. Especially, with the uncertainties in global trade, the necessity for Port of Rotterdam to be strategic in dealing with the competition in freight transshipment market in North Western Europe is unquestionable. Decisions relevant to the investments in infrastructure and capacity within the port would become key factors in determining the outcomes of the competition. However, such decisions possess inherent difficulties to be made due to the changes that can happen in the structure of freight distribution in Europe. Changes in logistic network will bring about change in the choice of ports in the north Western Europe and this may eventually impact the throughputs of these ports.

While there are many freight models that are developed to study the movements of freights within Europe, many of them don't incorporate logistic aspect as investigated in this research project. The

model developed in this research would enable analyses on the impacts of structural changes in logistic networks to throughputs of ports in Europe including port of Rotterdam. Approximation of the locations of facilities and the flows from Port of Rotterdam to these facilities and eventually to the end consumption sites would give a picture of how freight supply chain network in Europe looks like. Furthermore, strategic uncertainty analyses through explorations of different scenarios which involve perturbations of the states of the logistics network can also be performed to investigate uncertainties which come from external factors which may influence port throughputs. Finally, results of such analyses should give Port of Rotterdam a better insight on future circumstances which they need to anticipate in the planning for the development of their capacity and all the necessary investments which entails.

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Poster Session, Rotterdam, June 27, 2013

Planning of hinterland transport

Controlling the modal split

Introduction

This study considers the joint planning of a container transportation network. The network transportation must cost-efficient, reduce emissions and deliver containers on time. This supports a modal shift by consolidating containers on barge and rail services. The planning must be adaptable to disturbances.

Results

The study showed that the key parameter in the planning solution is the price of handlings[1]. It also showed that specific types of disturbances are always costly, while the additional costs for other types of disturbances can be kept low by smart planning updates[2].

On-time delivery
Or incur penalty

Different routes
RTM ← →North-West Europe

Transit costs
On barge, rail or truck

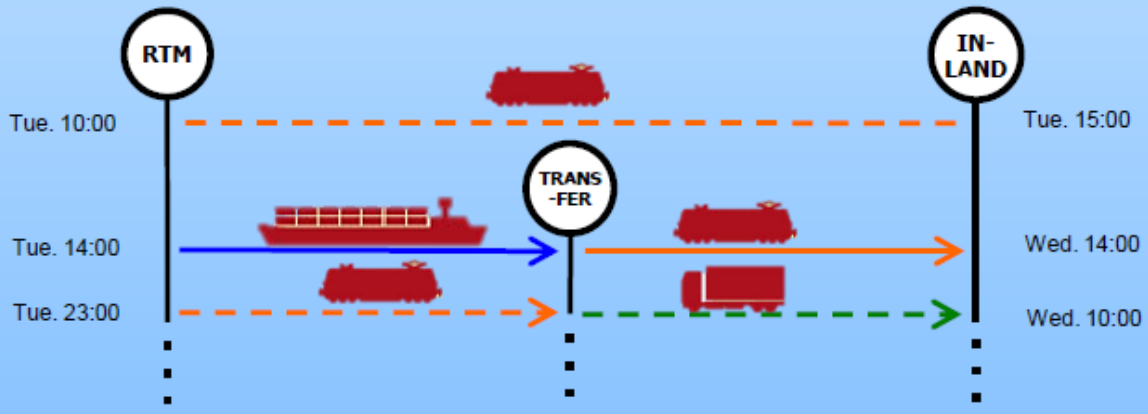
Available capacity
On barge, rail or truck

Handling costs

Emissions CO_2

Example: selecting a route for each container

In this study the problem is solved for a week of transportation at once: 1000s of containers between 10 destinations on 10.000+ possible routes. Per container the most suitable route is selected, e.g. for a container arriving in Rotterdam at Tue 3AM that must be delivered at the inland destination before Wednesday 11AM.



Future research

We aim to create efficient methods for planning updates in case of disturbances (delays, cancellations, congestion etc.), for instance by using smart rules of thumbs.

[1] Van Riessen, B., Negenborn, R. R., Dekker, R., & Lodewijks, G. (2013). *Service network design for an intermodal container network with flexible due dates/times and the possibility of using subcontracted transport* (No. EI2013-17). Erasmus School of Economics (ESE).

[2] Van Riessen, B., Negenborn, R. R., Dekker, R., & Lodewijks, G. *Analysis of impact and relevance of transit disturbances in an intermodal container network.* Submitted to LOGMS 2013

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Planning of hinterland transportation: Controlling the Modal Split

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An intermodal container transportation network is being developed between Rotterdam and several inland terminals in North West Europe. This EUROPEAN GATEWAY SERVICES (EGS) network enables an integrated network transport between 7 inland terminals and 3 Rotterdam seaports. To use this network cost-efficiently, a more integrated planning of the container transportation is required. The most relevant aspects of such a planning are identified with a new model. This model introduces three new features to the intermodal network planning problem. First, the model combines two formulations for a multi-commodity network: a minimum cost network flow problem and a path-based network design formulation. Secondly, the model allows for overdue delivery at a penalty cost. In this way the practical flexibility of negotiating delivery times with customers is more closely represented than the use of strict delivery time restrictions. Thirdly, the model combines two types of operation: both self-operated services, operated by the network company as subcontracted services, operated by partners are used. The model distinguishes between rail and barge services and the use of truck when necessary.

The model is applied at two different levels. At a tactical level, the optimal service frequencies between the network terminals is determined, considering barge or rail modes and both operation types (self-operated and subcontracted). This is called the service network design. The model is used to determine the optimal service frequencies between the terminals in the EGS network. The most influential aspects for the costs of this service network design are determined. The results of the experiments at the tactical level show that the costs for transferring have a strong impact on the amount of containers that are transported with intermediate transfers. An increase in intermediate transfers can lower the costs for transportation significantly.

The results are used as a basis for an adapted model at an operational level. With this model the impact of a disturbed service is determined, by comparing the undisturbed planning with a full planning update after the disturbance. This impact can be seen as a measure for the gravity of a disturbance: a high impact means that a disturbance comes at high costs, even if handled in the best possible way. Hence, a high impact indicates disturbances that must be prevented. A second measure is the difference between an optimal (full) update and a local update, defined as the relevance. The local update represents the current practice of the manual planners. A high relevance indicates a disturbance that can be solved in a much more cost-

efficient way by updating the existing planning fully, compared to only updating directly disturbed containers. The model is used for the same EGS case that was used at the tactical level. The impact and relevance of early departure, late departure and cancellation of services in the network are determined. The results show that service cancellations have the largest impact. Apart from that, early departure of a barge has a high impact as well. Indicators of disturbances that have a high relevance and should be solved with a full update are the following: the disturbed service is a barge, is self-operated and/or operates on a corridor with a high frequency of alternative services.

The study shows that the new model is suitable for solving the problem at both the tactical and operational level. Points of attention for the manual planning are recommended and a focus for automated planning is proposed.

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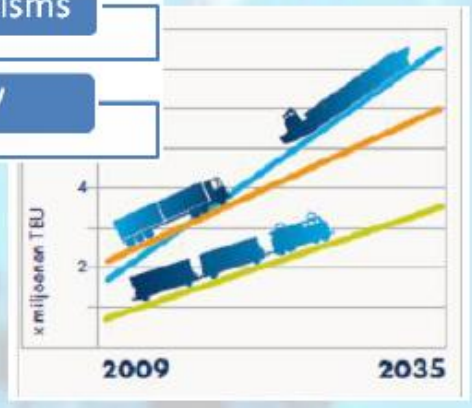
IMPROVING **HINTERLAND ACCESSIBILITY** FOR THE PORT OF ROTTERDAM

THE ROLE OF THE PORT AUTHORITY

Dubrovnik

IMPROVING BY UNDERSTANDING

- Accessibility / Rail Bundling
- New Governance Mechanisms
- Role Port of Rotterdam NV



The expected outcome of this project is a series of recommendations to the Port of Rotterdam aiming at improving hinterland accessibility. Goal is to identify and assess management measures and to evaluate the governance models within which these measures can be developed best. The recommendations will be based on both quantitative and qualitative analysis, evaluating both the impacts on the accessibility level of the port and the impact on the business models and strategic position of the actors involved.

Using these measures makes it possible to manage the quality and quantity of the Port of Rotterdam's hinterland network. In fact this is a redesign of the 'control panel' which the Port of Rotterdam NV and its partners can use to influence the competitive and sustainable development of the port

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PROJECT TEAM

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Improving hinterland accessibility for the Port of Rotterdam (NGI)

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TOWARDS A SUSTAINABLE HINTERLAND ACCESSIBILITY FOR THE PORT OF ROTTERDAM (DUBROVNIK)

Organisation

Dubrovnik is a 'NGI Powered by Maasvlakte 2' project done by a consortium of Erasmus University, TNO and TU Delft in cooperation with Port of Rotterdam NV.

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Background

Dubrovnik addresses the important issue of hinterland accessibility, putting the role of the port authority, Port of Rotterdam NV (PoR) in relation to its stakeholders central. Hinterland accessibility is considered a key factor for the competitive position of the port of Rotterdam (Port Vision 2030, Port of Rotterdam). To be able to guarantee hinterland accessibility, it is required that switching between transport modes is organized in an efficient way, and that the available infrastructures are utilized to their full extent. In order to meet the requirements, i.e. to switch efficiently between transport modes and to better use the available infrastructures, several stakeholders need to act in a coordinated way. Achieving such coordinated action is a shared responsibility and therefore it is difficult to hold individual organizations accountable. Moreover, natural incentive systems to coordinate actions in a bottom-up way are lacking. To effectively impose the requirements in a top-down way, would require new roles of the PoR, which as a landlord – in principle – has limited jurisdiction.

Over the last years PoR has already engaged itself into new roles that may help improve accessibility for the port. First of all, it has taken on a facilitating and investor role by creating independent organizations such as Keyrail, Portbase, and Verkeersonderneming, to address specific bottlenecks that limit accessibility. It has also taken on a regulating role by imposing modal split targets for concession contracts with new deep-sea terminals at Maasvlakte 2 in order to

address the bottleneck that some available infrastructures (waterways and rail) are not used to their full extent. Although these new roles and instruments have proven to have a positive impact, they have not resolved all bottlenecks. There is a need to further explore the possibilities for PoR to take on new roles and to use new instruments that are effective in making the hinterland better accessible. Figure 1 gives a structured overview of the potential roles a PA can develop based on its landlord function.

Figure 1: Roles for the Port of Rotterdam Authority - generic roles of landlord port authority, categorized by level of influence

Level of control	Role	Examples in Rotterdam
Direct influence	Infrastructure developer/manager	Keyrail, Verkeersonderneming
	Port/transport operations manager	No example
	Additional services manager	Portbase
	Regulator	Licenses, access conditions
	Stimulator /enforcer/ enabler	Incentives, pricing mechanism
Indirect influence	Facilitator	Platform function (Spoorcafe), financial means
	Lobbyer	I&M, Brussels, but also through communication

The most interesting roles to consider are the roles in which the port authority has direct influence on the implementation of measures. These roles also mean the greatest change from the traditional landlord role.

Dubrovnik project

The Dubrovnik project aims at identifying such new roles and instruments. An important aspect therein is that the role of the PoR is related to the roles other stakeholders play; the effectiveness of the instrument at hand can only be assessed when the other relevant stakeholders are taken into account as well. It is necessary to clearly show the benefits of measures that can be implemented using new governance mechanisms, how benefits are distributed among the actors, how this influences the business models of the actors, their strategic position and the risks and how actors are expected to behave given the implementation of measures. This is key to the analysis of a selected highly relevant case in Rotterdam's hinterland accessibility: rail bundling at the Maasvlakte 2.

Rail bundling case

Figure 7 illustrates the locations of the 4 to 5 foreseen deep sea container terminals at Maasvlakte 2. It is expected that none of the separate terminals will have sufficient cargo for a substantial amount of daily full trains to the various destinations in the hinterland, especially not in the first years of operation. This requires the development of an efficient and effective bundling process. If such a process fails to develop, this will result in inefficient rail distribution with a negative impact on both the share of cargo transported by rail and the quality of hinterland accessibility in general.

Figure 7: Lay-out of Maasvlakte 2 and planned locations of new container terminals.

There are several options for the PoR in this particular case, among which:

- To do nothing and wait until the market starts to move and come up with solutions.
- To actively negotiate and facilitate cooperation between the container terminals involved. This could be in the form of joint planning of trains and coordinated exchange of containers between the terminals. It could also be in the form of an independent organization, established by the container terminals involved responsible for the bundling and the planning of trains.
- To invest in the development of a physical common rail facility including internal transport and offer this to the deep sea container terminals
    - At a fee, or
    - To be earned back via port dues

Each of these options has an impact on the actors involved. In the first place the new arrangement should lead to clear operational benefits for the whole rail system. Second, the impact of the new arrangements on the business models and strategic positions of each of the actors involved should be clear as this indicates their willingness to accept the arrangement and also the conditions for the implementation. Finally before deciding, PoR should have developed a strong idea on the potential attitudes and (strategic) reactions of the relevant actors involved.

Within the Dubrovnik project a calculation tool is developed to assess the impact of the various options on the overall rail product of the port and also on the rail products of the individual deep sea terminals. Second an evaluation tool is developed, based on the principles of coalition game theory to asses qualitatively the potential impact of the options on the different aspects of the deep sea terminals' strategic positions.

Deliverables

The expected outcome of this project is a series of recommendations to the Port of Rotterdam aiming at improving hinterland accessibility. Goal is to identify and assess management measures and to evaluate the governance models within which these measures can be developed best. The recommendations will be based on both quantitative and qualitative evaluation, analyzing both the impacts on the accessibility level of the port and the impact on the business models and strategic position of the actors involved.

Using these measures makes it possible to manage the quality and quantity of the Port of Rotterdam's hinterland network. In fact this is a redesign of the 'control panel' which the Port of Rotterdam NV and its partners can use to influence the competitive and sustainable development of the port.