Erasmus Smart Port Rotterdam

The 3rd Erasmus Smart Port Rotterdam / Port Research Centre Rotterdam-Delft Poster Session

Rotterdam / RDM Campus, October 2nd, 2014

Erasmus Universiteit Rotterdam

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Partners:

The Third Erasmus Smart Port Rotterdam / Port Research Centre Rotterdam-Delft Poster Session

Rotterdam, October 2nd, 2014

Colophon

This is a publication by Erasmus Smart Port Rotterdam in cooperation with the Port Research Center Rotterdam Delft (Delft University of Technology).

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Introduction

In this report, posters and short introductions of more than 30 young port researchers are bundled, as presented on the Third Erasmus Smart Port Rotterdam / Port Research Centre Rotterdam-Delft poster session. The posters are being displayed at the Innovation Dock of the RDM Campus at Heijplaat/Rotterdam at October 2nd 2014.

We think the RDM Campus is a very attractive location to present new port research by PhD-students from the Netherlands and Belgium, because at the moment the RDM Campus is a location combining technical education, research centres and collaborating companies on sustainable innovations needed for the Rotterdam economy. Parties working in the RDM Campus aim to address concrete practical questions in the field of construction, mobility, product design, maritime operations and maintenance in innovation teams and communities of practice—where students, teachers, professors and entrepreneurs are working together. This is exactly the goal of the Third poster session. We like to present PhD-students and their professors to an audience of port entrepreneurs and port policy makers. This audience is directly linked to the members of Deltalinqs, the industry association in the port of Rotterdam, and to employees of the Port of Rotterdam Authority, the municipality of Rotterdam and also to members belonging to other ports and policy units, such as the Ministry of Infrastructure and the Environment. Besides, Deltalinqs, Port of Rotterdam and City of Rotterdam are, together with Erasmus University Rotterdam, the partners and founding fathers of Erasmus Smart Port. Port of Rotterdam and Delft University of Technology are partners in Port Research Centre Rotterdam-Delft.

The First poster session, March 6th, 2012, was focused on the establishment of a network of port researchers in the Netherlands and Belgium: linking port PhD-students and their professors and establishing close relation between researchers. The Second poster session, June 27th, 2013, was hosted by the Port of Rotterdam Authority. PhD-students were asked to pay special attention to the design and contents of their poster with respect to the new port strategy of the Port of Rotterdam or to the new vision of the port of Antwerp, as has been published in the documents 'Port Vision 2030. Port Compass' or the 'Sustainable report' of the Port of Antwerp. In this Second Poster session, a large number of professionals being members of the innovation teams working on the innovation agenda of the Port Vision 2030, paid a visit to the poster session.

The Third Erasmus Smart Port / Port Research Centre Rotterdam-Delft poster session pays special attention to the use of the research by PhD-students for the port business and for port policy makers. By looking at most of the posters, some clear links with port practice becomes clear: companies like BNP Paribas, Electrabel, GDF Suez, E.on, Gasunie, Vopak, IMS, Feederlines, Jungheinrich, ECT, Nissan, MHF, Port of Rotterdam or PCData are—amongst others—related to the research presented.

Foto: Paul Kampman

The group of PhD-students attending the poster sessions is of course a dynamic group; new PhD-

students emerge and other students successfully graduated and received the much coveted doctorate diploma. Two examples of PhD students who finished their PhD-project are Patrick Witte and Klara Paardenkooper. Patrick Witte (see picture left) was the winner of the First Prize in the First poster session. His dissertation is called 'The Corridor Chronicles. Integrated perspectives on European transport corridor development'. Patrick Witte graduated on April 28th, 2014 at Utrecht University. His research on—amongst others—strategies aimed at resolving bottlenecks in transport corridors was in-depth discussed in meetings devoted to the capacity problems related to the 'third track' of the Betuweroute. His multidisciplinary framework proved to be very useful.

Klara Paardenkooper graduated June 13th, 2014 at Erasmus University Rotterdam. Her dissertation was called 'The Port of Rotterdam and the maritime container. The rise and fall of Rotterdam's hinterland (1966-2010)'. She observed that the hinterland of the port of Rotterdam is shrinking. Much attention was given in the press and in the port of Rotterdam community to the results of her work, because of the importance of the characteristics of the hinterland to the port business. Both PhD projects of Patrick Witte and Klara Paardenkooper indicate the importance of PhD-research for the functioning of seaports and the port of Rotterdam in particular.

The posters in this report are made by PhD-students from the University of Antwerp, Vrije Universiteit Brussel, Delft University of Technology, University of Groningen and Erasmus University Rotterdam. Five posters were made by students from Belgium and thirteen posters were made by students of Delft University of Technology. In addition, posters of two very promising master students are included at the end of this collection. The posters are presented according the six themes: Economic Geography, Port Authorities and management, Supply Chain Management, Sustainability, Terminal operations, Traffic & Transport operations.

This indicates clear priorities, but also some missing links or white spots, such as the industrial seaport, transitions towards the biobased economy or port-city relations. Within the next months, Erasmus Smart Port will thrive for an important upgrade—Erasmus Smart Port 2.0—, in which a number of road maps will be produced by teams consisting of researchers, port firms and port policy makers. This will give a boost to demand oriented and smart port research, having clear implications for the Fourth Erasmus Smart Port Rotterdam / Port Research Centre Delft-Rotterdam poster session.

But first, we hope the research collected in this volume will be useful both for practitioners and academia. We also hope you will be inspired by the work of the young and promising researchers collected in this volume.

Prof.dr. Rob Zuidwijk, academic director Erasmus Smart Port Rotterdam
Dr.ir. Rob Stikkelman, director Center for Port Innovation Delft University of Technology
Robert van der Linden, Port of Rotterdam Authority.

Rotterdam/Delft, October 2nd, 2014

Contents

The 3rd Erasmus Smart Port Rotterdam/Port Research Centre Poster Session, Rotterdam, October 2nd, 2014

An Economic and Institutional Analysis of Multi-Port Gateway Regions in the Black Sea Basin

Promoter: Prof. Dr. Theo Notteboom

1. Problem Research

1. The rise of economic centers in Eastern and Central Europe creates opportunities for Ukraine to develop shortsea shipping services and water- and land-based hub-feeder networks to these areas.
2. The research of the potential of Ukraine in taking up a role in emerging distribution systems in East and Central Europe.
3. Research objective of the thesis: The incorporation and integration of Ukrainian transport potential into the EU economy.

2. Goal of the paper

1. Characterize the spatial dynamics of container ports in Black Sea (BS) by testing the validity of spatial models on port system development.
2. Present the expected future evolution path for port hierarchy in the region.
3. To assess to what extent the BS port region is following an 'expected' development path or can be characterized as an atypical port system following its own development logic.

4. Conclusions

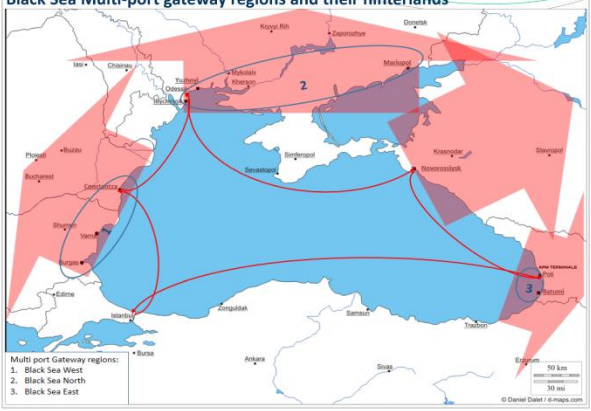
1. **The BS is a secondary port system, with its own peculiarities:**
- Bosporus Strait
- Specific hinterlands (have almost no overlap)
- North BS ports lost market position (since 1998) in favour of the West BS ports
- East BS ports have been bypassed by Novorossiysk port since 2003.

2. **The development process of the BS port system can't be clearly linked to the model developed by Taaffe et al. (1963)**
- # of ports has not decreased and the cargo did not concentrate in specific ports
- On the contrary, # of ports increased and is expected to increase further.

3. **Following the classical "Anyport model" of Bird (1980)**
- BS ports reached the stage of specialization in their development.
- The ports have not reached the advanced stage of "port regionalization" (Notteboom and Rodrigue, 2005).

4. **Challenge of the periphery (Hayuth, 1981)**
- West BS ports are losing shares and face fierce competition from Constantza.
- Illyichevsk port is loosing growth potential to North BS ports.
- Novorossiysk benefits from growth potential (2006-2011). Drivers: (i) local consumption, (ii) container terminals, (iii) Russian cargo deviation strategy from Ukrainian ports.

Black Sea Multi-port gateway regions and their hinterlands

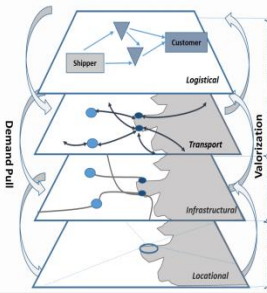


Kateryna Grushevska *, MSc

*ITMMA, University of Antwerp,
Kipdorp 59,
2000 Antwerpen, Belgium
kateryna.grushevska@uantwerpen.be

3. Methodology (1)

Hinterland and multi-layer approach to port dynamics



Types of port hinterlands	Concept	Element	Attributes	Challenge
Logistical	Flows	Mode, timing, punctuality and frequency of services.	Added value, tons-km, TEU, value of time, ICT	Supply chain management
Physical	Transport supply	Transport links and terminals	Capacity, corridors, terminals, Physical assets (fixed and mobile)	Additional capacity (modal and intermodal)
Macro-economic	Transport demand	Logistical sites (production and consumption) as part of GCCs	Interest rates, exchange rates, prices, savings, production, debt	International division of production and consumption

3. Methodology (2)

- Logistical hinterland layer analyzed in particular using the net shift analysis.
- The net shift analysis mirrors the entire container volumes (in TEU) that a port has actually lost or won from competing ports in the same range with the anticipated growth rate.

Application results of multi-layer approach to port dynamics

Port region/ stand-alone region	Concentration level	Concentration factors	Deconcentration factors	Path dependency	Hinterland served
BS West region *(Constantza, Varna, Burgas)*	Mixed dynamics, with deconcentration away from Constantza.	**Influx of transshipment flows to Constantza.** Commissioning of two **new container terminals in Constantza** (DPW, APMT)	Increased participation of Burgas port. Retreat of the transshipment flows from Constantza to Med ports	Non linear	**Romania, Bulgaria, Balkans** (part of)
BS North *(Odessa, Illyichevsk, Illyichevsk sea fishing port, Yuzhnyi, Mariupol)*	Mixed dynamics, with deconcentration away from Illyichevsk.	**Port expansion in Odessa** (HPC; Brooklyn Kiev) + **dry port creation** (Europort) in its neighborhood. **Port expansion in Illichivsk port** (NCC).	**New entrants:** Mariupol, Illyichevsk sea fishing port, Yuzhnyi.	Non linear	**Mainly Ukraine**, insignificant amount for other destinations (Russia, Moldova etc.)
		Political and economic stability			
BS East *(Poti, Batumi)*	**Deconcentration** away from Poti		**New entrant**: Batumi	Non linear	**Georgia, but mainly transit** (Azerbaijan, Armenia and Caspian states)
Novorossiysk	**Increased concentration** in Novorossiysk	**Increased number** of **direct calls** by shipping lines **Expansion** of container terminals	Future possible **deconcentration** caused by expected greenfield **port Taman.**	Non linear	**Russia** (from South of Moscow till Ural)

5. Future developments

1. **In the next 5-15 years more new entrants are expected, more precisely:**
- Port Taman in Russia ⇒ new multi-port gateway region in the North-East BS .
- Port in Georgia (Anaklia - 30 km North from Poti) ⇒ increased competition in the East BS multi-port region.
- New port in Crimea –not feasible (consumer base, hinterland connections + geopolitical tangles in the region).

2. **Main forthcoming competition in the BS region will be dictated by the major shipping lines Maersk, MSC &CMA-CGM (53 % of the market share in BS):**
3. **For the current year experts forecast a 0,6% dip for the whole BS Basin. For Ukraine in particular the fall will be the most significant - the container traffic is expected to decrease by some 20 % in 2014.**

BACKIS Between Black and Caspian Seas

Erasmus Mundus

BACKIS is an Erasmus Mundus Action 2 project funded by the European Commission aiming the set up of academic and staff mobility between universities from Caucasia (Armenia, Azerbaijan and Georgia) and Ukraine with European (EU) universities.

Universiteit Antwerpen

ITMMA INSTITUTE OF TRANSPORT AND MARITIME MANAGEMENT ANTWERP

Kateryna Grushevska, ITMMA (University of Antwerp)

An Economic and Institutional Analysis of Multi-Port Gateway Regions in the Black Sea Basin

kateryna.grushevska@uantwerpen

Promoter: Theo Notteboom, ITMMA (University of Antwerp) [1]

Kateryna Grushevska joined ITMMA of the University of Antwerp in 2013 as a PhD student under the BACKIS scholarship programme of the European Commission. She holds a MSc in Managemnet from Odessa Maritime University and MSc in Transport and Maritime Economics from ITMMA. Her research activities at ITMMA particularly focus on ports and logistics in the Black Sea region.

PhD Research

The expected rise in relative GDP growth in Eastern and Central Europe combined with increased consumer spending and manufacturing will drive the need to direct goods to these locations. These developments push changes in the design of distribution networks (e.g. through a move of European Distribution Centers (EDCs) to other regions and a network redesign towards a system of RDCs or more DC bypass operations) and will have an impact on the distribution of container flows among European ports. At the moment, distribution systems in Europe are still very much focused on Belgium and the Netherlands when it comes to EDC location and re-exporting activities. Ukraine is strategically located to provide an Eastern access to Europe and could therefore play a key role in facilitating trade between Asia and Europe. Besides that Ukraine's new "Law on sea ports" that is coming into force in June 2013 opens up new opportunities for investors and PPP in the port sector.

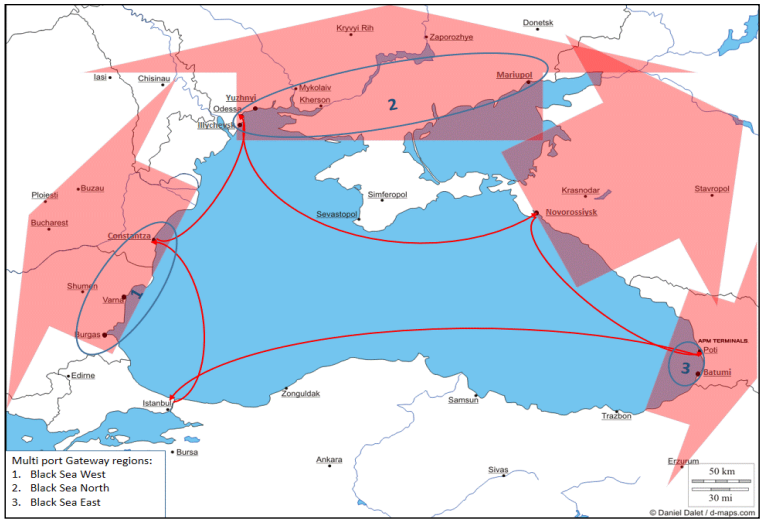
The rise of economic centers in Eastern and Central Europe creates opportunities for Ukraine to develop shortsea shipping services (via the Black Sea) and water- and land-based hub-feeder networks to these areas. This research project provides an academic study of the potential of the Ukraine in taking up a role in emerging distribution systems in East and Central Europe. Based on academic literature on distribution systems, the location of distribution centers and an extensive empirical analysis of the logistics infrastructure in the country, the project will assess to what extent particular regions in the Ukraine can serve as important gateways to Europe. An in depth analysis and component analysis for CIS ports with leading international reference ports resulting in a recommendation for optimal factors will be performed. This analysis will be linked to existing academic models (from economic geography literature, port economic literature and operations research) on distribution networks and port systems in view of updating these models with insights and developments from Eastern and Central Europe. As a result one of the potential research objectives of the thesis is: the incorporation and integration of Ukrainian transport potential into the EU economy.

Goal of the paper

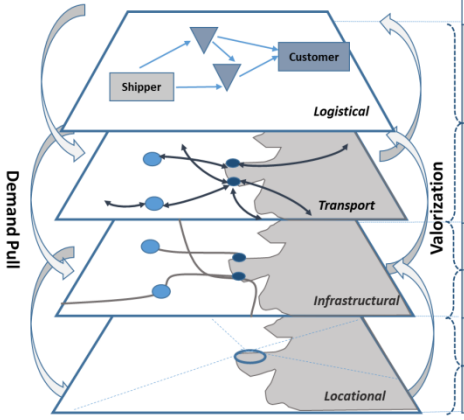
1. Characterize the spatial dynamics of container ports in Black Sea by testing the validity of established spatial models on port system development.

2. To present the expected future evolution path for port hierarchy in the Black Sea

3. The assess to what extent the Black Sea port region is following an 'expected' development path as portrayed in a number of port system development models, or alternatively, can be characterized as an atypical port system following its own development logic.



Methodology: Hinterland and multi-layer approach to port dynamics



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For logistical hinterland layer analysis in particular the net shift analysis was used which is a variation on the shift–share analysis presented by Notteboom (1997). The net shift analysis mirrors the entire container volumes (in TEU) that a port has actually lost or won from competing ports in the same range with the anticipated growth rate. The sum of all shift-effects equals to zero. The time intervals with considerable net volume shifts refer to a high degree of competition and dynamics within the container port system.

Conclusions

1. The Black Sea is a secondary port system, with its own peculiarities:

- Bosporus Strait
- Specific hinterlands that have almost no overlap
- North Black Sea ports lost market position (since 1998) in favour of the West Black Sea ports
- East Black Sea ports have been bypassed by Novorossiysk port since 2003, which preserved the predominant share

2. The port development process of the Black Sea port system can't be clearly linked to the model developed by Taaffe et al. (1963)

- # of ports has not decreased and the cargo did not concentrate in specific ports
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- West Black Sea ports are losing shares and face fierce competition from Constantza.
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Future developments

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- Port in Crimea – seams not feasible (consumer base, hinterland connections + geopolitical tangles in the region).

2. Main forthcoming competition in the Black Sea region will be dictated by the major shipping lines Maersk, MSC &CMA-CGM (53 % of the market share in BS):

- Hitherto joint services were spread over three ports: Odessa (2 terminals: Brooklyn Kiev and HPC), Yuzhnyi (TIS) and Illyichevsk (CTI).

3. For the current year experts forecast a 0,6% dip for the whole Black Sea Basin. For Ukraine in particular the fall will be the most significant - the container traffic is expected to decrease by some 20 % in 2014.

Yasmine Rashed (PhD student)* University of Antwerp

Container Demand Modelling and Forecasting: An Econometric Approach to the Port of Antwerp *

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Supervisors: Prof. Dr. Hilde Meersman and Prof. Dr. Thierry Vanelslander

Yasmine Rashed is currently an academic researcher and a PhD student at the Department of Transport and Regional Economics at the University of Antwerp, has a doctoral grant financed by BNP Paribas Fortis chair on transport, logistics and ports at the Department of Transport and Regional Economics. She previously worked as a teaching assistant and a researcher at the Arab Academy for Science, Technology and Maritime Transport (AASTMT), Egypt and a part-time researcher for the Egyptian Ministry of Transport. Her research focuses on quantitative transport economics in the port sector. She has obtained her bachelor degree and M.Sc. in Economics (2010) from the Faculty of Economics and Political Science at Cairo University. In addition, she has a joint Diploma in International Transport and Logistics by the AASTMT (Egypt), the Norwegian Shipping Academy and the Norwegian School of Management (Norway).

Research contents

The relation between demand of maritime transport and economic activity is dynamic and complex. This intertwined relationship is attributed to the fact that transport demand is a derived demand that involves numerous actors and factors in the decision process. Consequently that causes the complexity associated with modelling the movements of maritime freight traffic (Meersman and Van de Voorde, 2008, 2013) and (Chen et al., 2014). The research focuses on modelling the container flow to the ports, with application to the Port of Antwerp. First, a univariate analysis is followed based on the methodology of Box, Jenkins, and Reinsel (1976) as shown in Figure 1. The advantage of the univariate procedure is that it offers a systematic approach to building, analysing, and forecasting the time series models. A seasonal autoregressive integrated moving average model (SARIMA) with a dummy variable was applied to the monthly total container throughput of Antwerp Port. It showed that a SARIMA(0, 1, 1)(0, 1, 1)12 model was best fit for the data and the forecasting of the container flows.

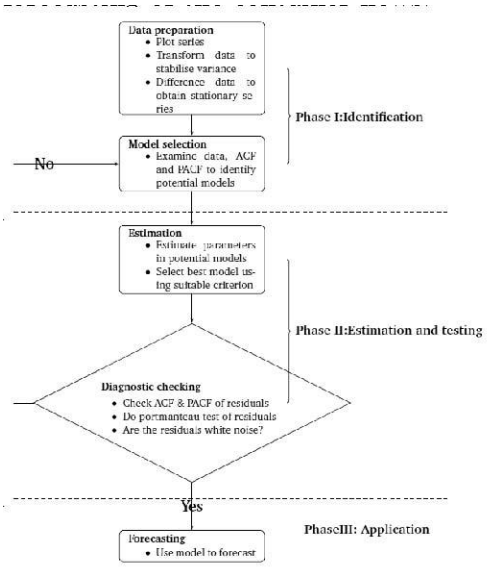


Figure 1The Box-Jenkins methodology for time series modelling. Source: (Makridakis, Wheelwright, and Hyndman, 1998) p.314.

Second, a bivariate model is used to identify the leading indicators for the container throughput

The 3rd Erasmus Smart Port Rotterdam/Port Research Centre Poster Session, Rotterdam, Oct. 2nd, 2014

CONTAINER DEMAND MODELLING AND FORECASTING

An Econometric Approach to the Port of Antwerp

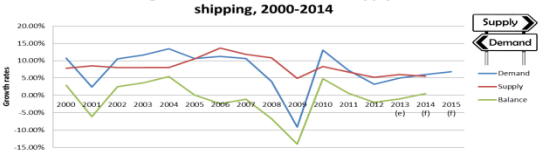
PhD candidate: Yasmine Rashed*

Promoters: Prof. Dr. Hilde Meersman and Prof. Dr. Thierry Vanelslander

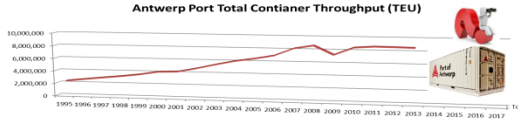
RATIONALE & APPLICATIONS

- Modelling maritime freight transport is complex and dynamic. It is characterised by numerous stakeholders, competitive environment, and interrelated relationship.
- Planning the port operations, hinterland activities, and investment decisions is primary based on the economic factors and volume of cargo handled, among others.
- The aim of the port authorities, investors, and port community is to meet supply with demand. On the one hand, undercapacity creates congestion and on the other hand, overcapacity represents losses in investments.

Global Annual growth rates of demand and supply in container shipping, 2000-2014

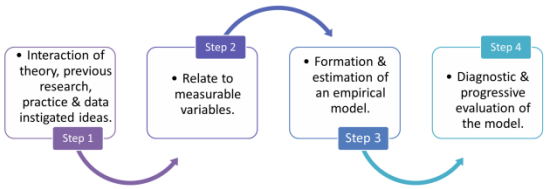


Antwerp Port Total Contianer Throughput (TEU)



METHODOLOGY

It is assumed from the theory of transport economics that container throughput oscillates with general economic activity, among others. Based on that the research question is: ***"How to model the relationship between the economic activity and the container throughput quantitatively?"*** then to employ this relationship in forecasting the container flow. The structure followed to build models is:



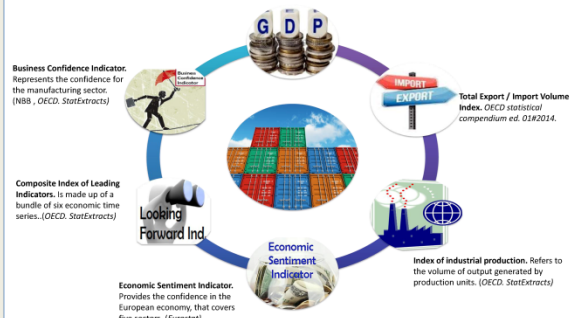
- A Univariate Analysis: It has the advantage of being independent of other variables and provide a systematic approach to building, analysing, and forecasting time series models. Based on the **Box and Jenkins methodology** to identify, estimate and test, and application of a **Seasonal Auto-regressive Integrated Moving Average** model: $\phi_p(B)\Phi_p(B^s)\Delta^d\Delta_s^D Y_t = \theta_q(B)\Theta_Q(B^s)a_t$
- To deal with the **nonstationary time series**, two groups of unit tests are applied ; (1) the traditional unit root tests (Augmented Dickey-Fuller and KPSS), (2) Unit root tests with structural break (Phillips–Perron).
- A bivariate Analysis: The notion of **"Granger causality"** test in a VAR framework is applied to identify the leading economic indicators for container flows:

$$\begin{pmatrix} y_{1t} \\ y_{2t} \end{pmatrix} = \sum_{i=1}^{p} \begin{bmatrix} \alpha_{11,i} & \alpha_{12,i} \\ \alpha_{21,i} & \alpha_{22,i} \end{bmatrix} \begin{pmatrix} y_{1t-1} \\ y_{2t-2} \end{pmatrix} + \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{pmatrix}$$

- Cointegration and error correction mechanism. Based on Engle and Granger approach, cointegration is a necessary Condition for the ECM model to hold. $\Delta y_t = \beta_1 \Delta x_t + \alpha(y_{t-1} - \beta x_{t-1}) + \varepsilon_t$
- This approach incorporates both the **long-run** relationship between variables and the **short-run** disequilibrium behaviour of time series. It also provides tools such the impulse response function that estimate the response of the system to **an external change.**

DATA

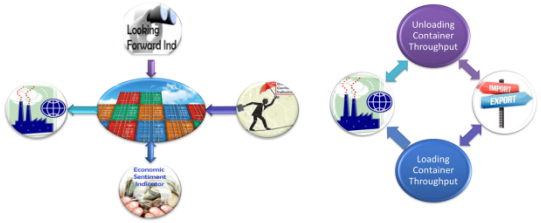
Monthly time series data of Belgium and the Port of Antwerp container throughput measured in TEU from Jan. 1995 – Jun 2014, as follows:



EMPIRICAL FINDINGS

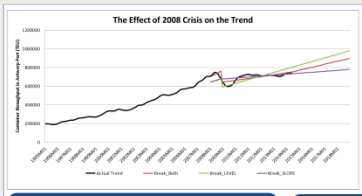
Assuming all other factors remain unchanged, the **SARIMA(0,1,1)(0,1,1)$_{12}$** model shows a y-o-y container throughput growth rate of 3.3% in 2014 and 1.3% in 2015.

Causality Relationship



→: the direction of the causality, i.e. changes in X precede changes in Y.
↔ : two way causality with very short time lag in-between or instantaneously occurring.

WORK IN PROGRESS



The sharp decline the container flows caused by the crisis has an effect on the evolution of the trend. It might be a change in level only, change in slope only, or both. The unit root test with structural break preliminary results did not accept the null hypothesis of trend-stationary. That might be attributed to the small sample size after the break point.

Cointegration & error correction mechanism

- Utilizing the results of the causality relationship between the economic and container flows, to measure the short and long run dynamics and the response of the dependet variable to a variable-specific shock.

Scenario based approach

- Incorporates scenarios for the economic indicators, port developments within the Hamburg Le-Havre range, and other indicators that reflect the growth of activity in the hinterland.

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The research is financially supported by BNP Paribas Fortis chair on transport, logistics and ports.

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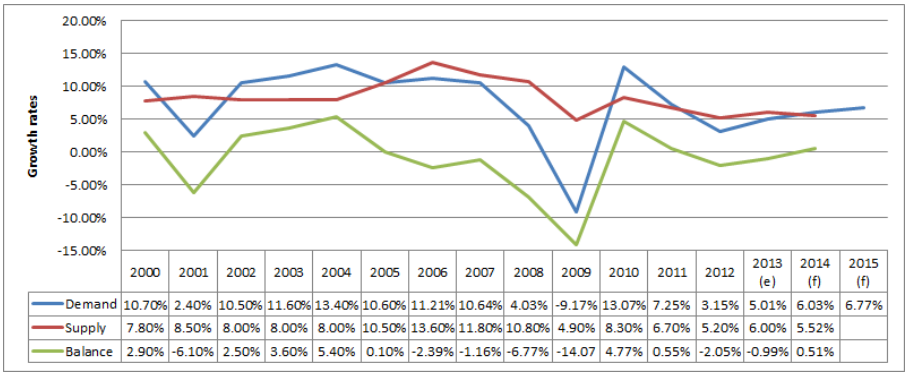
, using a selected number of monthly economic indicators. The approach applied is based on the Granger's notion of causality between two variables. An empirical model was conducted in the Vector autoregressive (VAR) framework using nonstationary time series (Lutkepohl, 1991, 2009), the test conduct is based on the methodology in Toda and Yamamoto (1995) Third, models based on cointegration and the error correction mechanism (work in progress) are used, where the leading indicators are used to overcome the problem of projections for the independent variables. This approach combines both the short and long-run dynamics, which enables to estimate the elasticities for the short and long-run relationships, and provides tools to estimate the response of the system to a variable-specific shock. The challenge is to incorporate the breaks in the unit root tests Engle and Granger (1987, chap. 2) and Perron (1989).

Possible applications of the research

The research contributes to the following policy issues: (1) Is the relation between container demand and economic activity stable over the long-run? and (2) How does the demand of container throughput adjust to shocks? The direction and stability of the relationship between container throughput and economic activity have crucial importance in the operational and investment in the port sector. Port demand modelling and forecasting enable the port authority, shipping companies, and terminal operators to make future financial and organisational planning. Moreover, forecasts provide the port policy decision makers with a tool to foresee the port existing and potential capacity utilisation, hinterland connections and logistics activities that may require investments.



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013 (e)	2014 (f)	2015 (f)
Demand	10.70%	2.40%	10.50%	11.60%	13.40%	10.60%	11.21%	10.64%	4.03%	-9.17%	13.07%	7.25%	3.15%	5.01%	6.03%	6.77%
Supply	7.80%	8.50%	8.00%	8.00%	8.00%	10.50%	13.60%	11.80%	10.80%	4.90%	8.30%	6.70%	5.20%	6.00%	5.52%	
Balance	2.90%	-6.10%	2.50%	3.60%	5.40%	0.10%	-2.39%	-1.16%	-6.77%	-14.07	4.77%	0.55%	-2.05%	-0.99%	0.51%	

Figure 2 Global Annual growth rates of demand and supply in container shipping, 2000-2014.
Source: Review of Maritime Transport 2013, UNCTAD, p. 68 and Clarkson Container Intelligenence Monthly, Aug 14.
Note: Demand growth is based on million TEU lifts. Supply data refer to total container-carrying fleet capacity, including multi-purpose and other vessels with some container capacity.

Acknowledgements

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Intermodal transport: The delta in the Delta

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Tom is a senior management consultant specialized in strategic and financial advice to the ports & logistic sector. Tom has more than 15 years of expertise working in a dedicated team of port consultants at PricewaterhouseCoopers. He has conducted various studies for public and private parties in the field of port economics, strategic planning and corporate finance. He has worked on assignments in Europe, North America, Middle East, Caribbean, China and India.

As a voluntary research fellow at the Vrije Universiteit Brussel, Tom is engaged in a research project investigating container shipping supply chains, which forms the research topic of his doctoral dissertation. Working as a management consultant in port economics, Tom had the opportunity to collaborate with many practitioners alongside the container supply chain. His dissertation aims at conveying valuable insights from practice to academic researchers opening up valid avenues for future research

Cathy Macharis

Cathy Macharis is Professor at the Vrije Universiteit Brussel. She teaches courses in operations and logistics management, as well as in transport and sustainable mobility. Her research group MOSI-Transport and logistics focuses on establishing linkages between advanced operations research methodologies and impact assessment. She has been involved in several national and European research projects dealing with topics such as the location of intermodal terminals, assessment of policy measures in the field of logistics and sustainable mobility, electric and hybrid vehicles, etc. She is the chairwoman of Brussels Mobility Commission.

Research summary

The swift exchange of the container between different transport modes has set the focus among researchers in intermodal transport to move freight from the dominating road transports to a combination lead by alternative transport modes being barge, rail or even short-sea. Growing concerns about People and Planet foster the need for such a modal shift. Contrary to these classic analyses addressing opportunities for modal shift, my research emphasizes the competition between end-to-end container transport chains. Embracing a 'global perspective', the research is not limited to the intermodal transport systems responsible for the exchange of containers between the hinterland and the port, but also accounts for the supplementary ocean transport systems which consolidate their volumes in the maritime load centres by employing container ships which continue growing in size.

The research specifically concentrates on the Rhine-Scheldt Delta, handling the bulk of Europe's maritime containers through its main ports of Antwerp and Rotterdam which are engaged in a competitive battle. In the Delta, the shipper can choose between (at least) two solutions which do basically exactly the same: bring the container from origin to destination, but use different logistic pathways routing the container over Rotterdam or Antwerp. As the overall system and each of its sub-systems is only as strong as the weakest link, I have postulated the following research questions addressing the perspectives of the two main actors in the container supply chain:

Tom Vermeiren

Intermodal transport
The delta in the Delta

Following the praxis of competing door-to-door chains, the inland transportation systems are to be analysed as part of a global container supply chain system carrying the goods from origin to final destination.

Research focus lies on the traditional intermodal inland transportation concept aimed at serving medium (+300 km) and long distance (+600 km) ranges **where the cost advantages of combined transport can be reaped in absence of cost competition from truck.**

In the Delta, the shipper can choose (at least) out of two solutions which do basically exactly the same.
As the overall system and each of its sub-systems is only as strong as the weakest link, **we can postulate the following research questions:**

Liner perspective (port-to-port)

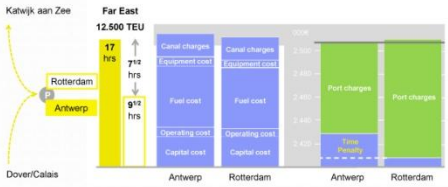
1. *To which extent act Antwerp and Rotterdam as differentiated alternatives to the ocean carriers, being the directors of the maritime transport chains?*
2. *How important is the maritime transportation system in the competition between end-to-end chains composed through alternative main gateways in the Delta, Antwerp or Rotterdam? Can it possibly alter the competitive attractiveness of the total chain?*

Shipper perspective (door-to-door)

3. *To which extent defines the combined inland transport system the strength of the total container supply chain system?*
4. *How can the intermodal land transportation system effectively strengthen the total chain?*

Can the routing of the container be altered by offering superior transport service characteristics, cost and quality?, specifically:
What are the main demand-side variables underpinning the choices of shippers between similar intermodal chains through alternative gateways serving medium and long-distance ranges in the shared hinterland of the Rhine-Scheldt Delta ports?

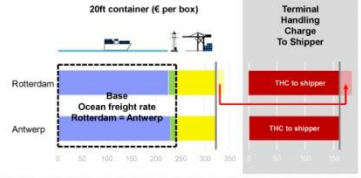
Liner perspective (port-to-port)



The** time penalty **to traverse the River Scheldt (IN + OUT) can be empirically derived from AIS vessel data.

Voyage costing analysis proves that the increased vessel related costs caused by the** time penalty is off-set when adding the more favourable port charges for Antwerp **to the ship costs.

The equal total ship costs is reflected in the** market's base ocean freight rates **charged to the shippers which are set** equal for Antwerp and Rotterdam **by the shipping lines.



The** terminal operators **strongly control the actual cost difference through their pricing policies** setting the handling rates to the liners, **as well as through their terminal performance which is influenced by berth availability (or waiting time), crane density/productivity, or non-productive time when the vessel is at berth.

***The handling rates, being commercial secrets, have been always** higher in Rotterdam.*

The difference in THC's (charged by the line to the shipper) strongly reflects the handling cost difference (charged by the terminal operator to the line).
***As a result,** no significant difference in the profit level of the maritime chain can be attributed to one of the ports.*

Given that the cost difference in the liner's handling rates is virtually passed to the customers,** Antwerp and Rotterdam act as direct substitutes, **under the premise of equal call sizes or volumes.

Ports able to capture** more volumes **in the hinterland can** leverage the voyage economics **of the liners, making them the preferred port of call. They do not only** reduce costs but also add more revenues, **and significantly increase the liners profit and cost competitiveness. Subsequently, the effect of differentiating hinterland transport systems adding more volumes will be amplified through the enhanced liner economics on the sea-leg.

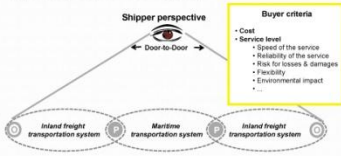
In absence of remarkable differences in cost, profit or quality, the** ship is likely to follow the volume **if it can freely choose between the 2 alternative load centres. A door-to-door assessment of the alternative chains following the reasoning of the shippers can point to a potential advantage inducing market demand. As differences in volume potential directly translate in the cost economics of the shipping line, the door-to-door view becomes at the direct interest of the ocean carriers.

Maritime transport systems have reached their optimum and do not define the competition between the end-to-end chains in the Delta. The findings imply that the land-leg is well positioned to influence the choice between alternative maritime channels to ship containerised cargo flows.

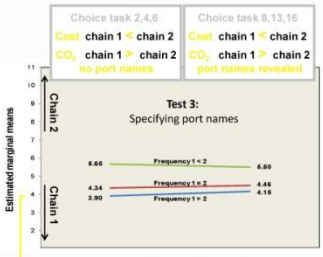
Shipper perspective (door-to-door)

The performance of the inland transport systems on the** shipper's buyer criteria **drives the differences between the door-to-door transport chains.

The** mutual performance is greatly reduced **when considering two chains using the same mode, but set up through alternative main gateways.



Functional** choice based experiment **including 16 choice tasks (derived from real case studies) designed to test five specific demand sensitivities of shippers in the Delta when needing to choose between two alternative routing or port options using a similar composition of inland transportation modes.



Test 1:
Small cost differences against minor CO_2 savings

- **Small total cost differences of resp. only 20 EURO or 40 EURO per box determine the allocation of shipments.**
- **Shippers do not put all their eggs in 1 basket.**

Test 2:
Enhanced frequency levels

- **Enhancing the frequency level only helps the more costly chain.**
- **Cost remains the driving decision factor.**

Test 3:
Specifying port names

- **Shippers did not change their choices when port names were disclosed.**
- **The port system does not play, even not for a 20-40 EURO premium.**

Test 4:
Impact of trade flow direction

- **Choices do not alter with trade flow direction.**
- **Other situational variables, such as maritime trade-lane, do not affect choice behaviour.**

Test 5:
Impact of mode label

- **Some respondents favouring the lowest cost rail option through Rotterdam switched their preference to Antwerp being the more costly chain when the label truck is applied.**

Theorem of the delta in the Delta

1. The **chain** is only as strong as its weakest link.
2. The 2 **main port systems** are non-differentiating.
3. **Ship** will follow the volume potential.
4. **Shippers** do not care if their cargo is shipped through Antwerp or Rotterdam.

*Intermodal **barge and rail systems**, not just for "green", but they are the fishing rods to catch more hinterland volumes, which are the bait to attract the 'big' ocean carriers.*

... from theory to practice ...

To practitioners & policy makers

The capital expensive Maasvlakte 2 is only as strong as the weakest link in the door-to-door container supply chain.
There appears to be no preference by the shippers for one of the main port systems in the Delta, where the difference or "delta" of the global container supply chains which run through Europe's largest container port system is strongly made up by the hinterland transportation systems as maritime transport systems have reached their 'optimum' point of scale and hardly vary between the two main load centres.

The research findings reiterate the differentiating role which intermodal inland shipping can play in Europe's largest concentration of intercontinental container flows. Intermodal transport is still at its infancy in Europe and offers the greatest potential to shape our economies. Instead of People and Planet, Profit may rather drive the growth of intermodal transport.

To researchers

Future research should follow the praxis of door-to-door chains instead of focussing on one of the transport chain components: maritime transport, port or land transportation.

Choice Based Experiments are a powerful tool to investigate transport demand. Broader choice based surveys are needed helping practitioners and policy makers to understand what works and what doesn't. Future CBE's should consider:

- ***Short distance range***
- ***Multiple mode options***
- ***Multiple port options***
- ***Multiple actors, buyer groups***

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Consult the presentation of Intermodal transport: the delta in the Delta at Youtube:

Part 1: https://www.youtube.com/watch?v=zVRGdJKIDXM
Part 2: https://www.youtube.com/watch?v=Jqs5TbrJtYU
Part 3: https://www.youtube.com/watch?v=D3r-IIkZpiA

Liner perspective:

1. To which extent act Antwerp and Rotterdam as differentiated alternatives to the ocean carriers, being the directors of the maritime transport chains?

2. How important is the maritime transportation system in the competition between end-to-end chains composed through alternative main gateways in the Delta, Antwerp or Rotterdam? Can it possibly alter the competitive attractiveness of the total chain?

Shipper perspective:

3. To which extent defines the intermodal inland transport system the strength of the total container supply chain system?

4. How can the intermodal land transportation system effectively strengthen the total chain? Can the routing of the container be altered by offering superior transport service characteristics, cost and quality?, specifically: What are the main demand-side variables underpinning the choices of shippers between similar intermodal chains through alternative gateways serving medium and long-distance ranges in the shared hinterland of the Rhine-Scheldt Delta ports?

By building on the findings from a number of hands-on empirical analyses, the PhD postulates the theorem of the delta in the Delta:

1. First, the starting point is that we need to consider the entire chain, including land transportation systems, maritime transportation systems and ports. The system is only as strong as its weakest link. Would any gear fail, the total system fails.

2. Second, looking at the ocean transport systems connecting port with port, we find that they are not differentiating as they produce the same profit to the line. This conclusion is reached under the important assumption that both ports offer the same volume potential, resulting into that call sizes and vessel load factors are the same.

3. If one of the ports can offer a larger volume potential, it will attract more liner services as the shipping lines can leverage their profitability. Liners therefore will tend to follow the volumes when deciding on the port of call in the Delta. So, the volume potential drives ocean carriers in port selection. On top, the improved efficiency of the bigger container ships makes that the cost to traverse the River Scheldt diminishes.

4. Taking than the perspective of the shippers, we interestingly find that shippers do not care at all if their cargo is shipped through Antwerp or Rotterdam. The routing of their containers is simply driven by cost considerations, while accounting for the service level constraints of their supply chain model.

So what is now the role of intermodal land transportation? Well, intermodal barge and rail systems connecting the hinterland with the main ports in the Delta, are there not just to make our environment more “green”, but they can be used as the fishing rods to attract more hinterland volumes, which are on their turn the bait to catch the ‘big’ ocean carriers. Intermodal transport solutions can make the difference in competing door-to-door chains. They are the delta in the Delta!

Applications: … from theory to practice…

As container volumes can easily switch between ports, the future of our container ports, engines of the national regional economies, is highly uncertain and volatile. Multi-modal transport chains connecting the main ports with the shared hinterland prove to be the single key differentiators in the competitive battle between the main ports. In particular, the scale-driven intermodal systems bear the potential to (re-)distribute volumes between the competing ports which are embedded in substituting end-to-end chains. Although billions of Euro's have been tied up in the development of more efficient and larger container vessels and the development of large scale deep-sea ports, intermodal transport has not yet reached its full potential on the land-leg which concentrates Europe's largest production and consumption centres. The research findings reiterate the differentiating role which intermodal inland shipping can play in Europe's largest concentration of intercontinental container flows. The economic value of intermodal land transport systems therefore supersedes its claimed environmental and social importance.

The research is therefore a wake-up call to all stakeholders: port developers and operators, logistics service providers, private investors, as well as public authorities which tend addressing intermodal transport primarily for its green and social merits. The theorem of the delta in the Delta proves that the capital expensive Maasvlakte 2 will be only as strong as the weakest link in the entire door-to-door chain. The investments in port infrastructure can only be fruitful if adequate investments are made in hinterland transport infrastructure efficiently connecting the port.

In particular, there appears to be no preference by the shippers for one of the main port systems in the Delta, where the difference or "delta" of the global container supply chains which run through Europe's largest container port system is strongly made up by the hinterland transportation systems contrary to maritime transport systems which have reached their 'optimum' point of scale and hardly vary between the two main load centres.

Future research should consistently embrace the praxis of door-to-door chains, instead of the tradition of focussing on one of the transport chain components only structured by research domain: maritime transport, port or land transportation.

Focussed Choice Based Experiments are valuable tools to investigate in a modern and efficient way the dynamics of transport demand. The CBE in my PhD. is to my knowledge the first CBE investigating transport demand in the Delta. The CBE is intended as a pilot study. Broader Choice Based Experiments are needed helping practitioners and policy makers to understand what works and what doesn't. Future CBE's should therefore consider:

- Short distance range
- Multiple mode options
- Multiple port options
- Multiple actors, buyer groups

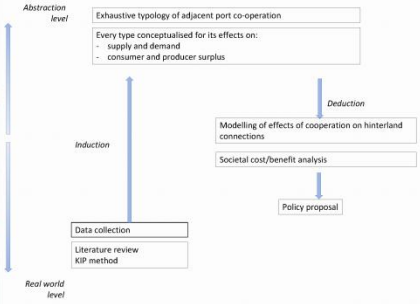
Instead of qualitative surveys, the CBE's are of a quantitative nature allowing obtaining robust results. The outcome of focussed CBE's form a valuable input for the development of effective commercial strategies and public policies.

Contrary to large scale choice based experiments aimed at modelling transport demand, the applied ANOVA repeated measures technique allows already obtaining valid practical results with a relative small sample size. The clear-cut approach structures the analysis in function of a number of practical research questions or tests making the approach understandable to a wide audience. A CBE is therefore a promising tool also for practitioners in the field.

The 3rd Erasmus Smart Port Rotterdam/Port Research Centre Poster Session, Rotterdam, June 30, 2014

PhD research by Joost Hintjens
Promoters: Prof. Dr. Thierry Vanelslander and Prof. Dr. Eddy Van de Voorde

Hinterland co-operation between seaport authorities and effects on consumer surplus

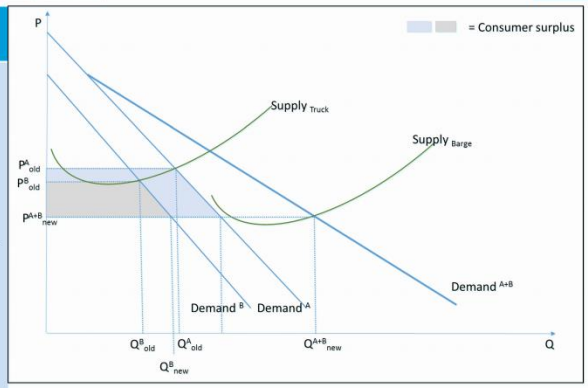


Take a post-it and add your suggestions

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 PlantijnUniversity College. He started his PhD research at the end of 2012 with the co-operation between adjacent seaport authorities as subject.

Drivers

- Ports from nodes to links
- Increased scale of maritime shipping
- Increased containerisation
- Increased concentration of market players
- Increased contested hinterland
- Increased congestion
- Eastward shift of the European Economic Gravity Center
- Reduction of GHG



Hypothesis

By co-operating, port authorities can facilitate the supply of hinterland services on destinations where a port alone cannot reach the necessary scale. This increases the consumer surplus and the regional welfare

Demand side effects

By cooperating, the PA's can make the cluster of ports more attractive thus moving the demand curve to the right and/or upward. By combining the market of two ports, the sum of available cargo might entice shipping lines to divert bigger or more vessels to the combined port. This would then bring more hinterland cargo to the port because more shipping opportunities would be available. This could start a growth process which would expand the hinterland of the combining ports.

Supply side effects

For smaller ports or for further lying destinations and origins the volumes might not be large enough to make bundling a possibility thus actually marking the border of the hinterland for this port. By cooperating, PAs can facilitate the combining of flows thus arriving at larger volumes and enabling bundling. This reduces the total and the generalised cost of transport thus moving the supply curve to the right while at the same time making the supply chain on which the ports are situated more competitive.

Question

Quid the producer surplus and external benefits?

Please take a post-it and add your suggestions

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SMARTPORT

Joost Hintjens
I learn more by listening than by talking
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Hinterland co-operation between seaport authorities and effects on consumer surplus.

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Supervisors : Prof. Dr. Thierry Vanelslander, Prof. Dr. Eddy Van de Voorde

1. Introduction

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 (PA) are concerned: shipping lines, shippers, stevedores; they fear that co-operation will diminish competition and thus reduce service levels and increase prices. Policy makers as well as 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. One of the more likely co-operation projects is the co-development of hinterland connections. Port authorities can facilitate the creation and development of services by logistic service suppliers that will result in a modal shift and an extension of the hinterland thus increasing the attractiveness of the port area also by reducing the cost for the users.

2. Objective

The objective of the research is to define whether co-operation between adjacent seaport authorities in the development of hinterland connections brings a net positive contribution to society. It aims to build a model that can quantify the shift of the demand curve that would result

from this co-operation and the effects on the supply curve this increased demand will have. This will result in a quantified effect on the consumer surplus.

3. 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.

Application in practice for the strategy of port authorities

Two 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 hinterland connection 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.

By cooperating PAs can facilitate the combining of flows thus arriving at larger volumes and enabling bundling. This increased efficiency reduces the total and the generalised cost of transport thus moving the supply curve to the right while at the same time making the supply chain on which the ports are situated more competitive. This increased competitiveness will also have a positive effect in demand and push the demand curve to the right too. PAs can facilitate or even organise the final mile of railroad or barge transport in their ports and by combining the final mile part of two adjacent ports the increased handled volume will lead to an economy of scale inside the port part of the railroad or barge while at the same time bringing together larger volumes of freight which enables more long distance train or barge connections to be economically viable.

Eventually these bundled streams of train and inland shipping need to be handled somewhere closer to their final destination. These inland ports, be they dry or wet, need minimum volumes to be economically viable. Cooperation between PAs can facilitate the bundling of streams to inland ports thus creating sufficient volumes to facilitate additional and further lying inland ports. In the case of existing inland ports, cooperation can create economies of scale and make more use of what are largely fixed costs in infrastructure. The expansion of the use of an existing inland port through cooperation will result in a more efficient use and the resulting economies, if transferred to the user, will move the supply curve to the right. If a new inland port is created where without cooperation there would not have been enough volume to make this possible, then the result will be an increased attractiveness of the concerned ports through an expansion of the market and the hinterland, this will move the demand curve to the right while at the same time the bundling will allow expensive road transport to be replaced by cheaper (for internal as well as external costs) rail or barge transport. The supply curve will move to the right due to the lower cost which will result in a lower price and a higher volume.

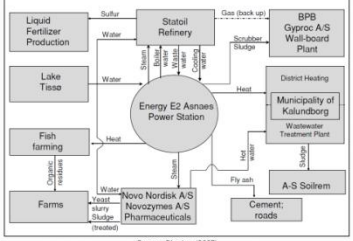
Curriculum vitae

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.

The 3rd Erasmus Smart Port Rotterdam/Port Research Centre Poster Session, Rotterdam, October 2nd, 2014

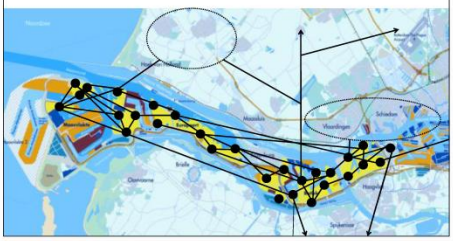
STRATEGIC LEVERS OF PORT AUTHORITIES FOR INDUSTRIAL ECOSYSTEM DEVELOPMENT: *Connecting theory & practice*

KALUNDBORG (Denmark)

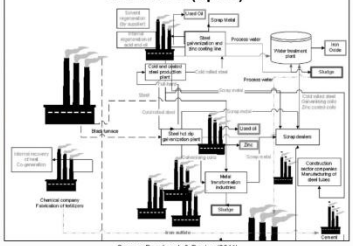


Source: Chertow (2007)

PORT OF ROTTERDAM (Netherlands) ???



SAGUNTO (Spain)



Source: Doménech & Davies (2011)

Major ports such as Rotterdam, Antwerp, Houston and Singapore's Jurong Port host large industrial complexes of (petro)chemical and other energy-intensive industrial firms. Port authorities face the challenge to contribute to both greater international competitiveness *and* better environmental performance of these complexes. The development of industrial ecosystems, in which firms located in port areas use one another's residual energy and chemical effluents as input for their own production process, appears to be a promising strategic response to this challenge.

How can port authorities foster the development of industrial ecosystems within their port-industrial complex?

THEORETICAL RESEARCH

- Since the 1987 release of the United Nations Brundtland Report on the importance of sustainable development (WCED, 1987), the associated required change from linear to more closed-loop systems of production and consumption has gained increased scholarly attention. This spawned the emergence of research on industrial ecology, the main unit of analysis being the industrial ecosystem.
- Industrial ecosystems are typically characterized by continuous resource transactions between the firms involved, due to which the proper functioning of their production processes is fundamentally interdependent (Ehrenfeld & Gertler 1997).
- Notwithstanding the opportunities for both greater international competitiveness and better environmental performance inherent in getting involved in industrial ecosystems (Esty & Porter, 1998), firms tend to be reluctant or unable to do so (e.g. Baas & Huisingh, 2008). Therefore, scholars have elaborated on the role of local or regional authorities in general in fostering the development of industrial ecosystems (e.g. Costa & Ferrão, 2010; Deutz & Gibbs, 2004; Mirata, 2004).
- Important strategic goals of many port authorities include the improvement of both the competitiveness of the firms located in their port area and the overall sustainability – which includes environmental performance – of the port-related activities of these firms (OECD, 2013; Van Den Bosch *et al*, 2011; Van Der Lugt *et al*, 2013; Verhoeven, 2010). Yet, up till now, the literature lacks an explicit focus on the role of port authorities in fostering industrial ecosystem development in the port area in order to achieve these strategic goals (Hollen *et al*, 2013).
- Focus on port authorities operating with the (extended) landlord port model. In large/medium-sized ports, the landlord port model seems to be the dominant port governance model (World Bank, 2007). In this model, the port authority is mainly responsible for the economic exploitation, long-term development and infrastructural maintenance of the port area (Brooks, 2004). Most landlord port authorities have at least two types of policy instruments at their disposal for realizing their goals: (1) investments in infrastructure and (2) land allocation (Baird, 2000).

FOSTERING THE DEVELOPMENT OF INDUSTRIAL ECOSYSTEMS BY PORT AUTHORITIES IN PRACTICE:

Strategic investment policy levers

- Physical infrastructure

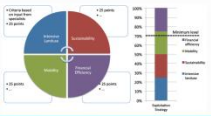
- Investing, through public-private partnerships, in the construction of common carrier pipeline bundles.
- Investing, through public-private partnerships, in the realization of 'plug & play areas' where bundled utility services are readily available for industrial firms that establish themselves in these areas.

- Knowledge infrastructure

- Co-creating and investing in linkages with universities and other knowledge/research institutes in the proximity of the port through both knowledge-based involvement and financial support.
- Co-creating and investing in platforms for knowledge and information sharing and collaboration between established firms in the port concerning industrial ecology-related initiatives.

Strategic land allocation policy levers

- Actively stimulating co-siting of industrial firms that can use each other's residual energy/chemical effluents.
- Introducing more stringent environmental sustainability criteria for land lease contracts with respect to both new lease contracts and contract extensions.



Implications and challenges for port authorities:

- Investing in common carrier pipeline infrastructure, co-created with external parties through PPP's, seems to be one of the most suitable strategic levers for port authorities to foster the formation of industrial ecosystems. Firms in ports tend to be unwilling to finance these investments only by themselves because of the high costs and/or the uncertainties involved.
- To stimulate the *post*-formation stage, investments in knowledge infrastructure are most suitable. In this way, port authorities can act as a 'knowledge broker' or 'knowledge bank' (cf. Von Malmborg, 2004) for firms to tap into → Need to recognize, through advanced account management, the difficulties these firms experience in becoming more strategically interconnected.
- Need for port authorities to strategize beyond their traditional landlord function (i.e., need for business model innovation): Towards an extended (and more entrepreneurial) landlord model.
- How can, in a context of competing ports (e.g. Rotterdam/Antwerp), new ways of collaboration between port authorities contribute to industrial ecosystem development on *inter-port level?*

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Rick M.A. Hollen, Erasmus University Rotterdam, Rotterdam School of Management

Strategic levers of port authorities for the development of industrial ecosystems: Connecting theory and practice

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Supervisors: Prof.dr. Frans A.J. Van Den Bosch & Prof.dr. Henk W. Volberda

Curriculum Vitae

Rick M.A. Hollen is a third-year PhD Candidate at the Department of Strategic Management and Entrepreneurship of the Rotterdam School of Management, Erasmus University. Prior to this 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 semester exchange programs at Copenhagen Business School in Denmark (2005), HEC Montréal in Canada (2007) and Pontificia Universidad Católica in Chile (2008), and conducted market research in India (2008) and Vietnam (2009). In between his Master's and PhD trajectory, he was team leader for the Dutch partner institute of the World Economic Forum and, for almost two years, Project Manager Business Development for a global technology and services company. His PhD research – which is funded by the Port of Rotterdam Authority and supervised by Prof. Dr. F.A.J. Van Den Bosch and Prof. Dr. Henk W. Volberda – focuses predominantly on managerial and (inter)organizational factors that increase the innovation-driven and sustainable international competitiveness of port-related firms, networks and ports in general, and on how port authorities can contribute to this challenge. Key topics in his research include management innovation (as part of social innovation), strategic value creation and business model innovation of port authorities, institutional entrepreneurship, logistics and industrial ecosystems, meta-organizations and port participation strategies. Some of his papers have been published or accepted for publication in international scientific journals (European Management Review, 2013; Maritime Economics & Logistics, 2015) and book chapters (e.g. in T.K. Das, 'Behavioral Strategy: Emerging Perspectives', 2014) while other papers have been presented at international conferences like the Strategic Management Society (SMS) Special Conference in Lausanne/Geneva (Switzerland, 2013) and Tel Aviv (Israel, 2014), the Academy of Management Annual Meeting in Orlando (Florida, USA, 2013), and the SMS Annual International Conference in Atlanta (Georgia, USA, 2013). He was selected to participate in the Emerging Scholars Workshop on 'Evolutionary Perspectives on Strategic Management' at the renowned Wharton School of the University of Pennsylvania (USA, 2013). Also, he co-organized Tracks/Subtracks on port competitiveness as part of the European Academy of Management (EURAM) Conferences in Rotterdam (2012), Istanbul (2013) and Valencia (2014). Furthermore, he has been involved in lecturing and, since 2012, MScBA Strategic Management Thesis supervision.

Contents of the presented PhD research

The co-authored research report 'The strategic value of the Port of Rotterdam for the international competitiveness of the Netherlands: A first exploration' (Van Den Bosch et al., 2011) 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. One of these topics is strategic

connectivity, which can be seen as an important instrument to contribute to the dual challenge of port authorities to improve both the international competitive advantage of their port (or port-industrial complex) and the strategic value of the port for the region and country. By means of further theoretical support and empirical research through, inter alia, case studies, the PhD research aims to provide a deeper understanding of the antecedents, outcomes as well as (inter)organizational and managerial factors related to at least three levels of strategic connectivity. That is, strategic connectivity (i) within port-industrial complexes, (ii) between ports within the same country (e.g., the ports of Rotterdam and Amsterdam), and (iii) between ports in different countries (e.g., strategic connectivity of the Port of Rotterdam with Shanghai Port and the Port of Antwerp). The research presented during the 3rd Erasmus Smart Port/Port Research Centre Poster session at the RDM Campus relates to strategic connectivity within port-industrial complexes by addressing the importance and development of 'industrial ecosystems'.

Industrial ecosystems are networks of legally autonomous firms – usually physically interconnected by pipelines – that use one another's residual energy and chemical effluents as input for their own production process (Ehrenfeld & Gertler, 1997). At the network level, converting by-products into product streams for other firms results in the creation of added value, reductions in the total use of feedstock and energy, and less waste disposal and emissions (Mangan & Olivetti, 2010). In these ways, the development of industrial ecosystems can result in improvements in both the international competitiveness of (networks of) firms and their environmental performance (Esty and Porter, 1998). Previous research has examined industrial ecosystem development during the 1990's and early 2000's in the Port of Rotterdam (Baas and Huisingh, 2008; Heeres et al., 2004). These and other port-related studies, however, did not address the role of port authorities in fostering this development. Instead, they described the historical background of industrial eco-systems and the role of the constituent firms and external organizations like Deltalinqs, the representative organization of all the industrial and logistical firms in the Port of Rotterdam. Although one of the main goals of port authorities is to facilitate firms located in the port in a way that these firms "can contribute most to a competitive and sustainable development of the port" (Van Der Lugt *et al*, 2013: 111), most port authorities have largely ignored their key role in deliberately fostering industrial ecosystem development as a way of contributing to achievement of these goals. Also, this role has been underexplored in the port-related literature. The presented PhD research aims to fill this gap by examining the following question: In order to improve both competitiveness and environmental performance of port-industrial complexes, how can port authorities foster industrial ecosystem development in these complexes? In doing so, we address both the formation stage and post-formation stage of this development. In the latter stage, the physical exchanges pertaining to the first stage become complemented by sharing information/knowledge on operational and/or managerial processes, with a main focus on strategic renewal and innovation.

Applicability of the presented PhD research

Major ports such as Rotterdam, Antwerp, Houston and Singapore's Jurong Port host large industrial complexes that consist of multiple refineries, chemical firms, energy service providers and other types of process industry firms. Recent developments such as the shale gas revolution in the USA and the building of considerable new petrochemical capacity in the Gulf countries have led to a changing competitive landscape in which gains in resource productivity or energy efficiency are becoming increasingly important for firms in ports to maintain and improve their competitive

position. These gains are particularly important because they imply the creation of added value as well as cost reductions. Industrial firms in ports in developed countries where, for example, cheap shale gas is currently not exploited or even prohibited – as is the case in the Netherlands and several other European countries – face relatively high energy and feedstock costs. Cost reductions are important for these firms to survive and for not replacing their production to other regions in the world. Such relocation of production would imply not only loss of employment and value creation in the ports where these firms are located, but also lower demand in these ports for raw materials – resulting in less logistics streams to these ports – and a drop in demand for logistics services to the hinterland. Gains in resource productivity or energy efficiency are also important for ports such as the Port of Rotterdam that have taken up the increasingly crucial role of energy hubs. Furthermore, firms in environmentally sensitive industries such as energy and (petro)chemicals which are located nearby residential areas face an upsurge in both regulatory and socio-political pressures to reduce, reuse and recycle raw materials and residual streams, and to reduce pollution in general.

As mentioned earlier, theory indicates that the development of industrial ecosystems is a promising strategic response to the challenge of improving resource productivity, energy efficiency and, in turn, the international competitiveness and environmental performance of firms. However, firms in ports are often unable or reluctant to get involved in or further develop industrial ecosystems due to, for instance, the substantial investments that need to be made in pipeline infrastructure and complementary relation-specific assets to enable the flow of residual energy and/or other by-products from one production plant to another. Also, firms with limited experience in managing interdependent relationships may encounter difficulties to reap the potential benefits. The PhD research has empirically and conceptually identified how a set of generic policy instruments of port authorities – i.e. (i) investments in physical and knowledge infrastructure and (ii) land allocation – can be turned into strategic levers to contribute to (or facilitate) the development of industrial ecosystems and, in turn, to improve both the competitiveness and environmental performance of their port-industrial complex. This research encourages investments, through public-private partnerships, in the (further) construction of common carrier pipe bundles (illustrated by the Multicore initiative in the Port of Rotterdam) as well as the co-creation of 'plug and play areas' in the port, where bundled utility services are made readily available for firms that establish themselves in these areas. Besides investments in physical infrastructure, however, also certain adaptations to the land allocation policy and investments in knowledge infrastructure are encouraged. For instance, regarding the latter, the research emphasizes the need for port authorities to act more as a 'knowledge broker' and 'knowledge bank' (cf. Von Malmborg, 2004) for industrial ecology-type of initiatives. Also, it highlights the need for port authorities to recognize – e.g. through advanced account management – the difficulties which firms in the port-industrial complex experience with regard to going beyond the formation phase in industrial ecosystem development. Related qualitative research conducted in the Port of Rotterdam – part of the PhD trajectory – has led to increased understanding of some of these difficulties. Insights from the research can be used also to examine how industrial ecosystems on an inter-port level – involving, for instance, firms in the already physically interconnected (but competing) ports of Rotterdam and Antwerp – can be fostered by new ways of cooperation between the port authorities involved.

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Maurice Jansen MSc, Erasmus University Rotterdam, Rotterdam School of Management

Partnerships for port development: an approach to build inclusive port clusters

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Supervisor: Prof. R. Van Tulder

Curriculum vitae

In accordance to the instructions, I would like to briefly introduce myself and explain a bit of my background. I was born, raised, living, studying and working with the port of Rotterdam in my backyard. During my MSc study Business Administration at the Erasmus University Rotterdam, I decided to dedicate my career to the transport industry and worked for four years as a logistics consultant at KPMG Transportation & Distribution and subsequently for another four years at UTi Worldwide, a global supply chain management company.

From 2007 until mid-2012 I headed the Netherlands Maritime University of applied sciences, part of the education institute of STC-Group, a knowledge institute focused on education and training for the ports, shipping, transport and process industry. As the first head of Netherlands Maritime University of Applied Sciences (STC-NMU) I was responsible for curriculum development, recruitment and selection of team of lecturers as well as for the execution of the Master Shipping and Transport program at STC-Group's main campus in Rotterdam as well as at STC-Korea, a branch school of the STC-Group. To safeguard quality standards, my team established and maintained an ISO9001-2008 certified quality management system for the education programs under the STC-NMU. In 2012 I successfully led the Master Shipping and Transport program through the NVAO re-accreditation process. From 2008 until 2013, I was thesis coordinator for STC-NMU, setting up research guidelines, maintain standards for Master thesis and coordinate students' thesis projects. I supervised dozens of students from a wide variety of nationalities and backgrounds dealing with a wide range of issues relating to different ports and transport corridors.

I consider this PhD study the next stage of my personal development calendar, an enriching experience and an opportunity to continuously improve my learning abilities. As an educator, I believe the best way to bring knowledge to other people it to engage in the knowledge process myself. While shaping my research skills I am better able to understand the difficulties my students face while conducting their thesis projects or write their research papers.

My research fits well with a research program 'how do inclusive business models contribute to inclusive growth', recently approved by NWO. In support of my research, my promotor prof. dr. Rob van Tulder states that "one of the major problems of 'inclusive growth' in developing countries is the so-called infrastructure gap. This PhD research by Maurice Jansen is a good addition to the NOW research and gives a perfect opportunity to conduct strategic stakeholder analyses and sort out stakeholder dialogues in order to determine conditions between macro and micro level inclusive development".

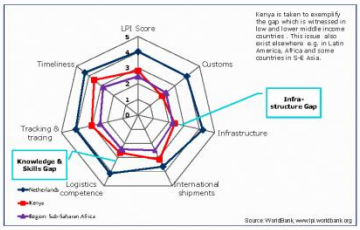
The 3rd Erasmus Smart Port Rotterdam/Port Research Centre Poster Session, Rotterdam, October 2, 2014

Partnerships for port development: an approach to build inclusive port clusters

PhD Researcher: Maurice Jansen; Promotor: Prof. Dr. Rob van Tulder

Maurice Jansen

The Issue



Kenya is taken to exemplify the gap which is witnessed in low and lower middle income countries. This issue also exist elsewhere, e.g. in Latin America, Africa and some countries in S-E Asia.

Impact of the issue

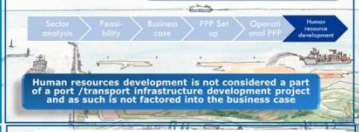
Negative externalities of port development

Business practice

Conventional approach to infrastructure development

Conventional approach to infrastructure development:

- Infrastructure development usually focuses on engineering physical infrastructure;
- Human resource infrastructure development is often sequential to physical infrastructure development
- As a result HRD is not capitalised in port development business case.



Human resources development is not considered a part of a port /transport infrastructure development project and as such is not factored into the business case

Research program

The Partnership Resource Centre (PrC) is built up as a flexible learning network. PrC is at the centre of a (virtual) network of professionals, academics and practitioners around the world that share and collect information on selecting appropriate partnerships and increasing their efficiency, impact and effectiveness.

Research scope

Public-private partnerships neglect inclusive development objectives

Silo approach leads to a continuing disconnect between infrastructure and knowledge gap

Research framework

Partnership monitoring & evaluation framework

Articulate conditions and success factors to improve inclusiveness of local partners and people in developing port cluster

Source: derived from Partnership Resource Centre

Problem Statement

Developing and transitioning countries face at least two gaps: an infrastructure gap and a knowledge gap. While developing infrastructure, the primary focus of port public-private partnerships is on developing physical port infrastructure, while neglecting investments in knowledge transfer mechanisms.

Research question

How can inclusive port public-private partnerships contribute to a more balanced way of port development in which local partners can capture the long-term value coming from knowledge and skills transfers between multinationals and local partners in port public-private partnerships?

Research goal

To contribute to the articulation of conditions, success factors for knowledge transfer within partnerships and the role of knowledge and research institutes as an enabler within developing port clusters to improve inclusiveness of local partners and people.

Related organisation

STC-Group is a non-profit foundation dedicated to educate and train students, professionals in the entire transport chain. Abroad, STC-Group is active in education, training and education infrastructure projects and participates in public-private partnerships.

STC-Group has training centres and JVs in Oman, Vietnam, Philippines, and South Africa and representative offices in Brazil and Colombia.

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Background to my PhD research

The issue: Finding the right balance in port development

From a purely economic perspective, ports and transport corridors are an enabler to trade, economic growth, employment and competitiveness. Ports play a crucial role for a country's economy and the competitiveness of traders and companies which participate in international markets.

Where ports and transport corridors are often associated with prosperity, employment and economic growth, and considered to be an enabler for trade, the negative externalities are often neglected. The lengthy planning and decision-making process of the Maasvlakte 2 project can be found in the precondition by the Dutch government to expand the port of Rotterdam in a sustainable way, i.e. growth while maintaining quality of the living environment for man and nature.

In countries such as The Netherlands governments have pushed through their priorities to port development projects in favour of or in contrary to different stakeholders involved. Central in the stakeholder approach is the level of engagement and the level of priority towards issues, which determines the dialogue to be implemented (Van Tulder, Van Tilburg, Francken, & Da Rosa, 2014), whether stakeholders are to approached inactively, re-actively, actively or pro-actively.

For most ports in developing countries, multinationals (MNC) are important foreign investors and therefore partner for development. as they have control over their global value chains (GVCs) the MNC connects producers and trading companies to international markets. (UNCTAD, 2014). Trade is increasingly driven through these global value chains: 80 % of global trade is coordinated by MNCs, and about 60 per cent of global trade consists of trade in intermediate goods and services (UNCTAD, 2014). Van Tulder (2010) raises concerns over the fairness within global value chains. As competitiveness between leading MNCs become more severe, suppliers run the risk of being trapped into these chains, increasing the dependency and limit their development possibilities.

Inclusive port development

In 2002 Prahalad and Hart (2002) introduced the bottom of the pyramid (BoP) concept, in which the authors called upon multinationals to look at globalisation strategies through the lens of inclusiveness. Prahalad and Hart challenge MNCs by stating that they can act as the provider of resources, leverage on their global knowledge base by sharing best practices, act as a catalyst to unite the range of actors required within the value chains, and transfer knowledge from top to bottom of the pyramid. UNCTAD (2013) addresses the development impact of GVC's in terms of local value capture, job creation, income generation and employment quality, technology dissemination and skills building, social and environmental impacts and upgrading and building long-term productive capabilities.

In port development literature, often the focus is on public-private partnerships – focussing on concessions, financing structures and revenue models - for the development of physical infrastructure. The involved parties claim to develop value for the local community through their business activities but how is knowledge shared, how are capabilities of local people developed and how is the local community empowered to develop new business activities themselves around the activities of the 'lead firms'?

The partnership for development framework, provides a sound theoretical basis to further investigate how port clusters are developing and to assess critical factors for success. Van Tulder (2008) brings forward the notion of partnerships which have become a central part of official development policy in a number of frontrunner countries, such as The Netherlands and Germany. He introduces a partnership monitoring and evaluation framework (appendix 1) in order to measure the efficiency, effectiveness, outcome and impact of development partnerships. There is not much agreement on assessing partnerships in the knowledge domain (Marra, 2004). The evaluation of the partnership design and implementation needs to take into account consideration of the institutional, financial, organisational and symbolic aspects related to the cooperative undertakings. Further study is required on the underlying causal mechanisms that link input, implementation and outcome.

Problem statement

The issue of inclusive public-private port partnerships is complex and has multiple levels. The macro level view of the issue consists of the global context and reflects how well the country's resources are used to be competitive and bring value added to the economy and society. The meso-level reflects factors on port cluster level, the level of engagement and interaction between stakeholders in dealing with development issues. The micro level involves factors that address internal company factors as enablers for knowledge exchange and development.

The primary focus of public-private port partnerships seems to be on developing the physical port infrastructure and port efficiency while the effectiveness of the partnership for the local stakeholders in the long run is not taken into consideration. As a consequence local actors in these ports are not included neither considered as equal partners and are thrown back into inactivity towards negative effects of port and transport corridor activities. MNCs with their global value chains have the knowledge, the infrastructure and the capabilities, they can act as the provider of resources, leverage on their global knowledge base by sharing best practices, act as a catalyst to unite the range of actors required within the value chains, and transfer knowledge. It is not clear which are the most effective mechanisms for MNCs to transfer knowledge and expertise and to what extent education and training partnerships can facilitate this process.

The leading research question is:
How can inclusive public-private port partnerships contribute to a more balanced way of port development in which local partners can capture the long term value coming from knowledge and skills transfer between multinationals and local partners?

This research aims to contribute to the articulation of conditions, success factors for knowledge transfer within partnerships and the role of knowledge and research institutes as an enabler within developing port clusters.

After a thorough literature review, a survey will be conducted to assess the intentions of port public-private partnerships, what is the perceived intention of the partners to solve the issues surrounding the port/transport area. Case study as the primary research methodology is chosen as a means to collect empirical data and allows for better comprehension of the complexity of the research objects in different local settings. Through case studies the transformation of inputs into activities and

outputs can be measured by reconstructing the collaboration between the partners over time. A bottom-up approach is adopted to local partners and to understand their perception on their participation, the level and quality of knowledge transferred and how they have influenced the implementation process.

Potential contribution to science and society

The Dutch government is a strong advocate of fair trade in the world. My research addresses the ambitions of research programmes set on a national level on sustainability and inclusiveness. In order to deal with the increasing complexity of the port in its context, knowledge and competences of the local stakeholders is a prerequisite to be able to cope with the challenges of sustainability and inclusiveness. Sustainability in my research is primarily set as sustaining knowledge, building inclusive supply chains, in a way that the local community understands the complexity and people are able to make the right trade-offs for the society, such as mitigating the negative externalities.

Inclusive development has not been adopted (yet) by MNCs around the world (Van Tulder, 2014). This research concentrates on the active (purposeful) strategies and effects of MNCs in their interaction with NGOs, governments and local stakeholders. The active effects he will investigate encompass the environmental, health and safety and employment practices of MNC's subsidiaries. My research fits in this research programme with a focus on multinationals active in a port and transport context.

Contribution of research to education practice at STC-Group

An important objective is to build knowledge on port development. Throughout my early life and into my career, I have had an interest in ports, and the interaction with its environment. The more I know, the more I am aware of the difficult issues that arise from the interaction of port activities with its environment. At my current employer STC-Group I can share knowledge with other people while they're studying or conducting their thesis project on a port related issue. The more this knowledge accumulates, the more I come to realize the necessity for an inclusive view on port development, taking into account the long term impact for the society. The research will allow for a better understanding how port clusters can sustain themselves as valuable nodes in global value chains.

The contributions of my research to education are the following:

- As knowledge accumulates in my research on port development, this new knowledge can be translated into education materials aimed to bring awareness to students on sustainable port and inclusive cluster development. Students form excellent ambassadors to carry home their knowledge and translate their expertise to a local context. These students from a variety of countries are encouraged to conduct research on the subject matter;
- Another contribution is expected to be related to the international activities of STC-Group. Abroad, STC-Group works together with both public and private partners, in relation to training and education activities. The evaluation of public-private partnerships as outlined in this research proposal will be useful to better prepare, manage and assess the collaboration with local partners. It will also shed light how knowledge networks work and are best utilized to cater for knowledge transfer.

The Megaproject Effect

The decision-making process of Maasvlakte II (1993-2008)

Dirk M. Koppenol MA

Research Problem

Maasvlakte II is a 2.3 billion euro port expansion of the Port of Rotterdam, the largest port in Europe. During the decision-making process, fierce conflicts arose. Not only, between the Port Management and the nature preservation and environment pressure groups, but also, between the local and the national governments. In 2008, despite these conflicts, the port expansion was executed with full support of all actors involved.

Main Question

Why did fierce resistance during the decision-making process of Maasvlakte II (1993-2008), change into full support for the project?

Theory

To explain one of the outcomes of my research, a combination of theory on megaprojects and entrepreneurship is used to show that a megaproject effect exists (a few persons rallied support). Moreover, theory on discourse coalition is used to show that the character of the resistance against Maasvlakte II is an important explanatory factor for the rise of full support.

Method

Comparative research: Maasvlakte II is compared to three earlier port expansions (1945-1970) and another Dutch megaproject, the Betuweroute (1990s).

Multi-actor approach: this research focusses on the local and national governments, the private sector and the nature preservation and environmental pressure groups.

Multi-disciplinary research: methods form history, economics and sociology are applied.

Preliminary Conclusions

1. Negative experiences with port expansions in the past delayed the decision-making process.
2. The character of the resistance against Maasvlakte II explains the rise of full support.
3. Eventually, only a few actors rallied the support for Maasvlakte II.

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Dirk M. Koppenol MA, Erasmus Universiteit Rotterdam (ESHCC)

The Megaproject Effect : the decision-making process of Maasvlakte II (1993-2009)

koppenol@eshcc.eur.nl

Supervisor: prof. dr. H.A.M. Klemann

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.

Research

Maasvlakte II is a 2.3 billion euro port expansion of the Port of Rotterdam, the largest port in Europe. During the decision-making process, fierce conflicts arose. Not only, between the Port Management and the nature preservation and environmental pressure groups, but also, between the local and the national governments. In 2008, despite these conflicts, the port expansion was executed with full support of all actors involved. That is why the main question arises: Why did fierce resistance during the decision-making process of Maasvlakte II (1993-2008) change into full support for the project?

Sources

As this research is the first inquiry into the whole decision-making process of Maasvlakte II, many new sources were used. In order to structure the research into these primary sources, key persons involved were interviewed, such as Ministers and their high-ranking officials as well as officials of the Municipality of Rotterdam, such as the Mayor, Alderman Port and the Director of the Municipal Port Management of Rotterdam. Moreover, also directors and employees of most nature preservation and environmental pressure groups were interviewed.

Method and theory

In this research I have divided 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 were important to generate support. Furthermore, a combination of theory on megaprojects and entrepreneurship is used to show that a megaproject effect exists (a few persons rallied support). Finally, theory on discourse coalition is used to show that the character of the resistance against Maasvlakte II is an important explanatory factor for the rise of full support.

Practical implications

In order to make a visionary plan**,** such as Maasvlakte II, acceptable to the national government, it has to be in line with the ruling national policy. Even during the decision-making process this can mean that the argumentation has to change. More practical, this means that visionary plans have to be flexible.

Using the term megaproject effect, the research shows that, especially, during large scale projects the number of influential persons is low. This underlines the conclusions of the 2004-2005 Parliamentary Inquiry, in which it was argued that during other megaproject in the 1990s the influence of Parliament was relatively low and the influence of certain ministers high. Alterations to the decision-making process of megaprojects can be made to counter the megaproject effect.

Yeshambel Melese, Delft University of Technology

Flexibility – for Smart Infrastructure Planning and Development Under Uncertainty Cases of Port Expansions and Carbon Capture and Storage Projects

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Personal Profile

Yeshambel Melese (MSc) is currently a PhD student at Delft University of Technology as part of the Erasmus Mundus Joint Doctoral Program, coordinated by University of Comillas in Spain, Delft University of Technology in the Netherlands, and Royal Institute of Technology in Sweden. His research focus on flexible design of large-scale energy and industrial infrastructures such as carbon capture and storage and power transmission expansion.

Dr. ir. Rob Stikkelman is researcher at the Delft University of Technology. He Completed his PhD on distillation subject, worked at Shell Pernis (1989/1991). He joined the Clean Technology Institute, from 1996 as managing director. In 1998, he was a founding father of the Port Research Centre, a successful collaboration between the Port of Rotterdam authority and the Delft University of Technology. In 2004, he started the Centre for Port Innovation. He is currently, Director of Center of Port Innovation/Port Research Centre, Delft University of Technology. In 2010, he did the preliminary work for the Next Generation Port Infra, Powered by Maasvlakte 2 program**.**

PhD research and relevance for PoR

The Port of Rotterdam and industrial complex around it provides a significant value for competitiveness of the Netherlands and the region. It is a massive infrastructure market in constant development. The PoR is expecting the port to grow from 430 mill. tones (2010) to anywhere between 475 and 750 mill. tones by 2030 or an implied CAGR of 0.5% to 2.8%. Rotterdam Port not only holds future potential for investors with interest in traditional port investments, there are many other opportunities to consider. As a result , there are various infrastructure developments (new and expansion) in an effort to keep the competitiveness of the port. This includes major energy and industrial infrastructures such as carbon capture and storage infrastructures and heat /cold exchanging pipeline networks, natural gas distribution networks and expansion of the port. However, decisions about large scale (infrastructure) projects have to be taken while future developments are uncertain. As these projects are implemented over several years, sometimes decades, there are many factors that can change in the meantime: technological advances, changing stakeholders, political shifts, and economic fluctuations. It is believed that in recent times these uncertainties have only increased, making decisions even more risky for private businesses and the port authority.

In port expansion as well as other large-scale projects uncertainty and flexibility are hardly taken into consideration. The traditional infrastructure projects planning and analysis methods are based on requirements that are unrealistically deterministic and does not systematically consider uncertainties. The common practice consists of three major phases. First, after relevant data is collected and analyzed , the most likely scenarios are identified, which include projections of major endogenous and exogenous drivers of the system. Then, according to those predictions, systems designers generate design concepts and select design parameters that enable the system to perform

The 3rd Erasmus Smart Port Rotterdam/Port Research Centre Poster Session, Rotterdam, 2nd Oct 2014

Flexibility – for Smart Infrastructure Planning and Development Under uncertainty

Cases of Port Expansion and Carbon Capture & Storage Projects

Y.G.Melese & Dr.ir.Rob Stikkelman

Introduction

The Port of Rotterdam and the industrial complex around it provides significant strategic value for competitiveness of the Netherlands and the region. There are various infrastructure developments (new and expansion) in an effort to keep the competitive edge. These include Maasvlakte 2, Carbon Capture and Storage, Syngas clusters , etc…

These projects indicate two major strategic goals:

- Maintain competitive advantage
- Sustainable development (i.e. Climate change mitigation)

Research Goal

These infrastructure projects involve major actors: Companies, Government Authorities and other institutions.

The scientific research goal is to develop and propose flexible strategies under dynamic policy, economics and technology uncertainties to maximize value for stakeholders.

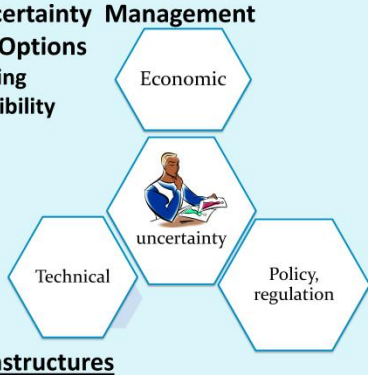
Method/Proposed Approach

Traditional infrastructure projects planning and analysis methods such as Discounted cash flow:

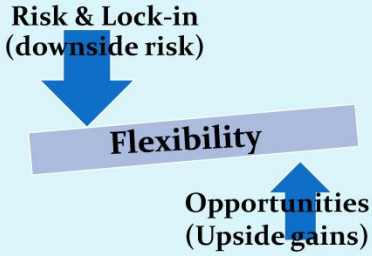
- Unrealistically deterministic
- Does not systematically consider uncertainties

Flexible Design Approach

- Pro-active Uncertainty Management
- Strategic Real Options
  - Value of timing
  - Value of flexibility



Flexibility in Infrastructures



Relevance for PoR

For The stakeholders investing:

- Investment in carbon footprint reducing infrastructures
- Better decision making under uncertainty
- Maintain competitiveness and enhance sustainability

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optimally under the predictions Economic evaluation of the design is then conducted, of which standard methodology, like discounted cash flow (DCF) analysis, optimization, and scenario planning, is applied to achieve the best optimal design.

Flexibility helps to proactively deal with uncertainties. The real options method provides a useful systematic framework for quantifying and operationalizing flexibility. The technical concept of an "option" is a right, but not an obligation, to do something for a certain cost within or at a specific period of time. The method provide designers and decision makers the extra degree of freedom of systematically considering and designing flexibility elements that worth the cost. In port expansion and other similar large-scale projects there are two major valuable real options.

- Timing or phasing of investments in infrastructure and superstructure;
- Building in flexible options in the port infrastructure, i.e. extra investments that can be utilized at a later stage, such as a deeper quay walls for larger future ships and stronger structures for greater loads in the future (also called building in margins);

A prime example of real option application in the Port of Rotterdam is a phased construction of Maasvlakte 2, which gives it the option to abandon the following phase of the project, and avoid a part of the capital expenditure if the market deteriorates. It shows the willingness apply new methods and techniques for investment decisions and the concept of uncertainty is being increasingly mentioned in the port sector. However, flexibility and real options analysis have not gained favor in practice.

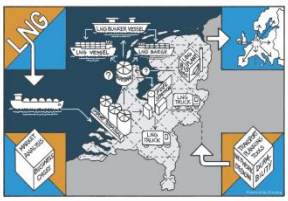
The problem is largely due to the fact that project appraisal is mostly carried out at the feasibility stage (mostly on the basis of a concept master plan) while technical design of port infrastructure is carried out at a later stage, almost always by a third party (consultants or advisors). The increasing popularity of various forms of design and construct contracts is reinforcing this trend. The motivation of the third party is generally limited to looking for an adequate and reasonably priced design alternative that meets the specifications, and flexibility is not high in the list of objectives. Moreover, a flexible option identified and incorporated in the technical design stage cannot be included in the initial project evaluation.

In this research we aim to develop useful flexibility (real options) identification, integration method for large-scale infrastructure development projects that are faced with dynamic uncertainties that involve significant risk for investors. Through this research we aim to develop useful tools, methods for stakeholders (especially private business) to investigate systematically uncertainties and device pro-active management strategies. The output of the research will help decision makers to make informed decisions and by so doing able to minimize down side risks (such as over capacity commitment, lock-in and path-dependency) and utilize the most of the upside opportunities (new markets, benefits from collaborations). Such smart investment strategies within the PoR will contribute to its competitiveness and encourage investment in carbon foot print reducing infrastructures: main goals of the PoR.

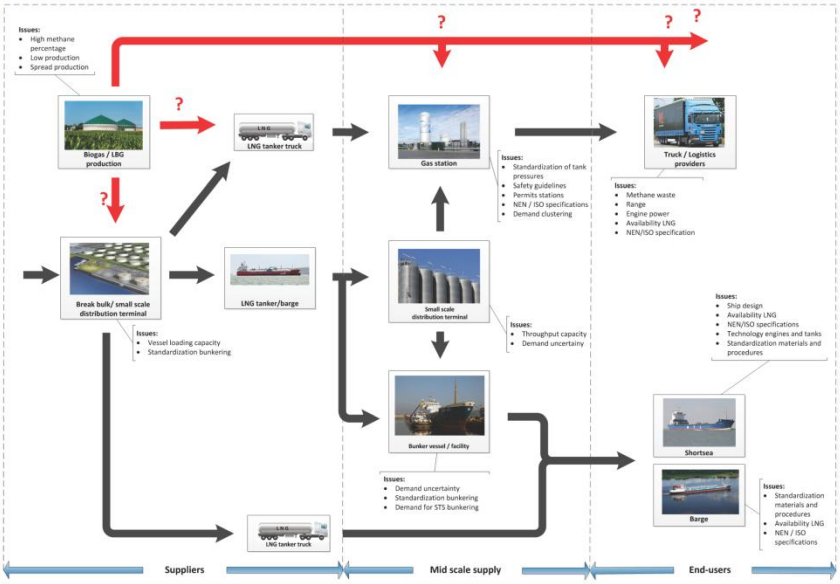
The 3rd Erasmus Smart Port Rotterdam/Port Research Centre Poster Session, Rotterdam, October 2, 2014

A Blueprint of the LNG Distribution Network

This explorative study aims to define a blueprint of the supply chain of LNG including relevant research questions, constraints, and data.



A Dinalog-project



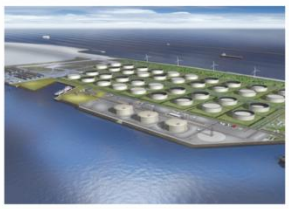
Blueprint of LNG network design

Method

Since this is an explorative research results are based on:

- Grey literature: Non- or semi-scientific studies, performed by practice or governmental institutes.
- Interviews and short live surveys with partners throughout the whole supply chain.

GATE terminal located at Maasvlakte Rotterdam
Source: Vopak



Results

Blueprint of LNG network (see figure):
Identification of the challenges that remain for the development of LNG as a fuel and the design of a distribution network.

SECA Area Europe
Source: Masterplan LNG Energy Valley, Stichting Energy Valley, 2013

Further research

1. The blueprint is empirical input for the conceptual model used for simulation studies of LNG demand. The simulation model will be able to identify the most efficient way (intervals, network configuration, modal choice, etc.) for replenishment of LNG stations at different demand scenarios.
2. The simulation model can be used to support business cases for investments in LNG infrastructure.

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A Blueprint of the LNG Distribution Network

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Supervisor: Prof. Dr. I.F.A. Vis

Simon Thunnissen is a researcher at the Faculty of Economics and Business (FEB) of the University of Groningen (RUG) since 2012. At the RUG, he works in the department of Operations under Professor of Industrial Engineering, prof. dr. I.F.A. (Iris) Vis. Simon Thunnissen has been involved from the start as a researcher in the Dinalog R&D project "Design of LNG Networks". Previously, he worked at the Port of Rotterdam Authority where, among other areas, he was involved in LNG bunkering developments. Other research projects that Simon is involved in, include cooperation and competitiveness studies of ports.

Introduction and aim

Industry and governments have gradually increased their resources for the development of LNG (Liquefied Natural Gas) as an alternative fuel for freight transport. Although a fossil fuel, LNG has significant benefits for emissions of Nox, Sox, and fine particles. Current LNG trucks and barges also realized a reduction of 15% in CO2 emissions. Apart from these societal benefits, gas reserves are large and operational cost reductions are possible with LNG. However, a new transport fuel is not introduced overnight as we know from electric cars and CNG. LNG is not yet widely available at gas stations or for shipping. Diesel is guaranteed to be available anywhere. LNG not. Yet, despite these challenges in scheduling for LNG trucks with hardly a network for supply, some logistics providers claim to have reduced their total cost of operation compared to diesel trucks. To make LNG a realistic option for more logistics providers, more gas stations for trucks and bunkering locations for shipping are needed. With current low, but growing demand it is the question for suppliers of LNG which locations offer the best possibility to have a profitable business. This explorative study aims to define a blueprint of LNG distribution network including relevant research questions, constraints, and data.

Methodology

To identify the requirements of the LNG distribution network, first the supply chain for LNG fuel was conceptualized based on a literature study. Subsequently, we performed a market consultation by conducting semi-structured interviews including industry partners from the whole chain: from logistics providers to LNG suppliers to biogas producers. We used the knowledge in this consortium of companies by conducting explorative interviews with each partner to identify which bottlenecks are experienced for the development of an LNG network. We compared this data with data already available in literature and sent the partners a revised list of the bottlenecks that they identified. This time they were asked to rank to bottlenecks in order of importance. In three occasions, we also held short live surveys and expert sessions among logistics providers, LNG suppliers, and a general public interest in logistics to verify the ranking outcomes. The outcomes of these steps were combined to visualize a LNG distribution network.

Through these steps, we deliberately take a 'consult market first' approach, because there is little academic literature available on LNG distribution networks and supply chains. With these 'empirical problems' summarized in the blueprint, we conclude our study with a short literature survey of supply chain network design (SCND) and location decision literature to identify potentially available solution methods and indicate research challenges for LNG distribution network problems (LNGDNP).

Expected results

This research has outcomes at different levels. First, the blueprint serves as a white paper with the challenges that remain for the development of LNG as a fuel. Secondly, the blueprint is empirical input for the conceptual model used for simulation studies of LNG demand. The simulation model will be able to identify the most efficient way (intervals, network configuration, modal choice, etc.) for replenishment of LNG stations at different demand scenarios. Lastly, the simulation model can be used to support business cases for investments in LNG infrastructure. Therewith, the blueprint supports the scientific goal of the project to develop tools for network design of new fuels while it also provides direct input for business cases.

Applications

This research is relevant for any port that aims to play a role in the LNG supply chain. The Port of Rotterdam, for example, has 'the ambition to become the number 1 European import, (re-)export, and bunkering hub for Liquefied Natural Gas (LNG)'.[1] But also Groningen Seaports is planning investments in the infrastructure for LNG.[2] Ports are furthermore an important link in the supply chain of LNG in Europe. The study shows that developments of the LNG-market for shipping and trucking are dependent on the LNG-specific developments in the port. When there are no storage and bunker possibilities, standardized regulations and equipment, well defined emergency procedures, or trained personnel, the introduction of LNG in the port will be delayed and therefore in all its hinterland markets. Finally, LNG could also provide a solution for the high Nox-, Sox- and fine particles-level in the port. All these aspects form a strong foundation for the introduction of LNG in ports.

[1] www.portofrotterdam.com (September 12, 2014)

[2] http://www.groningen-seaports.com (Juli 29, 2014)

Marjolein Zwerver MBA , Rijksuniversiteit Groningen

Dissimilar port development: revising the business model of landlord ports for the development of their locational function

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Supervisor: Prof. Dr. I.F.A. Vis

Research introduction

The PhD research has a focus on the development of ports, emphasizing the development of a ports locational function. The overall perspective is to discover which business model of a port will be able to affect the development of the ports location function in such a way that it will contribute to increased customer value whereby location distinctiveness can be achieved.

After a case study of a regional port (Eemshaven) in the Northern part of the Netherlands, the research analyses the organizational development of the port owner; this will also include the development and application of newly introduced earning models. Subsequently, an analysis of the investments will take place in order to see which products and services the port created in order to facilitate growth of the industrial port area. Next, an exploration of the value strategy that has been used by the port owner will be carried out. The obtained information of these projects will form a basis conceptualizing a revised business model for landlord ports. Afterwards a comparison between the development of a ports location function with a ports logistic function with respect to infrastructure and connections will be performed, in order to learn if the same principals could be applied with respect to logistic port development. Finally, the study explores the kind of material to be transported via a hub to uncover other materials that can be deployed to develop a hub function of a port location.

Research objective

The study holds three research objectives. The first one is to uncover the possibilities for a landlord port to create a locational advantage with the value proposition from their applicable business model. The second research objective is to explore the flexibility of the landlord business model in relation to the development of the locational function of ports. Thirdly, the research relates the location port development with logistic port development in relation to infrastructure an connections.

To achieve these research objectives, the following questions are put forward as research questions:

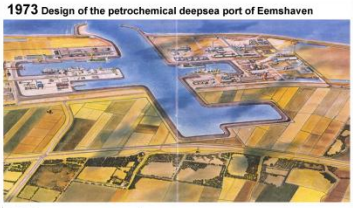
a) Which value proposition will create location advantage within the value system of the site user (industrial company), and
b) What is the design of the business model that can produce such a value proposition and
c) How will the site owner (port) will be able to realize development of its business location by attracting site users?
d) How does the knowledge of developing the logistic port function can be of assistance to develop the locational port function?
e) How can the hub concept be of assistance to develop the location function of a port?

The 3rd Erasmus Smart Port Rotterdam/Port Research Centre Poster Session, Rotterdam, October 2nd, 2014

DISSIMILAR PORT DEVELOPMENT

TRANSFORMATION FROM LOGISTIC PORT TO DATAPORT

1973 Design of the petrochemical deepsea port of Eemshaven



1974 Port of Eemshaven **1** year after construction

2004 Port of Eemshaven, **30** years after construction

2014 EnergyPort Eemshaven, **40** years after construction

2024 DataPort Eemshaven, **50** years after construction

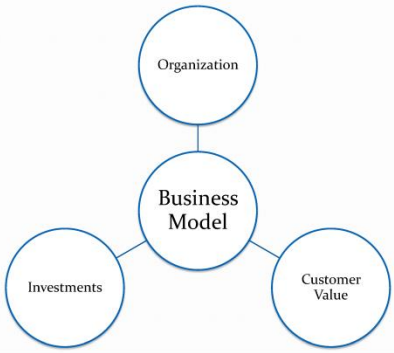
DATAPORT EEMSHAVEN

RESEARCH FOCUS

I. Ports with emphasis on development of port industrial area (location function)
II. Distinctive port development model compared with accepted port evolution models
III. The relation between location development and logistic development with respect to infrastructure and connections.

CASE STUDY: PORT OF EEMSHAVEN (NL)

The port development from construction, and delayed development to impressive growth: how did the port owner managed the development of the port? Which value propositions have been created? Moreover, what has been the significant value strategy the port adopted to influence its location value?



RESEARCH PROJECTS

From the case study five research projects will materialize into separate papers, emphasising :

1. the development of the port owners organisation
2. the development of products and services of the port to facilitate growth
3. the development of the customer value.

When focusing on the development of the location function of a port, what about the development of infrastructure and connections?

4. Can literature with respect to the development of the logistic function provide assistance?

Ships transport massive volumes, data cables transport photons.

5. What can we learn from the difference between the transported materials? Which other materials can be used to develop a hub function?

RESEARCH STRUCTURE

A: Case study (2014)
B: Research projects (2015-2016)
C: Conceptualization of a revised business model for landlord ports (2017)

EXPECTED RESEARCH OUTPUT

A revised business model for landlord ports which facilitates the development of the ports location function.

ERASMUS UNIVERSITEIT ROTTERDAM SMARTPORT

Port research Centre TU Delft

PhD Candidate

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Supervisor: Prof. Dr. Iris Vis

Practical enforceability

The expected research output will be a revised business model of landlord ports which facilitates the development of a ports location function. Escpecially for regional ports that are out of the range of liner services, the revised business model will assist port growth without the focus on logistic development. Moreover, the perspective of logistics will be broadened by the PhD research in order to become other hubs than only for the transport of raw materials and containerized cargoes.

PhD Candidate

This research will be carried out by Marjolein Zwerver MBA (1967), for 15 years marketing research manager of Groningen Seaports PLC, the owner of the port of Eemshaven. The PhD study is performed via the University of Groningen, faculty of economics.

The supervisor of this PhD research is Prof. Dr. Iris F.A. Vis, Professor of Industrial Engineering at the University of Groningen.

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The 3rd Erasmus Smart Port Rotterdam/
Port Research Centre Poster Session
Rotterdam, October 2, 2014

MAKING THE RIGHT PICK

Aligning Order Picking Methods, Incentive Systems, and Regulatory Focus to Increase Picking Performance

1. Background

- Efficient warehouses are vital for competitiveness of ports.
- Order picking, "*the retrieval of a number of products from their storage locations in the warehouse to satisfy orders of specific customers*", accounts for >50% of total warehouse costs (Tompkins 2010).
- Human labor is essential in picking, but scarcely researched. Typical models assume perfectly rational order pickers, or robots & machines.
- Behavioral aspects of order picking are largely ignored.

Opportunity!

- Taking picking methods as well as behavioral aspects into consideration (i.e. incentive schemes and picker characteristics) in predicting picking performance.
- Employing a specially erected full-size warehouse and a lab setting to evaluate order picking performance in practice instead of with models.

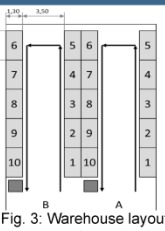

Fig. 3: Warehouse layout experiment 1

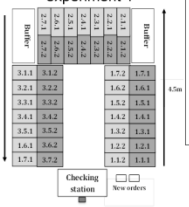

Fig. 4: Lab layout experiment 2

2. Methodology

- **Experiment 1** with 142 participants (28 university students, 75 vocational logistics students, and 39 professional pickers) in 48 four-person teams, picking in especially erected experimental warehouse setup (fig. 1, 3). 3 (picking methods) × 2 (incentive systems) design. Task: pick as many errorless orders as possible in 10 minutes.
- **Experiment 2** with 63 participants (university students) in 24 teams in lab setup (fig. 2, 4). 2 (picking methods) × 2 (incentive systems) design. Task: pick as many errorless orders as possible in 40 minutes.

Picking methods: parallel picking, pick and pass zone picking, dynamic zone (bucket brigade) picking (only in experiment1).

Motivational incentives: cooperation-based (best teams win prize) vs. competition-based (best individuals win prize) in experiment 1, individual-based (individual piece-rate pay) vs. team-based (team piece-rate pay) in experiment 2.

Productivity measured by # of completed order lines, *quality* measured by % of orders containing errors.

Promotion focus and *prevention focus* measured using Wallace and Chen's (2006) Regulatory Focus at Work Scale.

Fig. 6: Example impact scenario

Zone picking, competitive incentives

Initial situation

Change to cooperative incentives

+34.3% productivity
+64.7% errors

Going from 50% to 75% promotion focused pickers

+3.7% productivity
−24.9% errors

Potential 20% annual wage cost reduction

Fig. 1: Experimental warehouse experiment 1

Fig. 2: Lab setup experiment 2

3. Results

Experiment 1: In parallel picking, competitive incentives *15.2% more productive* than cooperative incentives. In zone picking, cooperative incentives *34.4% more productive* than competitive incentives. Mixed results in terms of errors. Results pattern especially pronounced for promotion-focused pickers (fig. 5).

Experiment 2: In parallel picking, similar performance of individual-based and team-based incentives. In zone picking, team-based incentives 11% more productive than individual- based incentives. However, fewer errors with individual incentives in parallel picking and with group incentives in zone picking.

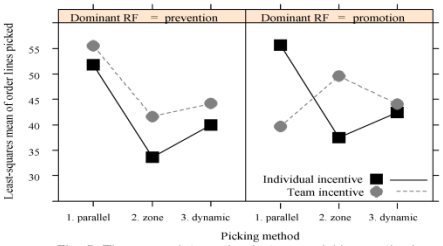

Fig. 5: Three-way interaction between picking method, incentive condition and regulatory focus on productivity

4. Conclusions

Based on controlled field experiment and lab study:

- Alignment of picking method, incentive system, and regulatory focus greatly impacts productivity (up to 47.5% gain, with no or very minor quality loss).
- Competitive incentives optimal in parallel picking, cooperative incentives in zone picking setup.
- Effects of individual-based incentives differ from competitive incentives.

5. Practical Implications

Warehouses can relatively easily gain productivity by

- implementing/modifying incentive systems based on results of these studies,
- selecting employees with particular regulatory focus.
- framing tasks in a way that fits with regulatory focus.

See fig. 6 for scenario of 20% potential wage reduction.

Results are directly implementable to achieve more efficient material handling, which is essential for the competitiveness of any port!

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ZADKINE · pcdata · zetes · NISSAN · JUNGHEINRICH · tempo-team · RSM ERASMUS UNIVERSITY

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Making the right pick: aligning order picking methods, incentive systems and regulatory focus to increase picking performance

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EDUCATION

Rotterdam School of Management, Erasmus University, the Netherlands
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Rotterdam School of Management, Erasmus University, the Netherlands
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Thesis: "Managerial Regulatory Focus and Occupational Safety: Safety Does Not Happen By Accident"

University College Utrecht, Utrecht University, the Netherlands
B.A. Honors in Liberal Arts and Sciences, Cum Laude **2007 - 2010**
Majors: Economics, Psychology. Minor: Statistics.

AWARDS

Dutch Logistics Master Thesis Award 2013 **2013**
Best Master thesis on a logistics-related topic in the Netherlands.

RESEARCH CONTENTS

Warehouses represent a vital link in the supply chain and a dynamic environment that boasts plenty of research opportunities. Ports have been strongly connected to warehouses since the beginning of international trade. Locating warehouses in ports not only facilitates the reception, storage, and intermodal transfer of incoming goods, but also enables companies to consolidate shipments at the place where most goods arrive, and offers the opportunity to provide additional (value adding) services where necessary. Even though an extensive body of literature on many aspects of warehousing exists, the role of the human factor in warehousing has been largely neglected. This is surprising, considering the enormous number of people that work in these facilities on a daily basis. Also in the Rotterdam region the presence of the port indirectly creates employment for thousands of people who work in warehouses. If these people behave differently than typically assumed in most modeling approaches, the results of such models will not be applicable in practice. Therefore, it is important to also empirically investigate how people actually behave while working on warehouse processes.

One of the most labor intensive and capital intensive processes that take place in warehouses is order picking, *the retrieval of a number of products from their storage locations in the warehouse to satisfy orders of specific customers*. In a typical warehouse, this process accounts for up to 50% of the operating costs, (Tompkins 2010), and in most warehouses this process is executed by humans rather than by machines (De Koster 2007). These pickers differ individually in the way they are motivated to do their job, and some people might be more suitable to execute certain tasks than

other people. This implies that individual differences among order pickers working in warehouses can have a substantial influence on warehouse performance, and that investigating under which circumstances these pickers can perform optimally is a research subject with large practical as well as theoretical implications.

To address this topic, we empirically investigated various picker-to-part order picking methods (parallel picking, zone picking, bucket brigade picking) and incentive systems (cooperative vs. competitive, individual-based vs. team-based) to bridge the gap between traditional models focusing on optimizing the order picking process and the order picking performance that can actually be observed in practice. To gain more insight in the individual differences between pickers, we employed regulatory focus theory. Regulatory focus can be described as a mindset that influences how people think and act, and is therefore likely to interact with the incentive system that is employed. Regulatory focus theory distinguishes between two self-regulatory strategies that influence behavior, and that potentially interact with incentive systems. A promotion focus emphasizes accomplishing desired, attractive, and positive goals and aims at achievement, growth, and advancement. A prevention focus emphasizes fulfilling duties, responsibilities, and obligations, and includes an element of fear of failing (Higgins 1998).
Our results show that when using a parallel picking method a competition-based incentive system increases productivity and quality compared to a cooperation-based incentive system, and that when using a zone picking method it is more productive to use a cooperation-based incentive system. This pattern of results was especially pronounced for pickers with a dominant promotion focus. Dominantly prevention focused pickers, however, were more productive with a cooperation-based incentive system, irrespective of the picking method. Additionally, a cooperation-based incentive system delivered a low quality performance in zone picking, but a high quality performance in dynamic zone picking. A second lab experiment partly replicated these results. Correctly aligning the picking method with a fitting incentive system and regulatory focus can lead to productivity gains as high as 47.5%, with only small or no quality losses.

APPLICATIONS IN THE REAL WORLD

The experimental approach of our research, featuring a specially erected full-size warehouse supplied by various material handling suppliers and participation of professional order pickers, is highly novel and should ensure that our findings are, to a large extent, directly generalizable to the practical setting of warehouses worldwide. In the experiments, we found that by optimally combining a given order picking method with either a cooperation-based or a competition-based, or either a team-based or individual-based incentive system can yield great benefits in terms of productivity and quality. Additional benefits can be reaped by assigning employees with a particular regulatory focus to a picking method and incentive system that best fits their regulatory focus.

For most companies, the potential positive effects of implementing an incentive system in general are probably no surprise. However, the best type of incentive and the magnitude of the effects of the choice between incentive systems might be not so well known. It should be emphasized that this study only compares a team-oriented and a competition-based incentive system. Most likely, the benefits for companies that currently do not have an incentive system are even larger. According to a meta-analysis by Condly et al. (2003), incentive systems deliver overall average performance gains of 22% compared to a situation without incentive systems. Implementing the findings of this study in

practice requires incentives that can be realistically made part of the company's reward structure. For individual incentives, an example of this is employing piece-rate pay in addition to a base wage. In our situation, this could be paying employees an additional amount per completed pick or order (a statistic registered by many warehouses already). Something similar could be implemented at the team level, in which case the additional amount is based on the team performance. It should be noted that also non-monetary incentives, such as small prizes or privileges, can be effective (Jeffrey and Shaffer 2007).

Regulatory focus is a construct that is relatively easy to measure with a questionnaire. As many warehouses use multiple picking methods in different parts of the facility (De Koster et al., 2007), companies might try to assign people with a particular regulatory focus to the right type of picking process, or even use regulatory focus as one of the selection criteria in the hiring process. As we have found, people with a dominant promotion focus are more productive in a parallel picking method with a competition-based incentive system, whereas people with a dominant prevention focus are more productive in a zone picking method with a cooperation-based incentive system. To make use of this, companies can re-assign employees with a particular dispositional regulatory focus to tasks that are better aligned with their regulatory focus. However, depending on the methods used, this option might not be present. Alternatively, the regulatory focus of a person can be influenced by situational cues. Companies can evoke a promotion or prevention focus by framing the tasks in particular ways. For example, to evoke a promotion focus, companies will have to frame the task in terms of potential gains, whereas a prevention focus can be evoked by framing the task in terms of potential losses (Crowe and Higgins 1997). Analysis of an example scenario in which our results are employed demonstrates that by aligning order picking methods, incentive systems, and regulatory focus warehouses can improve productivity without quality losses, and reduce wage costs by up to 20%.
These research findings offer concrete insights to warehouse managers about how to effectively incorporate knowledge on behavioral factors and individual differences among employees in their working procedures and policies, and provide avenues for efficiency improvement at relatively low cost.

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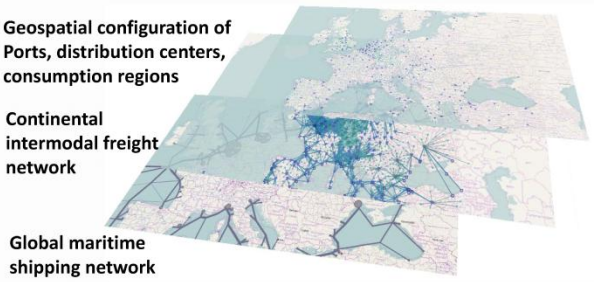
Strategic analysis of global intermodal freight transportation networks

The 3rd Erasmus Smart Port Rotterdam/Port Research Centre Poster Session, Rotterdam, 2nd October, 2014

Main research question: How can we systematically model global freight (container) intermodal transportation systems to deal with the uncertainties which lie therein?

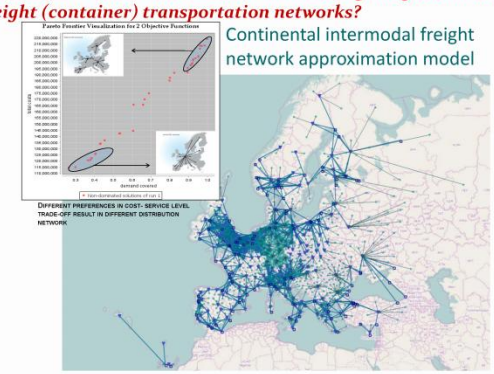
Answer: By structuring the global freight transportation system into sub-systems (as depicted by picture on the right) and model these sub-systems in an integrated manner.

Different sub-research questions were formulated to answer the main research question. The focus of the research is to develop an integrated model for hinterland and maritime freight transport networks. The model is used to estimate the impact of different plausible scenarios in the future on the performance of the global ports.



How can we take logistics considerations such as locations of distribution centers into account in modeling the global intermodal freight (container) transportation networks?

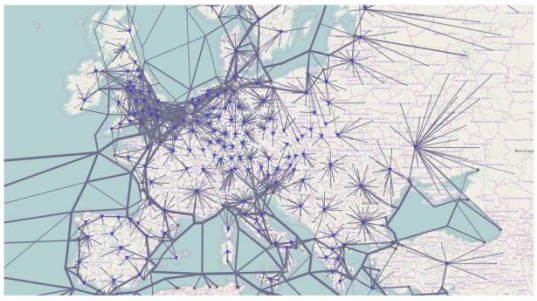
Continental intermodal freight network approximation model



The model produces estimated location of distribution centers in Europe, taking into account (container) trade flows between 1500 NUTS3 regions and the rest of the world, locations of 150 ports in Europe, and 309 potential DC locations in Europe (at NUTS2 level). Any future changes in the abovementioned factors can be simulated to estimate future distribution structures.

What are the impacts of changes in the locations of distribution centers on the global intermodal freight (container) flows?

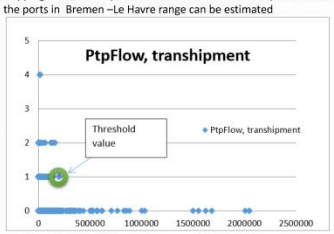
Integrated global freight intermodal logistics model



Integrated model consists of the WCM and the European Intermodal Freight Network Model. Using this model the impact of changes in distribution structure in Europe on Port choices can be simulated. Hence, the integrated model is capable of estimating the impact of changes in global trade pattern on continental distribution structure and eventually global freight(container) routing

What are the impacts of the emergence of direct shipping networks on the performance of the ports in Bremen- Le Havre range?

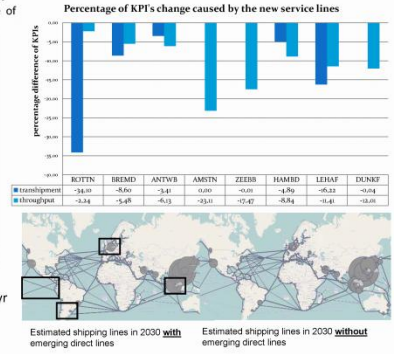
By simulating the new global maritime network which include direct shipping lines , the impact of this new network on the performance of the ports in Bremen –Le Havre range can be estimated



Using the World Container Model 160.000 port to port flows in 2030 scenario were observed.

The threshold value* is found at approx. 200.000 TEU/ yr

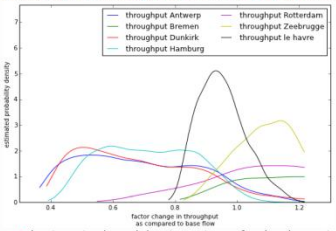
* the threshold value: a flow value above which the transshipment number becomes zero indicating direct shipment



How can we structurally investigate the uncertainties of the global intermodal container networks?

The Exploratory Modeling Analysis technique was used to analyze uncertainties which are inherently present in the freight transport network involving Ports in Bremen – Le Havre range. 10.000 Scenarios are evaluated and systematically analyzed.

Exploratory Modelling Analysis on the world container network



A value of 1 on the x-axis means that the flow has stayed the same compared to base case in 2006.

- The Gaussian kernel density estimate for the change in throughput for each of the ports in the Bremen- Le Havre range
- Port of Rotterdam has a range of throughput variation between 55-120 %

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Strategic analysis of global intermodal freight transportation networks

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1. CURRICULUM VITAE

Ronald Apriliyanto Halim (1986) is a PhD researcher at the transport and logistics group in TPM faculty under the supervision of Prof. Lóránt Tavasszy . He began his PhD research in 2011 soon after graduated as the first international Transport and Infrastructure Systems Engineer from Delft University of Technology. Ronald decided to study in the Netherlands after being offered a full scholarship from the Royal Dutch Shell in 2008.

Being fascinated with the application of mathematical sciences in many fields Ronald finds his passion in applying optimization techniques in both modeling the transport flows of goods at the global level and designing transport infrastructure networks. His main research area is in modelling the global flows of containers using transport models. The approach he develops makes use a combination of different models to explain the characteristics of intermodal freight transportation network globally. Using the models he develops Ronald helps stakeholders such as Port Authority of Rotterdam to gain a strategic insight on the future impacts of the changes in international trade and transportation system on their capacity and competence. His research findings are generally discussed with the Business Intelligence department of the Port Authority. Ronald also has done several projects together with the Indonesian ministry of transport to help providing policy recommendations in designing Indonesia's freight transport network.

2. MODELING GLOBAL INTERMODAL FREIGHT TRANSPORTATION 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. We can find this phenomenon in While the need to include logistics consideration in freight transportation models has been acknowledged for assessing the extent the spatial pattern of international intermodal freight logistics network would evolve, there haven't been, unfortunately, many models developed to serve this purpose.

One general problem that is addressed in this research is the integration of logistics considerations in freight modelling methods particularly those which are used in modelling global intermodal freight transportation networks. We further look into different sub-systems of the global freight intermodal network such as both hinterland distribution structures and global maritime shipping networks and investigate how logistics models can be used to explain the formation of intermodal freight transport networks and eventually intermodal global freight flows. Ultimately, the models which have been developed would be useful to help informing decision makers on the impacts of the uncertainties which come from changes in the global freight transportation system.

Given the limited time available and the focus of this research in relation to the interests of the port authority, several modeling exercises, and case studies have been performed throughout the research project:

1. Modeling the European freight intermodal distribution structures.

2. Developing an integrated model of the global container intermodal network. The model is going to be used to perform a case study on how changes in the European distribution structures will influence port choice.

3. Modeling the impact of the emergence of world's direct shipping lines on the European port's throughput.

4. Exploratory modeling analysis on the impacts of uncertainties in the global container networks on the European ports' throughput.

2.1 Research problem

The research problem can be defined based on the main and sub research questions described below:

Main research question:

- How can we systematically model global freight (container) intermodal transportation systems to deal with the uncertainties which lie therein?

Sub research questions:

- How can we take logistics considerations such as locations of distribution centers into account in modeling the global intermodal freight (container) transportation networks?

- What are the impacts of changes in the locations of distribution centers on the global intermodal freight flows?

- What are the impacts of the emergence of direct shipping networks on the performance of the ports in Bremen- Le Havre range?

- How can we structurally investigate the uncertainties of the global intermodal freight (container) networks?

2.2 Research Objective

The main research objective of this project is to answer the main and sub questions presented above by developing an integrated model of the global intermodal freight (i.e. container) transport systems. The model is designed to support the understanding and analyses of the impacts induced by the changes in global logistic drivers such as: changes in trade flow patterns, development of new infrastructure (ports, rails, and terminals), shift in economic growth and consumption patterns, and the increase of scale/capacity of shipping lines.

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 networks both in the maritime (such as shipping network) and land sides (such as hinterland supply 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 aspects as investigated in this research project. The models 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 they need to anticipate in the planning for the development of their capacity and all the necessary investments which entails.

The 3rd Erasmus Smart Port Rotterdam/Port Research Centre Poster Session, Rotterdam, Oct 2nd, 2014

Multi-agent cooperative intermodal container transport planning

Le Li[1], Rudy R. Negenborn[2], Bart De Schutter[1]
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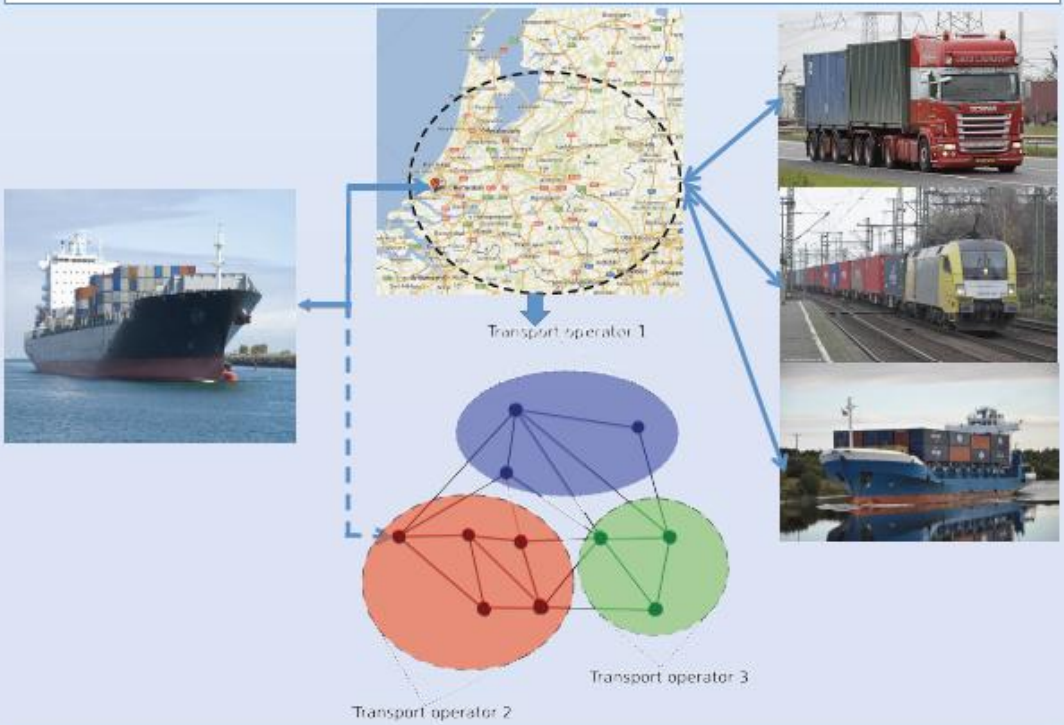
Multiple transport operators can be involved in the container delivery process within an intermodal freight transport network. Coordinating their actions in an effective manner is the big challenge.



Research question

How can the total container delivery cost within an intermodal freight transport network among the Port of Rotterdam and inland terminals be minimized while retaining the independent operation capability of different transport operators?

Research approach

- Improve the planning performance of transport operators via better real-time and cooperative planning
- Develop distributed and cooperative model predictive control methods for cooperative container flow control considering information privacy

Research goal

- For who:
  Container transport operators
- For what:
  Develop efficient cooperation mechanism for cooperative container transport planning among multiple transport operators

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Multi-agent cooperative intermodal container transport planning

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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 and the proposed research approach

To reduce freight transport costs and the environmental and social effects of freight transport, intermodal freight transport has been used in practice and investigated in scientific research for several decades[1-2]. Intermodal freight transport innovates in the sense that better freight transport performance (e.g., lower transport costs, less environmental and social effects, etc.) are obtained by integrating the use of multiple modes of transport (e.g., trucks, trains, barges, etc.) over an intermodal freight transport network (IFTN) and an intensive use of information and communication technology (ICT) in the freight delivery process.

Intermodal freight transport operators (IFTOs) provide freight transport services by managing their own or hired transport capacities, e.g., transport vehicles, freight handling equipment, etc. At the operational level, the container flow management is done in a short time scale (e.g., hourly) by controlling container flows that leave each intermodal terminal and that change from one modality to another modality within each intermodal terminal taking into account the dynamic changes of transport demands, intermodal freight transport network properties, and traffic conditions in the network.

For intermodal freight transport in a large IFTN, multiple IFTOs can be involved in the freight delivery process. Each IFTO controls container flows in a subnetwork while taking into account the interactions of container flows from neighboring subnetworks. To minimize the total freight delivery cost in the whole network and retain the independent operation capability of the IFTOs, they need to control container flows in a cooperative way while considering information privacy.

We propose to model intermodal freight transport from a container flow perspective[3] and investigates the cooperative intermodal freight transport planning problem among multiple IFTOs over their subnetworks belonging to a large IFTN. A multi-agent cooperative intermodal freight transport planning approach will be developed by using the DMPC structure for controlling container flows by multiple IFTOs in their subnetworks in order to minimize the overall freight delivery cost for serving certain transport demands. Adopting the DMPC scheme proposed in [4-5], the cooperative planning approach is derived by decomposing the augmented Lagrangian formulation of the joint intermodal freight transport planning problem into subproblems for each IFTO. IFTOs cooperatively solve their subproblems in a parallel fashion through iterative exchange of planning information.

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Intelligent Maintenance of Belt Conveyor Systems PhD candidate

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Supervisors: Prof. G. Lodewijks, Yusong Pang

Xiangwei Liu received a bachelor's degree in Mechanical Engineering at Wuhan University of Technology, China, in 2008. Later on, he graduated with a MSc degree in Mechanical Engineering at Wuhan University of Technology in 2012.Currently he is a PhD student at the Section of Transport Engineering and Logistics of Delft University of Technology. His research project includes load analyses of bulk material, conveyor belt and idlers, and intelligent monitoring and maintenance of belt conveyors.

Supervisor team

Yusong Pang graduated in China with a MSc degree in Electrical Engineering. From 2000 he worked at Practis B.V. and Seaview B.V. in the Netherlands. After his PhD research of intelligent belt conveyor monitoring and control in 2007, he worked at the Advisory Group of Industrial Installations of Royal Haskoning the Netherlands as project engineer and mechanical engineer. Currently, he is an assistant professor in the Section of Transport Engineering and Logistics, Delft University of Technology, the Netherlands. His main research interest is in Reliability Control and Sustainability Management in Material Transport.

Prof. Gabriel Lodewijks studied Mechanical Engineering at Twente University and Delft University of Technology, The Netherlands. He obtained a Master degree in 1992 and a PhD on the dynamics of belt systems in 1996. He is President of Coveyor Experts BV, which he established in 1999. In 2000 he was appointed professor of the department Transport Engineering and Logistics at the Faculty of Mechanical, Maritime and Materials Engineering. From 2002 he was appointed as chairman of the department, and from 2011 as vice Dean of the Faculty of 3mE. His main interest is in belt conveyor technology, automation of transport systems, material engineering and dynamics.

Intelligent Maintenance of Belt Conveyor Systems

Belt Conveyor Systems (BCSs) play an important role in dry bulk handling and conveyance applications, for instance bulk terminals like EMO. The continuous performance of BCSs counts on the reliability of each component, for example idler rolls. Facing these numerous spatially-distributed idler rolls with characteristics of random failure, traditional 'crew walking along the conveyor' maintenance strategy cannot meet the challenge.Existing maintenance executions at Port of Rotterdam are still rather costly yet low efficient, labour intensive and time consuming. Every year, it costs bulk terminals millions of euros for proper maintenance of dry bulk transport systems. Maintenance activities normally require the belt conveyor systems to stop running, otherwise it is too dangerous for maintenance personnel. The stop of the conveyor systems larges limits the capability of dry bulk transport at bulk terminals. On the other hand, insufficient maintenance of transport systems may lead to catastrophic failures or huge loss of profits.

Intelligent Maintenance of Belt Conveyor Systems

Xiangwei Liu, Yusong Pang, Prof. G. Lodewijks

Introduction

Belt conveyor systems are involved intensively in dry bulk transport at Port of Rotterdam till port vision 2030. How to maintain the reliability of existing conveyor systems has priority for efficiency and competitiveness. Existing maintenance are costly yet low efficient, labour intensive and time consuming. "***Smart Port***" necessities technical innovations for maintenance.

Research Goal

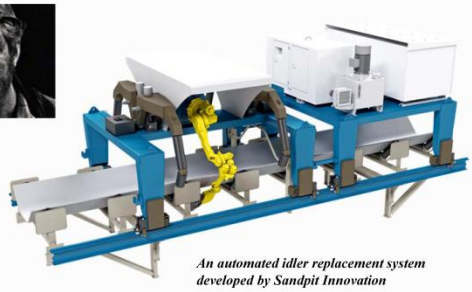
This research project aims to develop an artificial intelligent decision-making system as "***the Brain***" of automated idler replacement systems.

The Intelligent Maintenance System is expected to largely improve the productivity, safety and sustainability of dry bulk transport system while lowering maintenance cost.

Keywords

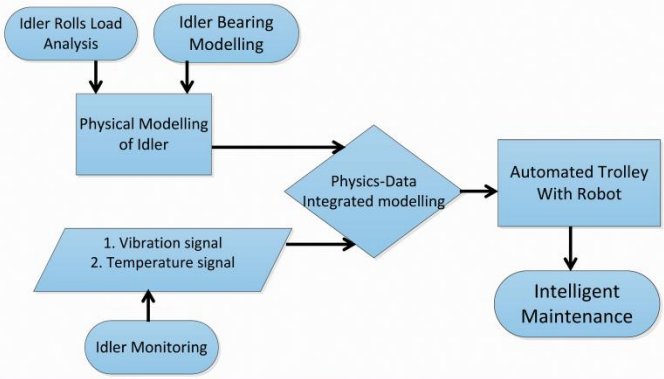
- Bulk solids mechanics
- Dynamics of belt conveyor
- Idler failure mechanism
- On-site condition monitoring tests
- Artificial Intelligent Decision-making

picture from bvhrubber.ro



An automated idler replacement system developed by Sandpit Innovation

Research Approach



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Instead, automated maintenance with an intelligent decision-making function can be a promising alternative. This research aims to develop an Intelligent Maintenance System (IMS) which can fulfil the task of idler maintenance without human involvement. The proposed IMS consists of an Automated Maintenance System (AMS) and an Intelligent Decision-making System (IDS).With the development of robotic techniques, the AMS has been introduced into the maintenance of idlers of BCSs recently. For instance, robot-assisted inspection and replacement of idler rolls have been realized. However, the bottleneck of the AMS is that it still needs maintenance personnel to make a decision on which idler rolls to replace. By applying Artificial Intelligence, instead, an IDS can be developed in order to give such decisions to the AMS. As a result, this research project focuses on the development of the IDS.

To achieve the goal, theoretical analysis of lifetime prediction of idler rolls, as well as experimental study of the failure mechanism will be performed. For the theoretical analysis of lifetime prediction, firstly the load on idler rolls due to bulk material and the belt is investigated by using soil mechanics. With the achieved load distribution, the analysis of the fatigue lifetime of journal bearings of each roll can be conducted and a physical prediction model will be developed.

For the experimental study, a test rig for the Idler Endurance Running Experimentation (IERE) is developed. During the experiments, different rolls will be run to failure on an in-situ belt conveyor system. Thermography, vibration and acoustic signals will be acquired, analysed and compared. A conclusion will be made on how to achieve reliable prediction of the impeding failure of idler rolls based on acquainted monitoring data. A data model will be developed from which the indicator of the impending failure of a roll can be detected. In the end, we will integrate the physical model and the data model. The advantages of the two models are combined while the drawbacks will be diminished. With the integrated physics-data model, the IDS can be developed. As a result, the IMS of belt conveyors will be fully realized which can largely improve the efficiency, safety and sustainability.

Possible applications in Port of Rotterdam

In the Port Vision 2030 of Port of Rotterdam, dry bulk still composes a large part of the total throughput in all business models. As a result, it is essential to fully utilize existing facilities like belt conveyors in bulk terminals. On the other hand, sustainable future of Port of Rotterdam can only be realized by applying technology innovations, in which innovations of maintenance technologies play an important role in terms of competitiveness, efficiency, profits and safety.

The output of this research project is an innovative maintenance system – Intelligent Maintenance System of Belt Conveyor Systems. The ambition of the IMS is to automatically carry out inspection and maintenance activities without human involvement. The possible applications in Port of Rotterdam can be: Bulk terminals such as EMO, EBS and EECV. EMO is the largest terminal for coal and iron ore in Europe [1]. Every year, EMO transports tens of millions of tons of coal and iron ore with their belt conveyor systems. To meet the capacity, proper maintenance of the belt conveyor systems is critical. With the Intelligent Maintenance System developed in this project, higher reliability and efficiency, less downtime will be expected. As a result, more profit will also be produced.

Reference

[1] EMO, 2014. [Online]. Available: http://www.emo.nl/introduction/en.html

The 3rd Erasmus Smart Port Rotterdam/Port Research Centre Poster Session, Rotterdam, October 2, 2014

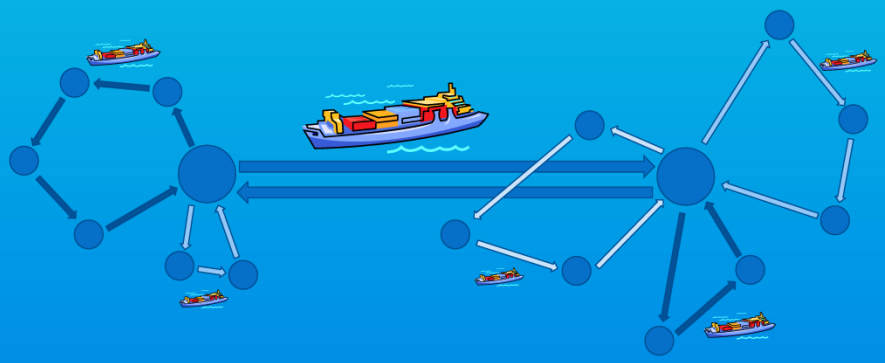
Shuttle services in liner shipping networks

Advantages

- Economies of scale at sea; large ships are more efficient at sea and shuttle services have relatively long sailing times compared to port times.
- All containers have to be unloaded in each port, eliminating the possibility of blocking containers and the need of stowage planning and increasing the port productivity.
- Delays are mainly incurred in ports and recovered at sea, which makes shuttle services more efficient to manage delays.

Disadvantages

- More transshipments are needed, because each container that has to be transported between two feeder ports has to be transshipped at least twice, increasing the transshipment cost in the network.
- Large container ships may suffer diseconomies of scale in ports.
- Transit times of the containers might increase because of the additional transshipment and waiting time.



Initial results:

A case study is performed using a benchmark dataset. Three hubs are identified in the network: Rotterdam, Algeciras and Singapore. Shuttle services are introduced between these three hubs, while all other ports are served by feeder routes. The shuttle network is competitive to the best known networks for this dataset: a profit increase of 2.5% is found compared to the best network in current literature.

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Econometric Institute, Erasmus School of Economics, Erasmus University Rotterdam
Promotor: R. Dekker

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ERASMUS SCHOOL OF ECONOMICS

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Shuttle services in liner shipping networks

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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 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. Traditional liner shipping networks consists of a combination of simple and butterfly routes. In simple routes, ports are all visited exactly once on each rotation, while in butterfly routes ports are allowed to be called twice during a rotation. Hub-and-spoke networks consist of a small number of large hub ports, which are connected with each other. All other (smaller) ports in the networks are called spokes or feeder ports and are only visited on routes originating from and destined for their closest hub. Shuttle networks are hub-and-spoke networks where the routes between the hubs include shuttle routes. A shuttle route is a direct route between two ports. Our research also focuses on the feasibility of shuttle routes in liner shipping networks.

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.

Possible applications

Shipping lines want to implement the route network that satisfies all requirements and maximizes their profit. In our research, we try to develop methods to construct these networks. However, it is still a very difficult problem to find the best network that satisfies all the practical requirements. Our research also develops models that can be used to compare networks, which can be used as a decision support tool by liner companies. Furthermore, by investigating the profitability of shuttle services in liner shipping networks, we compare different network structures, like conventional, hub-and-spoke and shuttle networks, with each other. Shipping lines can use these studies in their decision on the structure of the route network that they are going to use. Ports might also be interested in the feasibility of shuttle services, since it can improve their competitive position. The delay management research is also used as a decision support tool at a liner company. We developed models that can be used to compare the cost of different buffer time allocations. Using these models liner companies can get insight in the cost of arriving a few hours earlier or later in a certain port. These costs can then be used in the negotiations with ports about the berthing windows.

Potchara Pruksasri, Delft University of Technology

COMMERCIAL DATA PROTECTION OF THE SUPPLY CHAIN DATA PIPELINE

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Supervisor: Prof.dr.ir. J. (Jan) van den Berg

Curriculum Vitae

Potchara Pruksasri has obtained both Bachelor's and Master's degrees of Computer Science at Khon Kaen University, Thailand. He has employed as a lecturer at Mahasarakham University, Thailand before he received a PhD scholarship from Thai government to study in the field of supply chain and logistics. He is currently working on his PhD research at Section ICT, Faculty of Technology, Policy and Management (TPM), Delft University of Technology. His research focuses on information security of the supply chain system in order to secure data exchange of the supply chain. Several studies of information security have been published during his PhD. Additionally, he worked in the CASSANDRA project, co-funded by the 7th Framework Programme of the European Countries that aims to improve visibility and security of the European supply chain system.

Prof.dr.ir. J. (Jan) van den Berg studied mathematics and physics at the TUDelft while being active in the national student movement. In 1977, he received the diploma of Mathematical Engineer. From 1977-1989, he lectured courses in mathematics, physics and computer science on institutes of higher education in Breda and Eindhoven, and mathematics and physics at the secondary school of Nampula, Mozambique. From 1989-2006, he worked at the Econometric Institute of Erasmus University Rotterdam. His PhD-thesis entitled "Neural Relaxation Dynamics" was finalized in 1996. From 2006, up till now he worked at TUDelft again, mostly on topics related to (Big) Data Analytics and/or Cyber Security. On July 9 2013, he was appointed as full professor Cyber Security at Faculties of EEMCS and TPM.

Commercial Data Protection of the Supply Chain Data Pipeline

Trading and transporting of goods currently needs a large amount of support information in order to make better visibility and accountability in any process. The international supply chain not only needs to maintain a "just in time" delivery, but effective information exchange along the transportation is also required. Supply chain stakeholders, for example, consignors, consignees, private bodies and governmental authorities expect accurate, correct, updated and secured data for their internal activities. Thus, high-quality information is definitely crucial for the supply chain systems. However, the current supply chain system still suffers from deficiency data such as incorrectness and unreliability. These poor data decrease the visibility of the supply chain and cause vulnerabilities to many illegal actions in the process, for instance, tax evasion and smuggling.

To improve the quality of data, UK and Dutch customs proposed the new idea of the supply chain information system (SCIS) named the "Seamless Integrated Data Pipeline" or shortly the "Data Pipeline". The principle of the Data Pipeline communication is shifting from the traditional Data Push to the Data Pull model based on an assumption that only authorized partners in the Data Pipeline community who wish to get information should directly request data over the internet to the information's sources (owners). By this principle, data at the source are supposed to be the most correct and genuine. Moreover, sharing and exchanging information over the internet must be in control of the access, and the delivery of the exchanging message must be secured. The confidentiality of commercial data of businesses must to be properly operated because the business secrets are valuable properties of the organization.

COMMERCIAL DATA PROTECTION OF THE SUPPLY CHAIN DATA PIPELINE

Introduction

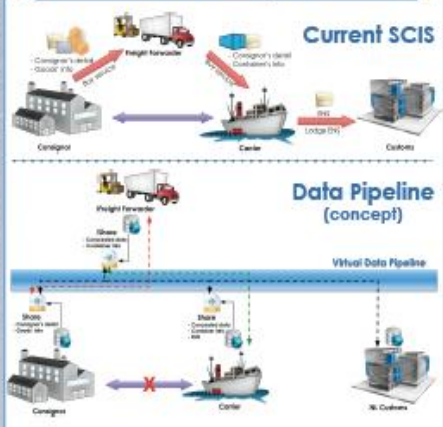
The Seamless Integrated Data Pipeline concept or "Data Pipeline" was proposed to the EU in order to improve data quality and visibility of current supply chain information systems. The Data Pipeline is designed by shifting from the traditional "data push" to the "data pull" model. A key requirement of this system is that information sharing and exchanging must be safe and reliable. We took up this great challenge to study and introduced the Distributed Trust Backbone, an infrastructure of secure data exchange, to ensure data in the new system is highly secured. Security protocols of the model can control and protect information during the exchanging process. The simulation of the prototype system demonstrates the data protection mechanism is functioning properly in the real world. Eventually, Commercial data of businesses in the case study are protected from inappropriate parties and be assured its confidentiality within the designed model.

Challenges
- New Supply Chain IS
- Data Push to Data Pull
- Secured sharing and exchanging
- Commercial Data Protection

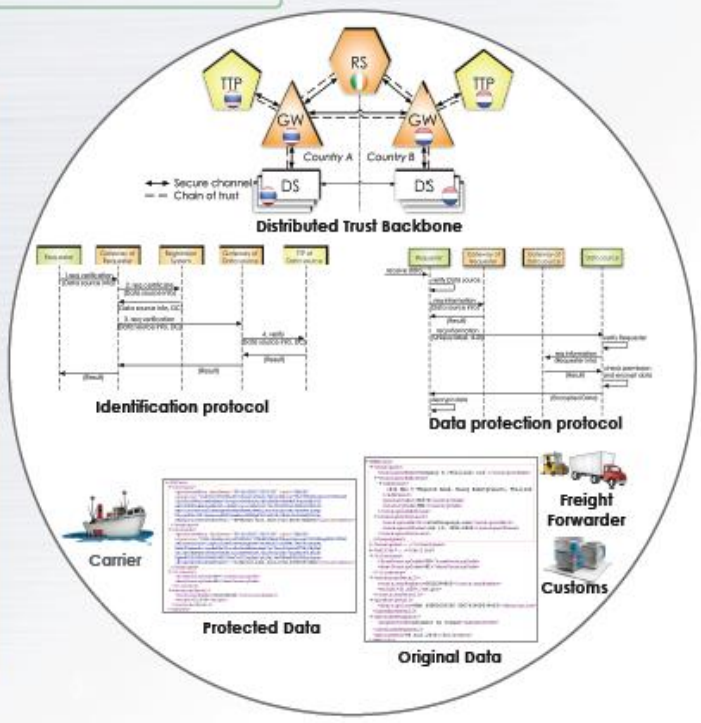
Solution
- Distributed Trust Backbone
- Data protection protocol
- Encryption and Digital Signature

Simulation
- Prototype system
- Asia - Europe trade lane
- A case study of Import Control System (ICS)

Research goal



The goal is to demonstrate how the proposed Data Pipeline model assures the confidentiality of commercial data of businesses while exchanging in the reality.



The benefits of this research

Businesses: This research increases the confidence of the private sectors in the new Data Pipeline system and the damage from losing business information should be reduced.

Government authorities: This research is usable as a pilot study for further developments of the new information system. The most correct data exchanged in the system enhances the accuracy of the risk assessment processes. The visibility and security of the supply chain system will be improved.

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TU Delft Erafung ERASMUS UNIVERSITEIT ROTTERDAM SMARTPORT

The basic requirements Confidentiality, Integrity, Availability and Accountability (CIAA) of data are required for securing the information system, but the directions to reach the requirements are diverse depending on the business context. An international supply chain presents a context unique from others both in the formation of data and security mechanism. In 2012, our Data Pipeline model named the Distributed Trust Backbone (DTB), which focuses on information security aspect, was proposed. Core components and security protocols are carefully designed and implemented based on the Public Key Infrastructure and Digital Certificates technologies. It achieves the core concept of the Data Pipeline and undertakes the data security including identification, authentication and data protection.

In the series of designing a secure information system, the reality check and practical integration to an actual situation must be performed to assure that the designed model supports real business activity. An import control system (ICS) of the supply chain has been studied and selected to be the case study because it is simple but presents an obvious vulnerability that needs to be considered. The prototype of the model is implemented in 3 different countries: Ireland, Netherland and Thailand along the Asia – Europe trade lane in order to demonstrate how the proposed model protects business transactions during exchanging process.

The Distributed Trust Backbone's components the Registration System (RS), the Country Gateways (GW) and the Trust Third Parties (TTP) are cooperating to delivery business transactions between the Data Source system (DS) and the requester in a secure way. Based on the process of lodging the ENS in the ICS, the proposed model can control and protect sensitive data of business parties by the designed identification and data protection protocols. The commercial data of businesses included in the transactions are concealed from inappropriate actors. The simulation prototype shows our model assures the confidentiality of transaction's data of the case study and supports the actual business activities.

This research in the real world

This work is designed and developed based on the new concept of the future supply chain information system, which is currently in the initial phase in the cooperation of many European organizations (CASSANDRA: http://www.cassandra-project.eu and CORE: http://www.coreproject.eu). A multitude of developments needs further studies both in technical and business aspects because it is new and yet unstable. However, both public and private sectors benefit from this research in term of better understanding of the needs from government authorities and businesses.

Business view: Designing and developing a new system in order to be used in the governmental activities, it mainly focuses on the requirements from the authority side, for example, the needs of the most correct and sufficient of data. These requirements sometimes make difficulties to private sectors. A case study of the ICS shows that shifting from traditional to the new system (the Data Pipeline) causes some concerns at the business side because they must prepare and share their data related to the shipment to other parties by regulations. Some of the data are confidential and sensitive to lose their business opportunities. The private bodies, thus, not fully support the governmental projects when they still concern about the risk on their valuable properties.

This research presents the mechanism to protect the commercial data of businesses in reality. The visualization of the simulation prototype in the research assures the private sectors can preserve their secrets in the system by the proposed model, which is very crucial to the businesses. This research increases the confidence of the private sectors in the new information system, and the damage from losing business information should be reduced. The supply chain stakeholders should trust and put more collaborative to the project when the security mechanism assures their sensitive information will be completely protected.

Government view: The governmental authorities particularly the port and customs directly benefit from the new concept of the Data Pipeline, but there is no consensus of its components and protocols until today. The visual demonstration of the concept in the real business activity presented in this research makes clear view of the proposed model to the governmental organizations. They can use this pilot study to support the planning of the next step. In addition, this work focuses on the effective data exchange that vows correctness, accuracy and security of information. This high-quality information enhances performances of the border control processes such as making a decision in the green lanes procedure. The green lanes strongly depend on high-quality risk assessments. In their turn, high-quality risk assessments strongly depend on accurate data. This work assures information will be most correct, accurate and reliable. Therefore, it definitely reduces the supply chain vulnerabilities and increases the visibility of the supply chain systems in the real world.

Bart van Riessen, Erasmus University Rotterdam

Synchromodal Container Transportation

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Supervisors: Dr. R. Negenborn, Prof. R. Dekker

Key objective of Bart van Riessen

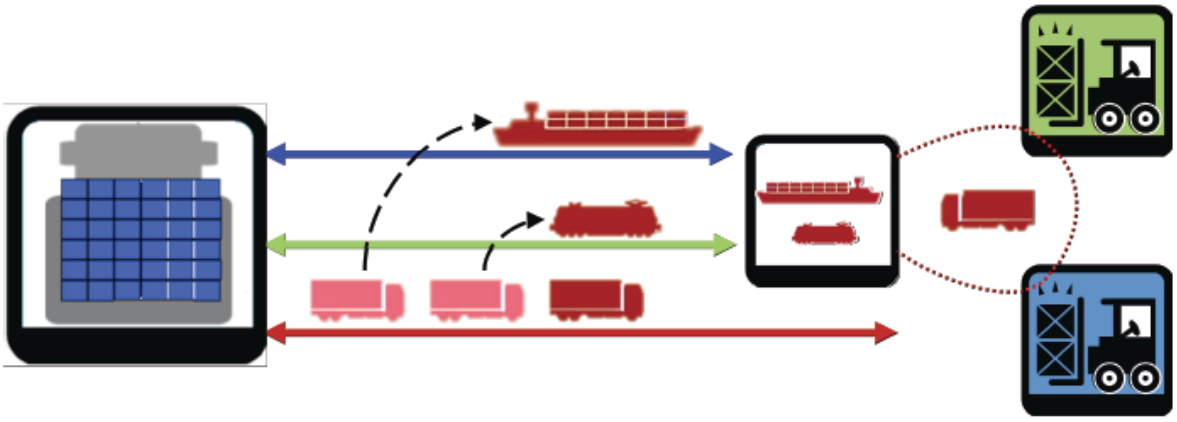
The key objective of this research is to **enable synchromodal planning in inland container networks**. No uniform definition for synchromodal transportation exists yet, but in this proposal a definition is used adapted from the Platform Synchromodality: *Synchromodality is the optimally flexible and sustainable allocation of cargo to different modes and routes in a network under the direction of a logistics service provider, so that the customer (shipper or forwarder) is offered an integrated solution for its (inland) transport.*

Background and Research Problems

Inland transportation in networks in North-West Europe is mostly considered per corridor and not for the network as a whole. This is the case for mainly three reasons: Firstly, no suitable methods for creating an integrated network plan exist yet. Secondly, adapting the plan in real-time responding to delays and other changes occurs manually, by planning operators that focus on specific corridors and inland connections. Thirdly, because of the customer's restrictions with its transportation orders, the network orchestrator misses the flexibility to switch between modes and routes and thus cannot achieve the benefits of synchromodal planning.

For achieving the objective, this study will contribute to new practical methods for solving all three problems of applying synchromodal planning in current practice:

1. Integrated network planning: Methods for creating an integrated transportation plan for intermodal transportation networks that are operated by a network orchestrator.
2. Methods for real-time network planning: Methods for creating the transportation plan in real-time and updating it continuously as new information arrives.
3. Creating planning flexibility: Methods for persuading clients to allow flexible transportation planning.



The 3rd Erasmus Smart Port Rotterdam/Port Research Centre Poster Session, Rotterdam, Oct 2nd, 2014

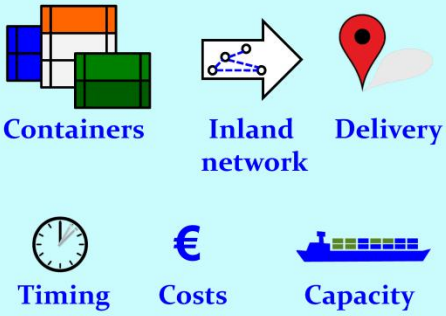
Synchromodal container transportation

Bart van Riessen, Rudy Negenborn, Rommert Dekker

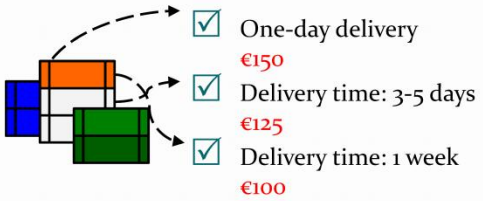
Key objective
Enabling synchromodal planning in inland container networks

Contributions
1. Differentiated transportation products
2. Real-time decision support
3. Integrated network transportation plans

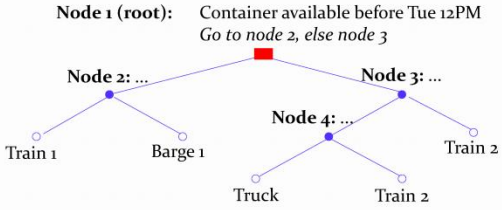
Goal of the container network operator
- Deliver all container transport orders
- Efficient use of the available network
- Considering time windows, costs and capacity



1. Differentiated transportation products
- Key characteristics: reliability, price, flexibility
- Client requirements
- Flexible in mode, route and lead time. E.g.:

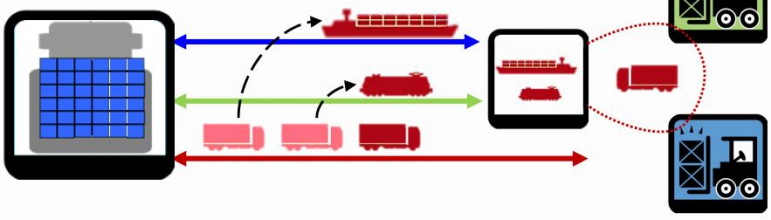


2. Real time decision support
- Integral routing of containers in the network
- Simplify planning complexity
- Real-time scheduling and updating. E.g.:



3. Integrated network transportation plans
- Create optimal transportation plan using flexibility in mode, route and lead time
- A balance between costs, on-time delivery and the modal split of barge, train and truck.

Value of flexibility:
- cost reduction?
- shift from trucking to intermodal services?
- Improved reliability?



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Featured publications (2014)
- Impact and relevance of transit disturbances on planning in intermodal container networks using disturbance cost analysis. Accepted for publication in *Maritime Economics and Logistics.*
- Service network design for an intermodal container network with flexible transit times and the possibility of using subcontracted transport. Accepted for publication in *Int. J. of Shipping and Transport Logistics.*

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Approach

New planning methods are required for both the initial transportation plan and planning updates because of changing circumstances in daily operation. This research will develop planning methods for creating the initial synchromodal transportation plan, as well as the online methods for planning updates. These methods will be used to determine how valuable certain planning flexibility is, i.e. to what extent it enables a more efficient the network transportation plan.

Apart from the challenges in transportation planning, a new type of relation with customers is required to allow synchromodal planning. Nowadays, customers ordering a container transport often explicitly specify the desired mode and departure time for the transportation, allowing very limited freedom to the network operator for network-wide optimization. This research will assess what incentives can be used for customers, for instance with different pricing mechanisms, to promote transport orders with more planning flexibility for the network operator. Determining the price incentives depends on the results about the value of planning flexibility.

Funding

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Control of interacting machines in automated container terminals

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Supervisors: R. Negenborn , G. Lodewijks

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

2.1 Research Goal

Improve the performance of automated container terminals

2.2 Research topic

2.2.1 Improve Energy efficiency

The operations at automated container terminals for handling a large number of containers over a year consume a great deal of energy. Huge amount of energy consumption does not only increase the handling expenditure but also generates more CO2 emission using these automated machines at automated container terminals. Hence, energy efficiency of container handling has received much attention for more sustainable and more economic operations.

1) Consider the case of the open-loop control suing integrated flow shop scheduling and optimal control [1].

2) Consider the case of the closed-loop control using model predictive control for handling uncertainties [2].

2.2.2 Improve vehicle autonomy

More intelligent AGVs are developed for allowing free-ranging movements. New designed GPS-based AGVs allows free movements freedom, which is different from the fixed path guided by makers, wires, lasers or computer vision. This free-ranging behavior can shorten the driving distance of AGVs when they are used for transporting containers between the quayside area and the stacking area.

But the free-ranging behavior of AGVs increases the complexity for controlling operations of automated container terminals. This may arise the traffic congestion of AGVs and deteriorate the performance of the quayside operation for container handling due to disturbances from collision avoidance. Advanced algorithms for integrating the interaction of multiple AGVs and the interaction of AGVs with other types of machines must be developed for performing the high handling capacity of automated container terminals.

This research topic is still under development. Part of this research is in [3].

Outcomes of this research project

1) Result in more energy-efficient automated container terminal management
2) Develop an algorithm for generating a more applicable scheduling of interacting machines considering the collision avoidance constraints.

References

[1] J. Xin, R.R. Negenborn & G. Lodewijks (2014). Energy-aware control for automated container terminals using integrated flow shop scheduling and optimal control. Transportation Research Part C: Emerging Technologies, 44, 214-230.
[2] J. Xin, R.R. Negenborn & G. Lodewijks (2014). Energy-efficient container handling using hybrid model predictive control. Submitted to a journal.
[3] J. Xin, R.R. Negenborn & G. Lodewijks (2014). Trajectory planning for AGVs in automated container terminals using avoidance constraints. In Proceedings of the 18th IFAC World Congress, Paper 1306, Cape Town, South Africa.

Control of Interacting Machines in Automated Container Terminals

Jianbin Xin, Rudy Negenborn, Gabriel Lodewijks

Challenges for container terminal operators

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

Topic 1 & 2: Improve energy efficiency

- Consider the case of open-loop control using integrated flow shop scheduling and optimal control [1]
- Consider the case of closed-loop control using Model Predictive Control for handling uncertainties [2]

Topic 3: Improve vehicle autonomy

- Generate collision-free trajectory planning of AGVs integrated with scheduling of interacting machines
- Decompose the integrated planning problem using a hierarchical architecture
- Solve a collection of small-scale mixed integer linear programming problems iteratively

  Part of this topic is presented in [3]

Outcomes of research

- Developed a methodology for modelling and controlling of interacting machines in automated container terminals
- Create value for terminal operators and equipment manufactures

Research goal

Improve the performance of automated container terminals at the operational level

Overall Approach

Control theory for hybrid systems

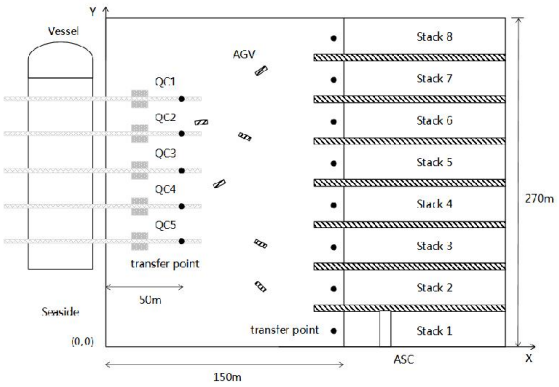

Fig 1. Automated container terminal benchmark system

Publications

[1] J. Xin, R.R. Negenborn & G. Lodewijks (2014). Energy-aware control for automated container terminals using integrated flow shop scheduling and optimal control. Transportation Research Part C: Emerging Technologies, 44, 214-230.

[2] J. Xin, R.R. Negenborn & G. Lodewijks (2014). Energy-efficient container handling using hybrid model predictive control. Submitted to a journal.

[3] J. Xin, R.R. Negenborn & G. Lodewijks (2014). Trajectory planning for AGVs in automated container terminals using avoidance constraints. In Proceedings of the 18th IFAC World Congress, Paper 1306, Cape Town, South Africa.

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Prioritization in Modal Shift Policies

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Supervisor: Prof. C. Macharis

Dries Meers acquired the degree of Master of Science in Geography in a joint program of the Vrije Universiteit Brussel and the KU Leuven. Currently, he is a research associate at the MOBI research group at the Vrije Universiteit Brussel. His PhD work focuses on intermodal transport and the further development of the Location Analysis Model for Belgian Intermodal Terminals (LAMBIT). He has particular research interests in the evaluation of policy measures related to the use of intermodal transport, problems and decision aid in modal choice decisions and location analysis with a focus on optimally locating intermodal inland terminals. Finally, he is also interested in how a modal shift to more sustainable transport modes can be achieved.

Cathy Macharis, the promoter of Dries Meers, is Professor at the Vrije Universiteit Brussel and visiting professor at the University of Gothenborg. Her research group MOBI (Mobility, Logistics and Automotive Technology) is an interdisciplinary group, focusing on sustainable logistics, electric and hybrid vehicles and travel behavior. She has been involved in several regional, national and European research projects dealing with topics such as the location of intermodal terminals, assessment of policy measures in the field of logistics and sustainable mobility, electric and hybrid vehicles etc.

Research content

Numerous reasons force port authorities and logistics service providers to supplement or improve hinterland services by alternative transport modes, such as rail, inland navigation and short sea shipping. An extensive multimodal transport network gives them the opportunity to offer shippers a wide range of transport possibilities and in addition, it allows ports to increasingly compete for contested hinterland. Furthermore, these alternative transport modes can alleviate congestion problems in and around the port area. And also policy makers have clear interests in acquiring a modal shift in hinterland transportation.

In this research, a Geographic Information Systems (GIS)-based methodology is proposed to detect the transport flows yielding the greatest potential for modal shift in a study area. Different transport flow datasets are combined to gain detailed insight into current unimodal road transport of containers. This allows identifying individual companies, whose transport flows are theoretically well-suited to switch to intermodal transport services. In complement to other modal shift analyses, the aim of this research is to compare different transport flows and rank them based on their affinity for a modal shift. The rationale behind ranking transport flows or companies on their estimated success rate for modal shift is that the most highly ranked companies can be approached and guided individually in their modal shift efforts in a later stage. This research presents a case study, testing the methodology for the provinces of Limburg in Belgium and the Netherlands for container flows to and from the ports of Rotterdam and Antwerp.

The 3rd Erasmus Smart Port Rotterdam/Port Research Centre Poster Session, Rotterdam, October 2, 2014

Prioritization in modal shift policies

Dries Meers & Cathy Macharis

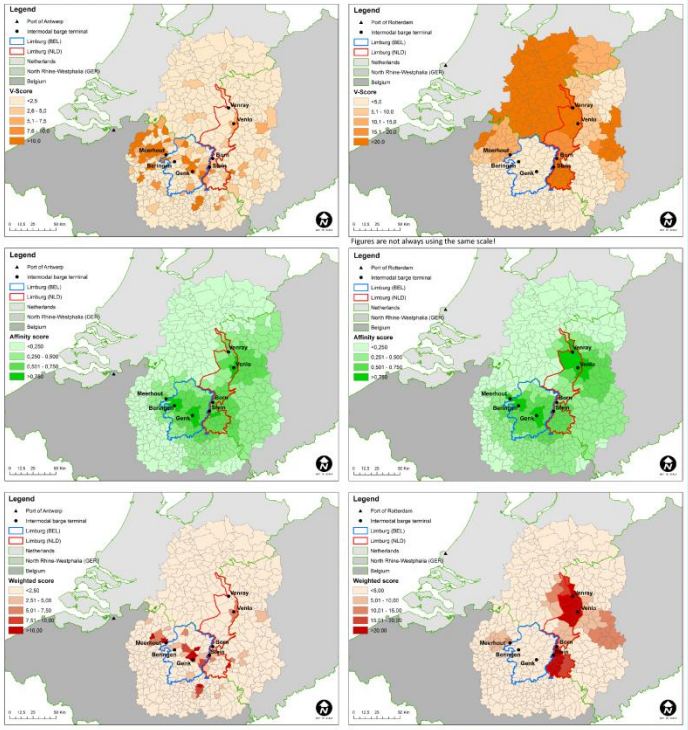
Research context: Policy makers and port authorities in Belgium and the Netherlands want to trigger or facilitate a **modal shift** from truck transport to transport modes such as rail transport and inland navigation for reasons of sustainability, hinterland acquisition, avoiding (congested) road transport ...

Research question: How to locate the road transport flows/businesses in Belgian and Dutch Limburg with the highest estimated chance for a successful shift to inland navigation for the transport of containers?

Research methodology and results:

Macro-scan modal shift potential

1. Identification of suitable **transport flows** through a four step methodology. Relevant origin/destination datasets are converted through normalization, aggregation/disaggregation and weighting into Volume-Scores on municipal level.
2. Identification of most suitable company **locations** through a three step methodology. An affinity index is calculated, based on an intermodal/unimodal price ratio, the intermodal transport post-haulage transport time and product type characteristics (when available).
3. Combining transport flows and company locations characteristics in a **global weighted score**, ranking the individual geographic entities on their modal shift potential.



Conclusion: Relevant ranking of flows, but output highly dependent on quality input data and few detailed data concerning Rotterdam flows available

- Sensitivity analysis: low impact of weights of company location and product type criteria and additional promising scenarios (e.g. empty depot)
- Follow-up: identification of flows and companies

Main Sources:

Bottani, E., & Rizzi, A. (2007). An analytical methodology to estimate the potential volume attracted by a rail-road intermodal terminal. International Journal of Logistics Research and Applications, 10(1), 11–28.

Ruesch, M. (2001). Potentials for Modal Shift in Freight Transport. In 1st Swiss Transport Research Conference (STRC), March 1-3 (p. 17). Monte Verità / Ascona.

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To identify the most suitable locations and companies, different parameters are included in the analysis: container volumes and the types of goods currently transported by road, the prices of unimodal road transport and their intermodal alternatives, the post haul transport time and the type of goods transported. The volume parameter was estimated by combining different datasets, resulting in a Volume-Score on municipal level. The price comparison parameter and the time for post haulage could be derived from simulations with LAMBIT. All the input information is made relative and converted in location specific global scores using weights derived from Bottani and Rizzi (2008)[3], ranking all locations based on their estimated modal shift success rate for transport to/from each sea port.

The results show a ranking of geographic entities in the analyzed area, making it easy for follow-up research to identify the companies or the transport flows with a high success rate for a modal shift to intermodal transport. The results are however to a great extent dependent on the reliability of the analyzed freight flows datasets and the estimation of the parameters and their weights which results in the overall affinity of a geographic entity, relying to a great extent on expert judgment. In addition, sensitivity analyses are conducted, which confirm the limited impact of the weights attached to the included criteria.

Research and applications in real world for business and policy making

The research described in the poster was commissioned by the Provinciale Ontwikkelings-maatschappij (POM) Limburg and the Logistiek Platform Limburg from Belgium and the Kamer van Koophandel (KvK) from the Netherlands. The study they commissioned had a twofold goal, of which the first one was to map the modal shift potential of the two adjacent provinces Limburg. A second part of the study, which was performed by consulting agencies, had as goal to perform a micro-scan of the companies and their transport flows, which are most suitable for a modal shift to inland waterways transport. The most eligible flows are to be selected next for individual guidance in modal shift efforts. The contribution of our research thus provides the input for finding the companies, with the highest success rate for modal shift.

Also for the port and transport community, this study provides some interesting insights. As the success rate for modal shift can be estimated through modelling efforts, the results can be used for strategic decision making. The results of the analysis are however highly dependent on the quality of the input data. This clearly brings up the importance of getting a detailed insight in the hinterland destinations, origins and volumes of the goods transshipped in the ports. The proposed methodology is particularly relevant to discover opportunities for new intermodal connections in the perspective of the sustainable modal split aims of ports and for hinterland competition among ports. The applied methodology could however also be used to assess the modal shift potential for case studies in other regions or for individual companies.

[3] Bottani, E., & Rizzi, A. (2007). An analytical methodology to estimate the potential volume attracted by a rail-road intermodal terminal. International Journal of Logistics Research and Applications, 10(1), 11–28. doi:10.1080/13675560600819668

RESPONSIBLE PORT INNOVATION
By PhD Researcher: B. Adhi Priyambodho

Promotor

Supervisor

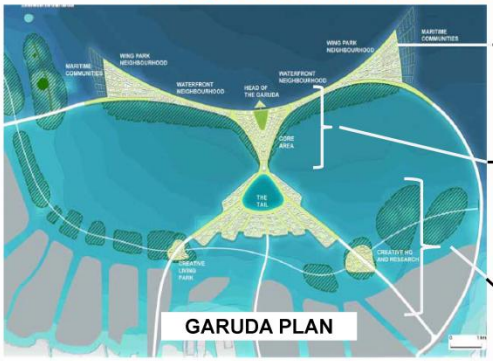
Deltares

DEPARTEMEN PEKERJAAN UMUM

PT. Pelabuhan Indonesia III (PERSERO)

Kementerian PPN/ Bappenas

Responsible Port Innovation as an Integrated Solution based on a diversity of expert and stakeholder values

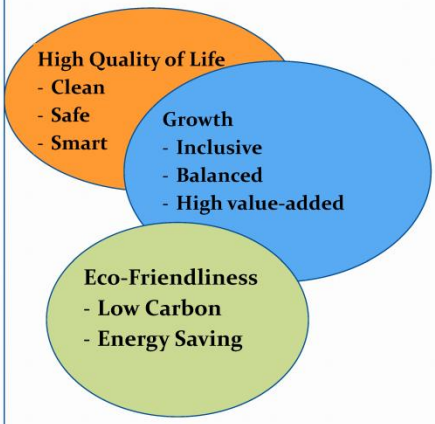


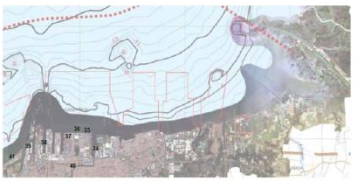
The Wing Connections

Body and Head; the Central Business District

Goals of the Jakarta Port Plan

Concept of Integrated Solution





PhD Researcher

Master Student

Problems

Solid Waste

Floods

Traffic

Catchment

Water Quality

Water Supply

Spatial Planning

Subsidence

Main questions in the dissertation project are :
- How to reconcile diverging, competing and/or conflicting values?
- Which methods could be used or developed for that purpose?
- How could Responsible Port Innovation be applied in practice?

The goal of this project is to develop a Responsible Port Innovation methodology and strategy. In the project, case-studies are made in order to find answers. One of these cases is the Jakarta port development. The study focusses on the present multi-faceted Garuda plan and especially applies Social Impact Assessment (SIA) and Cost Benefit Analysis (CBA).

Focussed on ethical values, Responsible Innovation is a good motor of economic growth and employment. This research project aims to address the challenges for the future of world port cities in a responsible way. First and foremost, Responsible Port Innovation starts with involving the public, stakeholders and their perspectives and values. Responsible Innovation has many aspects, and this project especially concerns sustainability and environmental protection, beside economics and technology.

" Responsible Innovation is an issue for all stakeholders and requires communication, information exchange and collaboration at early levels when a dispute can still be made in the design of systems, infrastructure and high cost of failure and public rejection can still be prevented " (Van den Hoven, 2012).

The 3rd Erasmus Smart Port Rotterdam/Port Research Centre Poster Session, Rotterdam, October 2nd, 2014

ERASMUS UNIVERSITEIT ROTTERDAM
SMARTPORT

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Port Research Centre
TU Delft

TECHNISCHE UNIVERSITEIT DELFT
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Kementerian Pendidikan & Kebudayaan
Republik Indonesia

Adhi Priyambodho , Delft University of Technology

Responsible Port Innovation

b.a.priyambodho@tudelft.nl

Supervisors: Prof I.R. van de Poel, Dr. W. Ravesteijn

Adhi graduated from the Department of Civil Engineering at Gadjah Mada University (UGM) and continued his studies taking the master programme of civil engineering at Diponegoro University (UNDIP). After receiving his master degree, he was a Junior Lecturer at the Engineering Faculty, Civil Engineering Department, UNTIRTA, Indonesia and then started his PhD research at Delft University of Technology (TU Delft) which is about " Responsible Port Innovation ". He started to work at TU Delft as a PhD researcher with Dr. Wim Ravesteijn (Assoc. Prof) as daily supervisor and Prof. Dr. ir. I.R. van de Poel (Ibo) as promotor. For the Jakarta Port research project Adhi working together with Caiyan Qin, master student from Harbin Institute of Technology, China.

A. Content of the research

A world port city can be conceptualized as a centre in several senses, like a place where groups of domestic and international people come together, of growth in terms of logistical and supply chains, a place at the crossroads of accountability, compliance and law enforcement systems (e.g. customs, tax and policing, safety). Such cities are meeting points of communities from different nationalities and spiritual and cultural backgrounds. They are places where investments and capital as well as manpower, are brought together for economic growth. Places where maritime traditions are continued with plans for future development. And they are both hotspots of cultural conservation and technological innovation, including Responsible Innovation (RI), which "…refers to ways of proceeding in Research and Innovation that allow those who initiate and are involved in these processes at an early stage (A) to obtain relevant knowledge on the consequences of the outcomes of their actions and on the range of options open to them and (B) to effectively evaluate both outcomes and options in terms of ethical values (including, but not limited to well-being, justice, equality, privacy, autonomy, safety, security, sustainability, accountability, democracy and efficiency) and (C) to use these considerations (under A and B) as functional requirements for design and development of new research, products and services" (European Commission 2013).

Focussed on ethical values, Responsible Innovation is a good motor of economic growth and employment. This project aims to address the challenges for the future of world port cities in a responsible way. First and foremost, Responsible Port Innovation starts with involving the public, stakeholders and their perspectives and values. Responsible Innovation has many aspects, and this research project especially concerns sustainability and environmental protection, beside economics and technology.

The goal of this project is to develop a Responsible Port Innovation methodology and strategy. The project is especially focussed on ways of dealing with a variety of engineering and stakeholder values.

Main questions in the project are :

- How to reconcile diverging, competing and/or conflicting values?
- Which methods could be used or developed for that purpose?
- How could Responsible Port Innovation be applied in practice?

In the project, case-studies are made in order to find answers. One of these cases is the Jakarta port development. The study focusses on the present multi-faceted Garuda plan and applies Social Impact Assessment (SIA) and Cost Benefit Analysis (CBA). The Rotterdam Port Maasvlakte 2 project will serve as a reference case.

B. Research content

Area : Greater Jakarta is the 2nd largest urban area in Indonesia (Jabodetabek), consisting of several districts and/or cities, like Jakarta, Bogor, Depok, Tangerang and Bekasi. The total population of Jabodetabek is around 30-35 million people. Bogor and Depok are situated on higher ground than Bekasi, Tangerang and Jakarta, resulting from neighboring volcanoes 2000- 3000 meter above sea water level (SWL).

Problem field :

1. Lack of spatial planning, flooding, a deficient water supply, it is a catchment area for high rainfall, the water quality in the district/region is insecure, there is a lot of solid waste in the small and big rivers, decrease of green area, and traffic jam.

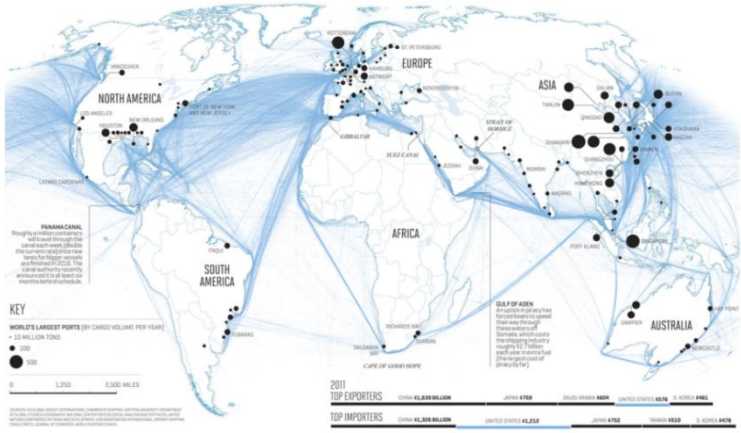


Fig 1 : Shipping lines in the world

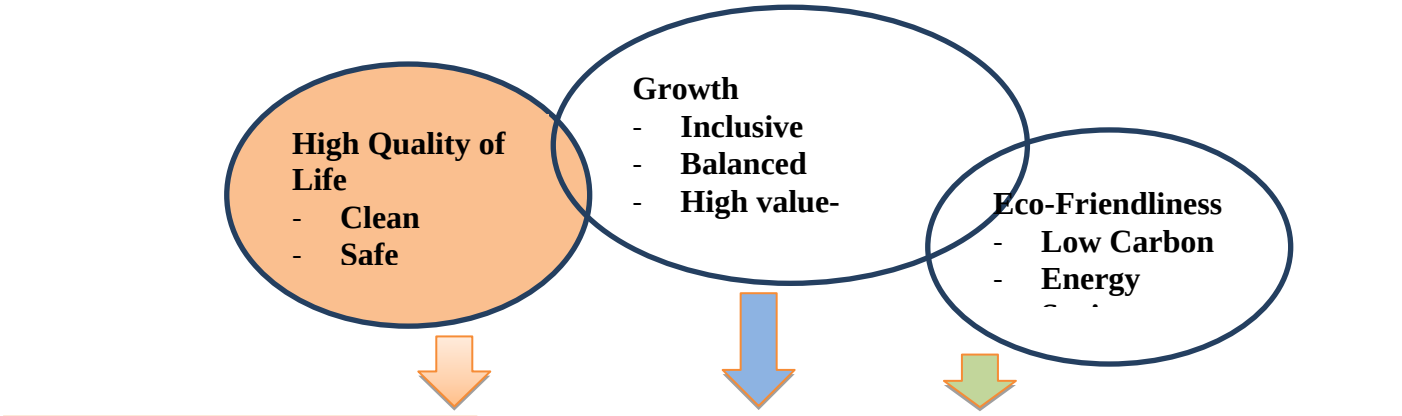
Fig 2 : Jakarta as capital of Indonesia

Sources : RTRW Jabodetabekpunjur, Presidential Decree 54/2008

Fig 3 : Jakarta Port location

2. Difficult access by road : the Jakarta government is reluctant to expand the road network for fear of more traffic congestion,
3. Tanjung Priok Port cannot handle big ships,
4. Lack of capacity and space to expand, including resistance from the local community.

Concept of Integrated Solution



A. Better Urban Environment

A.1.Development of MRT-based New Urban Transport System
A.2.Development of Road Network
A.3.Promotion of Urban Re-Development,
A.4.Improvement of Water Supply And Sewerage System,
A.5.Solid Waste Treatment,
A.6.Flood Management,

C. Multiple

B.1.Development of Cilamaya Port,
B.2.Improvement of Tj.Priok Port,
B.3.Development of New International Airport,
B.4.Improvement of Soekarno-Hatta International Airport,

B. Low-Carbon Energy

C.1.Low-Carbon Power Supply Development.
C.2. Development of Smart Grid

Application of the Integrated Solution :

The Garuda Plan (see figure 4-6), called "The Great Garuda", will be a project in a densely populated area. In the planning, they are considering population density, potential land-uses, functions, activities, the creation of neighborhoods, the character of streets and spaces, and visual and physical connections and associations. Mapping densities, green space areas, the catchment area and transportation facilities are considered in the design of the Great Garuda. The Jakarta Port has been designed to be able to serve larger and larger vessels up to 2030.

The NCICD (National Capital Integrated Coastal Development) concept aims and promises to solve the problems, not only with regard to the Jakarta Port capacities, but also other issues, offering solutions like: sea dikes to protect Jakarta from flooding; toll roads to service the rapidly increasing numbers of cars, trucks, and busses; railways & (MRT) Mass Rapid Transport to reduce traffic jams causing considerable economic losses; sanitation & drainage networks preventing flooding.

The NCICD infrastructure plan shall be integrated with other existing plans, including:

1. JCDS Jakarta Coastal Defense Strategy 2012
2. Masterplan of the Ciliwung–Cisadane area
3. Integrated Transportation Master Plan Study of Jabodetabek / SITRAM (Phase II)
4. Port Master Plan for Tanjung Priok
5. Jakarta Sewerage and Sanitation Master Plan (Review 2011)

Fig 4. The Indonesian national symbol : the Garuda

Fig 5. Visualisation of the east and west lake including the Garuda as a part of NCICD

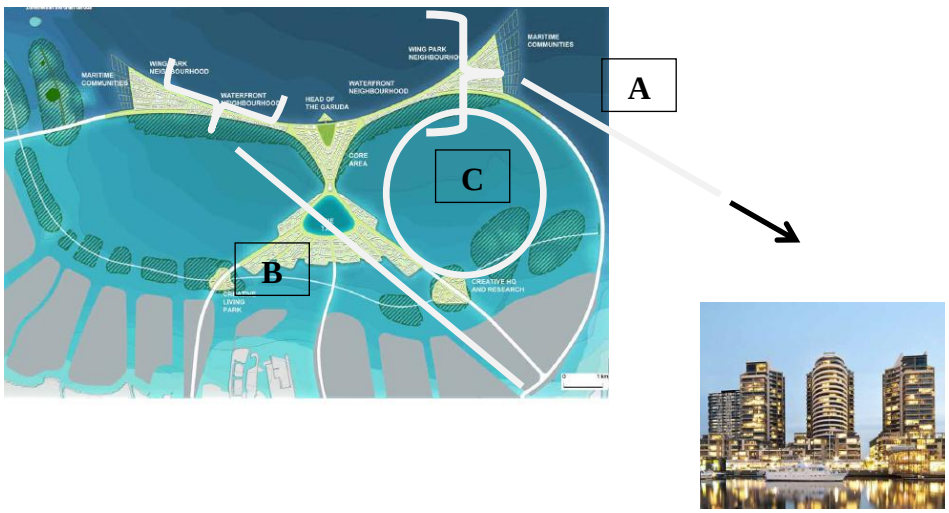
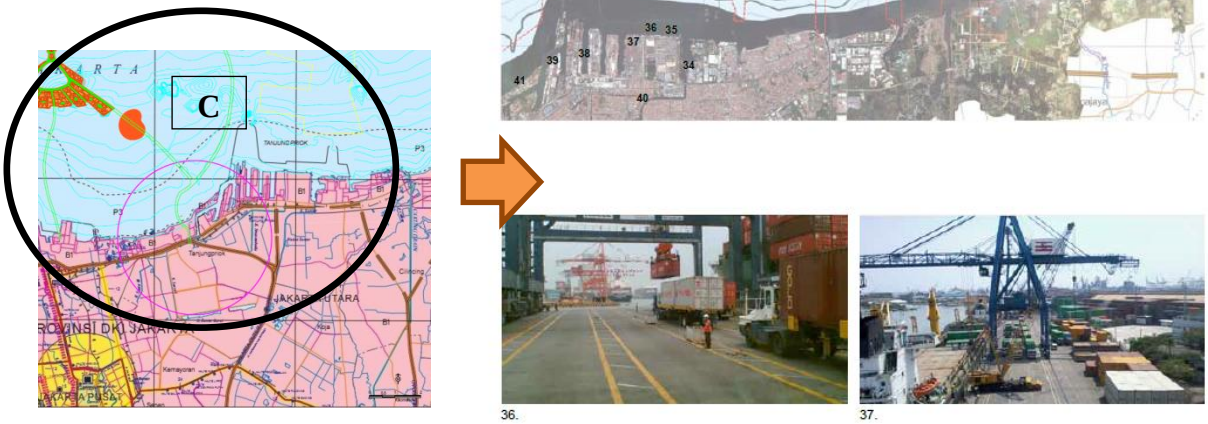


Fig 6. The Garuda Plan based on NCICD the Central Business District

A.Body and Head;

B. The Wing Connections



36. 37.

C. Proposed new Jakarta Port

In the dissertation project, Responsible Innovation research into the Jakarta Port area and plans includes impact assessment and the evaluation of the outcomes in view of project goals and stakeholder values. The Garuda Plan will be assessed with Social Impact Assessment (SIA) and evaluated with Cost Benefit Analysis (CBA).

D. Possible recommendations

The development of Tanjung Priok consists of three stages:

1. Short-term (2012-2017) : the construction of a container terminal (phase one), will be assessed in stage 2 : construction/implementation,
2. Medium-term (2018-2023) : container terminal (phase two),
3. Long-term (2024-2030): container terminal (phase three),

Medium and long term plans will be made on the basis of the experiences in stage 1 : planning/policy development. The Social Impact Assessment research could lead to recommendations to be used in the policy and decision making processes.

Natalya Rijk, Erasmus University Rotterdam

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

rijk@fsw.eur.nl
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 second year's Ph.D student of Public Administration. I am 25 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 the relationship between the Port of Rotterdam Authority, governmental authorities and businesses in matters of Energy Port.

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 centred 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 wider multi-level and multi-actor relationships, 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. My supervisors are prof.dr. Harry Geerlings, dr. Frans van Nispen, and Ruud Melieste.

In my spare time I volunteer at the animal shelter in Leiden, am an avid video gamer, like to read books, at times try to write books (fiction), and practice yoga.

What am I researching?

As the world's largest regional energy market, Europe's challenges with respect to climate change, sustainable energy access and technological advancement are exemplary for the challenges faced worldwide. The creation and implementation of public policies is meant to tackle such challenges and move societies forward. The European Union has been slowly but surely taking hold of more and more policy fields over the years of its existence. 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 Authority.

In its strategic document *Havenvisie 2030* the Port of Rotterdam Authority (PoR) envisages a transformation towards a green Energy Port, an ambition which is backed by the Rotterdam Climate Initiative (RCI). Rotterdam Energy Port is a growth concept focusing on infrastructure, transhipment,

The 3rd Erasmus Smart Port Rotterdam/Port Research Centre Poster Session, Rotterdam, October 2, 2014

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

HOW DOES THIS WORK?

KEYWORDS

(MULTI-LEVEL) GOVERNANCE
EUROPEAN UNION
ENERGY PORT
NETWORK ANALYSIS
LNG
CCS

WHY IS THIS RELEVANT?

- HELP REALISE ENERGY PORT AMBITIONS
- IMPROVE DIALOGUE BETWEEN PORT OF ROTTERDAM AND 'BRUSSELS'
- PROVIDE INSIGHT IN PORT OF ROTTERDAM'S NETWORK
- CONTRIBUTE TO THE ORGWARE OF THE PORT
- HELP IMPLEMENT HAVENVISIE 2030
- FOSTER CONNECTION BETWEEN BUSINESS AND RESEARCH

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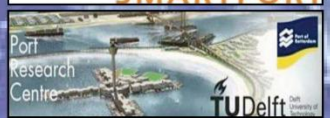

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ERASMUS UNIVERSITEIT ROTTERDAM

production and knowledge with regards to energy. Developing the Energy Port is part of the policy and mandate of the Port of Rotterdam Authority. The concept consists of five pillars and a backbone. The five pillars are the LNG hub, the coal and biomass hub, the CO_2 hub, (sustainable) electricity generation, and energy efficiency. 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 and is subject to stringent sustainability criteria. One of the most notable developments of the last years is the Gate terminal for LNG, which enables LNG storage and transport, both as cargo and as fuel. 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, challenges provide rough waters for the port to navigate through. The large-scale development of shale gas in the U.S. has 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. Competition with other ports is high, with the Port of Hamburg undergoing rapid growth again after a period of decline. The EU has shifted policy priorities to combat climate change from the development of CCS to renewable energy, which makes CCS initiatives difficult to finance. The lack of investments into sustainable energy elsewhere, for example Eastern Europe, hampers the effectiveness of climate change action.

It would be in the interest of the Port of Rotterdam to have similar sustainability demands (and a level playing field) 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[4] have focused on issues such as green transport, bio-based economy (BBE), CO_2 reduction, energy efficiency and so on. However, the EU leaves matters of port policy up to its Member States, while many other regulations that are relevant to the port (or the industry in the port) stem from various Directorate-Generals, thereby blurring the legislative picture. The relationship between levels of government is at best ambiguous and is further complicated when considered in a networked perspective in which private sector actors and other non-governmental actors also take part. In short: we are observing a dynamic context in which the Port of Rotterdam Authority has to operate. The relationships between the Energy Port actors are embedded in a wider multi-level and multi-actor context, which may have fundamental consequences for these relationships over time. Rotterdam Energy Port has a multi-level governance aspect due to the participation of actors such as governments, companies, NGOs, and even citizens — both national and international. However, whenever multiple actors are present, there will be multiple goals and strategies to achieve these goals as well. Sometimes these contradict and cause tension, possibly straining the network. Add to this picture the EU's tendencies to Europeanise port policy, either through soft or hard law, and the PoR is facing both an advocacy

[4] 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.

problem and a potential loss of sovereignty, while it was used to being able to heavily influence Dutch policy-making. The question how Energy Port governance can be explained and what its consequences are then arises.

To answer the main research question, this study draws on multi-level governance literature to provide a starting point for further inquiry. Assuming that both public and private actors are important in policy-making surrounding Energy Port matters, I look at how they interact and which channels are important for the Port of Rotterdam Authority to monitor. A network analysis gives insight into who is important in Rotterdam Energy Port, what they bring to the table, what they want, how they are connected to each other, and what role power plays in their relationships. The current economic and political context will also be considered, since external developments can have great impact on policies or on the day-to-day operations of the Port of Rotterdam. My two illustrative cases are LNG and CCS.

What are the practical implications of my research?

This thesis contributes directly to the implementation of an important part of *Havenvisie 2030* and it will provide the Rotterdam Port Authority with instruments to influence EU decision-making and project funding based on a network analysis and resulting recommendations. As stated above, the Port of Rotterdam has high ambitions concerning its Energy Port. This ambition coalesces with the Rotterdam Port Authority'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 Authority 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 management in a network consisting of both public and private actors encompassing multiple levels of government.

The Port of Rotterdam Authority 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 PoR 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. 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.

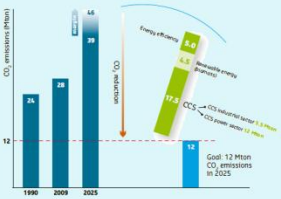
The 3rd Erasmus Smart Port Rotterdam/Port Research Centre Poster Session, Rotterdam, October 2nd, 2014

CCS and the barriers for its fully deployment in the Port of Rotterdam

Juliana Sara da Silva, MSc, MBA

Introduction

The Rotterdam Climate Initiative (RCI) has the ambitious of reducing 50% of its CO_2 emissions by 2025 while promoting the economy in the Rotterdam region. CCS plays a vital role in achieving this goal: it'll be responsible for about 65% of CO_2 emissions reductions.



CCS will contribute to around 65% of Rotterdam's emissions reduction target

Research Goal

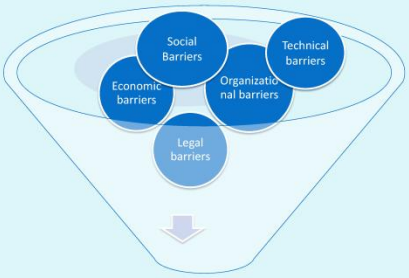
CCS is a complex project with many interviewing factors. Besides the high interest of major public and private players, the lack of knowledge about these factors impose barriers for a fully successful implementation of CCS.

Research aim: identify and assess the main barriers for developing CCS from the perspective of different types of stakeholders. Which barriers are more important and how they influence each other.

Scientific contribution: improve the understanding of project complexity from the point-of-view of a project that is on early phase of development.

Methodology

Literature Review:



Short list with 7 main barriers from literature

↓

Survey with CCS experts

↓ ↓

Ranking of the barriers (AHP model)

Mutual influence of the barriers (DEMATEL model)

↓ ↓

Strategies to better manage CCS barriers

Relevance for PoR

- Identification of the main bottlenecks and the most influential factors affecting CCS projects;
- Development of a better framework for the decision-making evaluation process.;
- Development of strategies to better manage CCS projects and to more efficiently and effectively allocate resources.

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Juliana Sara da Silva, Delft University of Technology

CCS and the barriers for its fully deployment in the Port of Rotterdam

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Supervisors: Prof. Dr. P. Herder, Dr. ir. R. Stikkelman

Curriculum Vitae:

Juliana Sara da Silva has a background in chemical engineering and an Erasmus Mundus Master in environmental studies. During her career, she worked as a trainee in a steel industry and then worked two years and a half in project departments of chemical industries, being my last job at Dow Chemical. During this period, she also concluded a MBA in Administration. Currently she is in her third year of her Erasmus Mundus PhD program in Sustainable Energy Technologies and Strategies (SETS) with association with the University of Comillas, in Madrid and the Royal Institute of Technology, in Stockholm.

Juliana is supervised by Prof. Dr. Paulien Herder and Dr. ir. Rob Stikkelman.

Research:

In the Netherlands, the Port of Rotterdam, whose industries are responsible for 85% of CO_2 emissions in the area, have an ambitious CO_2 reduction target. Envisioning keeping its lead position during the energy transition to sustainable energy economy, the port aims at realizing 50% reduction by 2025 compared to 1990. Around 65% of this amount is expected to be achieved via CCS initiatives.

However, implementing CCS is not an easy task. CCS is a complex project, characterized as having several intertwining factors, which hinders a successful development and implementation process and makes the outcomes difficult to predict. These complex factors, here defined as barriers, exist and impose hard constraints for a proper continuation of the project. The consequence is that, even with a high interest of major public and private players, CCS initiatives in the Port of Rotterdam are still in the beginning phase.

In terms of scientific gap, I've observed that most researches focus their studies on project complexity only of projects that have already finished or are in advanced stages, such as during front-end development (FED) phase. It's missing in literature a proper understanding and analysis of the factors affecting complexity of projects on very early stage of development, when several unknowns, uncertainties and risks are involved.

Another limitation of the current literature is the lack of studies that quantitatively prioritize and analyze the interactions among the several complex factors and dimensions. In a complex system, different factors, which are connected directly or indirectly, may have different reasons: economic, technological, regulatory, social.. Each of them with different influence, importance and impact on the system.

They are very diverse and difficult to assess. Under the constraints of limited resources (information, budget, knowledge, manpower, time), there are no action that can overcome all these barriers simultaneously. A sort of prioritization is needed. An appropriate decision-making (DM) approach is then necessary to prioritize these barriers and allocate resources more efficiently and effective.

Therefore, the purpose of my research is twofold. First I aim at understanding complexity from the point-of-view of a project that is on early phase of development. For that, I'm analyzing CCS projects being developed in the Port of Rotterdam. My objective is to identify and assess the main complex factors that can be considered barriers for the development and implementation of CCS from the perspective of different stakeholders. I believe that divergent points-of-view can seriously jeopardize the progress of the CCS project, once that a consensus during the decision-making process is more difficult to be achieved.

Second, I want to determine which complex factors are the most important ones and how they influence each other. For that, I'll apply a hybrid multi-criteria decision method (MCDM), combining two quantitative methods: the Analytic Hierarchy Process (AHP) and the Decision Making Trial and Evaluation Laboratory (DEMATEL). AHP is applied to prioritize and rank complex factors in terms of their contribution to complexity of CCS projects. DEMATEL is used to define and describe the interactive relations and dependences between the different factors via a causal-effect relationship map. These methods are able to quantify the subjective judgment of decision makers in a way that can be measured and evaluated. In the end, I'll conduct a series of interviews where strategies to better manage these barriers are discussed and developed.

The proposed methodology can be highly benefit the take-off of CCS projects in the Port of Rotterdam. The outcome of my research can help decision-makers to identify the main bottlenecks as well as the most influential factors affecting CCS projects, developing a better framework for the decision-making evaluation process. Thus, strategies can be designed to better manage these projects and resources can be more efficiently and effectively allocated.

Mariska van der Sluis, Erasmus University Rotterdam

Port related transport emissions and its health impact: how to undo it?

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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 (www.mariskavandersluis.nl) 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 on the health impact of port related transport (road- and waterways) and the development of better knowledge transfer strategies to reduce the health impact of port related transport in the Rotterdam urban area.

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 this period, she developed an interest in knowledge transfer processes and complex governance issues.

PHD Research

The research bounded to this thesis aims to contribute to the knowledge and, ultimately, the development of new policies concerning the urban health impact of port related transport activities, especially in Rotterdam.

Health impact

Particulate matter pollution is linked to cancer, asthma, premature death and cardio-respiratory diseases. Recent scientific studies show that black carbon is one of the most damaging components of particulate matter and is greatly increased near busy roads. Using particulate matter as a standard near busy roads, the health impact of transport related emissions is underestimated, by a factor of five. However, particulate matter is still the standard used in Europe, also when it comes to estimating health impact near busy roads. The Rotterdam region is home to the largest port complex in the nation, which highly relies on diesel-powered ships, trains, and trucks to sustain its operations. Therefore, also the health impact of port related transport emissions in the Rotterdam region is underestimated. In this thesis, new calculations using black carbon as a health impact indicator are made, in close collaboration with the DCMR 'Milieudienst Rijnmond', the Rotterdam Port Authority and Erasmus MC (department of Public Health).

The 3rd Erasmus Smart Port Rotterdam/Port Research Centre Poster Session, Rotterdam, 2-10-2014

Negative health effects of port related traffic in the Rotterdam urban area: what is the impact and how to undo it?

Black Smoke as health indicator

Health impact underestimated

using PM as indicator near busy roads (x5).

Black Smoke (EC), mainly produced by diesels, is a better health indicator in urban areas

Large health benefits for Rotterdam: no diesel, no living close to busy roads/highways

Port related emissions of black smoke (EC), A20 and A13

Highway	% freight in emissions	EC %, avarage	Health impact close to the highway	EC %, max.	Health impact close to the highway
A15	50%	6	- 4 years	15	- 10 years
A20	25%	2	- 16 months	6	- 4 years

DCMR, 2014

Black smoke causes:

Alzheimer

Asthma

Less longcapacity growing up

Heart disease

How to undo it?

Literature says:

Barriers

- Time
- Access to health impact Information
- Language & presentation

Facilitators

- Support within organization
- Strong network
- Collaboration with researchers

Policy makers in Rotterdam speak out:

Barriers

- Fear of weakening position port
- Lack of intergovernmental support
- No unanimity among researchers

Facilitators

- Time
- Public support / public pressure
- Easy access to health impact information
- Language and format
- Measurable health effects/ costs for society

Port companies say:

Interviews in 2014/2015

ERASMUS UNIVERSITEIT ROTTERDAM
SMARTPORT

Port Research Centre TUDelft

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ERASMUS UNIVERSITEIT ROTTERDAM

Erasmus MC

On the long term, 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. However, diesel is still the most cost-efficient fuel in transport. The ambition to establish a transport system that reduces the problem of black carbon and other fine particles significantly, should be defined as a high one, since the past has proven this is a difficult problem to tackle.

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. 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'*.

This phd research want to contribute to achieve this goal, not only by providing new calculations, but also by analyzing the bridges and barriers to achieve this goal. Insights in these bridges and barriers are obtained throughout intensive contact (interviews) with all relevant stakeholders: from policymakers on the local, national, and international level (EU) to the (transport)companies in the port area.

The 3rd Erasmus Smart Port Rotterdam/Port Research Centre Poster Session, Rotterdam, Oct 2nd, 2014

Predictive Path following for waterborne AGVs -- with application to Inter Terminal Transport

Huarong Zheng, Rudy R. Negenborn, Gabriel Lodewijks

Background

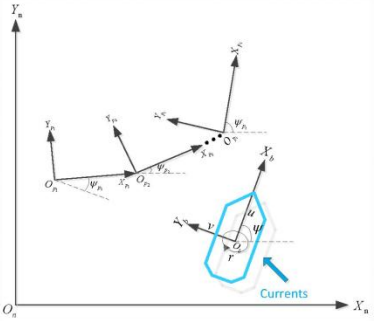
1. Increasing volume of container transport in port area;
2. Complex layout of terminals, e.g., Maasvlakte 2;
3. Inter Terminal Transport (ITT) via waterborne mode in an innovative, automated and optimal way.

Goals of this research

Proposing waterborne AGVs (Automated Guided Vessels) for ITT with focusing on low level trajectory optimization, including both single AGV **path follwing** and multiple AGVs **cooperative coordination**, pioneer research work for vessel companies and port authorities.

Challenges

- Limited manoeuvrability
- Multiple conflicting objectives
- State, input and output constraints
- Nonlinear vessel dynamics
- Overshoot when switching reference
- Smooth tracking with timing requirements



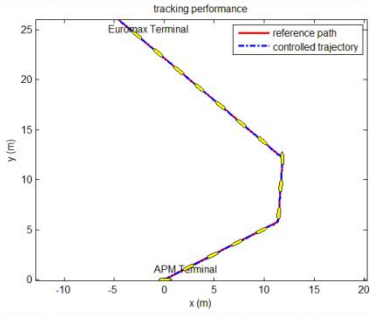
Why MPC ?

- Predictive feature
- Optimization based control technique considering cost function quantitatively and constraints explicitly
- Linearizations are conveniently implemented about previous predicted optimal trajectory

Approach

- A 3 DOF maneuvering model with kinematics expressed in path frames for
  - *minimizing cross-track and along-path tracking errors*
  - *predictive switching reference paths avoiding overshoots*
- Successive linearizations in the framework of Model Predictive Control (MPC)
- Parameterization of reference for smooth tracking
- An upper level generating along-path references over the receding horizon guarantying a required (minimal within a time window when not feasible) time of arrival

Simulation results



Required time of arrival: 300 s; Actual arrival time: 299 s.

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Predictive Path following for waterborne AGVs with application to Inter Terminal Transport

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Supervisors: Dr. R. Negenborn, Prof. G. Lodewijks

1 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).

2 Research Contents

2.1 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.

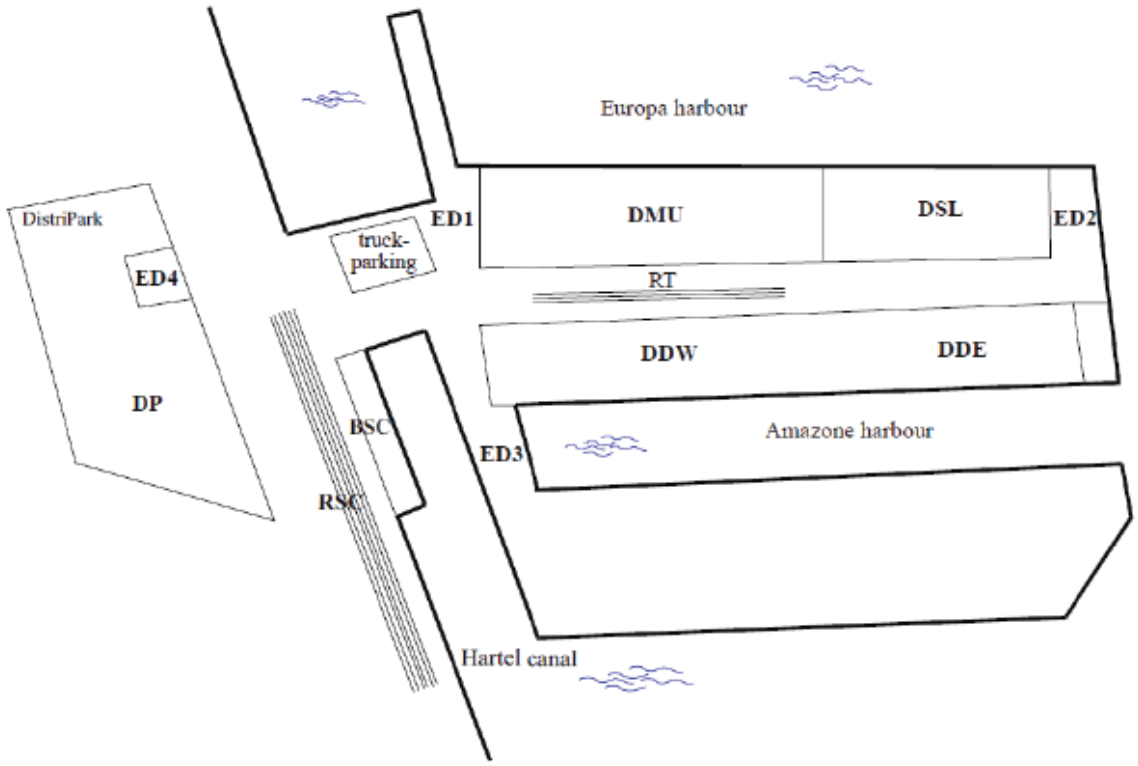

Figure 1: General layout of the Maasvlakte

2.2 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 prediction 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 manoeuvrability 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 logistic swarehouses, 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.

2.3 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.

3 Relation with Port Vision 2030

Keywords for the development of the Port of Rotterdam are flexibility, efficiency and sustainability. PortVision 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 roadtraffic in port and at the same time, form a closed automated transport route for a smart port.

Individual waterborneAGVs 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 Collision sat 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 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 determine 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, efficiency and sustainability, which is in accordance with the vision of the Port of Rotterdam.

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The 3rd Erasmus Smart Port Rotterdam/Port Research Centre Poster Session, Rotterdam, October 2, 2014

"Methodology to assess ports and waterways on safety and capacity"

X. Bellsolà Olba, Dr. W. Daamen[1], Prof. T. Vellinga[2] and Prof. S. Hoogendoorn[1]

Problem Description

Globalization trends in maritime transport are leading to rapidly growing ship dimensions and increasing flows in ports and waterways. Ports and waterways are quite inflexible infrastructures and difficult to expand. This implies that the aforementioned increase in vessel movements leads to more hazardous situations.

Research Objectives

- Describe and quantify safety and capacity in ports and waterways.
- Combine different performance indicators in a unique tool to support and assess the planning port phases (expansion or new).
- Assess and improve port designs.
- Assess risk and traffic management strategies.

Port design

Automatic Identification System (AIS)

Research Development

1) Safety and capacity definition and quantification
2) Analysis of real information:
   - AIS data
   - Authorities, Port Stakeholders or other actors needs and requirements
   - Actual Port designs
3) Combination of Safety & Capacity
4) Methodology development
5) Cost quantification
6) Case studies
7) Multi-Criteria Analysis

Port Stakeholders, Authorities or other actors

Research & Real World

The resulting methodology will be a tool for Stakeholders or Policy Makers with application to reality to:

- ❖ Assess and compare different scenarios and infrastructure designs through Multi-Criteria Analysis (MCA).
- ❖ Assessment of traffic management strategies and navigational rules.

Expected results

- ✓ Simulation-based methodology for the future assessment and design of ports and waterways.
- ✓ Real case studies both in the Netherlands and China

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Methodology to assess ports and waterways on safety and capacity

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Curriculum Vitae

Xavier Bellsolà Olba is a PhD Candidate at the Delft University of Technology since January 2014. Prior to his current position, he obtained a 5-year Bachelor and MSc equivalent degree in Civil Engineering (2011) at the Polytechnic University of Catalonia (UPC), in Barcelona, Spain. As part of his studies he participated in an international semester exchange program at the Chalmers University of Technology in Sweden (2010).
Before starting his PhD trajectory, he worked as a Project Engineer in the development of infrastructure and hydraulic engineering projects both in Spain and Chile.
His PhD research, funded by NWO, mainly focuses on relation and estimation of safety and capacity in vessel traffic in ports and waterways.

Contents of the research

Globalization trends in maritime transport are leading to rapidly growing ship dimensions and increasing flows in ports and waterways. Ports and waterways are quite inflexible infrastructures and difficult to expand. This implies that the aforementioned increase in vessel movements leads to more hazardous situations.
Furthermore, ports need to handle a higher traffic demand that implies longer waiting times for vessels, which reduces the capacity of the system. Because of the increasing demand, ports and waterways need to be optimized or expanded or new ports have to be designed. In all cases, both safety and capacity of the system should be guaranteed.
The aim of this research is the development of an assessment methodology relating several indicators for ports and waterways, including safety and capacity. Moreover, vessel behaviour and vessel interaction with the port infrastructure and its traffic performance will be analysed. This is a multidisciplinary research and it involves many different aspects, resulting in an assessment methodology with general applicability.
This methodology will be based on a simulation model that is currently being developed by TU Delft. This model will include vessel behaviour, human factors and external conditions, like hydraulic and weather conditions. Furthermore, based on game theory, bridge team behaviour will the base for this innovative microscopic traffic simulation tool.
AIS (Automatic Identification System) records vessel's motion and manoeuvring, among other relevant information, and it will provide new data for the calibration and validation of the model and it will be useful to have better knowledge of vessel navigation and it will help to develop and improve the resultant methodology. Port designs will be analysed in deep to get relevant information from different possible designs and their effects on safety and capacity in these infrastructures.

The process to develop this methodology will consider the current state of the art and AIS data analysis as an assessment of the model input or for new model requirements. These will be used as the base for the development of the method. Additionally, the new requirements will be evaluated also in accordance to the needs and requirements from port stakeholders or other actors related, that will assess both, model and methodology. All these steps will lead to other relevant indicators to be included inside assessment tool, as environment or others.

From the output of the model, the different performance indicators will be analysed and assessed in order to link them and develop the assessment methodology in busy waterways and ports with a dynamic analysis.
Once the main criteria and performance indicators are analysed and identified, it will allow to an economical quantification and the generation of some multi-criteria analyses (MCA), which results will be the base of this suitable tool for the assessment of safety and capacity in ports and waterways. It should allow to be used and applied in any desired scenario, based on the cited MCA. The tool will be tested and applied to real cases both in the Netherlands and China.

The research and possible applications in the real world

Since there is an increasing social conscience about avoiding hazards, dangerous situations and accidents, especially in urban areas, an extensive research already exists related to quantitative risk assessments or risk based index assessments, mainly based in collision avoidance or terminal operations. Port authorities are aware of these problems and try to mitigate the existent hazards, and anticipate future hazards. Higher densities lead also to a higher amount of vessels into the system, that raises its capacity, but there is no research developed considering both, safety and capacity.
Due to the complexity of the problem and the lack of research and tools to support port authorities, this project will be developed.
In order to complete the whole research, needs or requirements from different stakeholders, actors or policy makers, that are related to the Port and vessel navigation and directly involved in the field, will be identified and considered. This will be done in order to create a method generally acceptable and applicable by them, as well as to connect the research with the real world .
Furthermore, as introduced before, real AIS data and port designs will be analysed with the aim of obtaining a better insight into the reality of navigation issues and infrastructure characteristics.
Moreover, since all infrastructures need high investments, decisions have to be evaluated under the economical perspective. Because of this, one of the most important factors to take into account to expand or build new infrastructures is the cost of each component and how it should influence the choice of one thing or another depending on economic aspects. Main costs will lead to the definition of some relevant economical indexes for the development of MCA.
After the development of the methodology, test and assessment of real scenarios will be carried out in order to show its applicability. MCA results will be the base of this suitable tool for the assessment of safety and capacity in ports and waterways and all the different actors should be able to use it for their different needs, as it could be to improve port designs, navigation rules or traffic management strategies.

Shijie Li, Delft University of Technology

Intelligent Waterways for Inland Water Transport

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Supervisors: Dr. R. Negenborn, Prof. G. Lodewijks

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.

The 3rd Erasmus Smart Port Rotterdam/Port Research Centre Poster Session, Rotterdam, Oct 2nd,2014

"Intelligent Waterways" for Inland Water Transport

Shijie Li, Rudy R. Negenborn, Gabriel Lodewijks

Current problems

1. Terminal planning for inland vessel handling is inadequate
2. Limited information exchange between inland vessel operators
3. Uncertain waiting, handling at waterway infrastructure and inland vessel arrival times

To improve

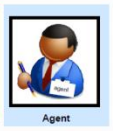
Efficient coordination and collaboration

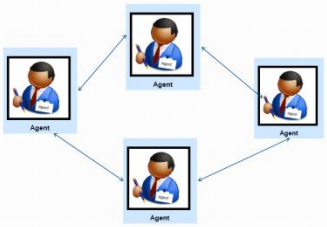
How?

Research approach

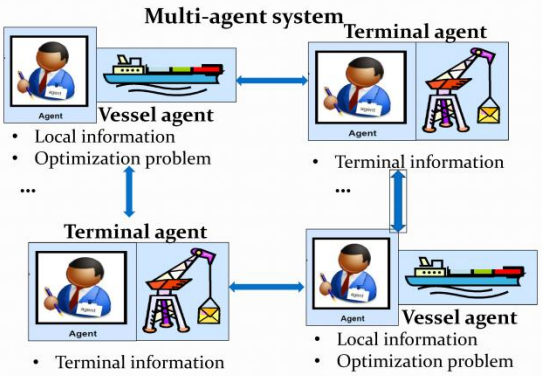
1. Formulate the problem based on **multi-agent system** in which inland waterway users are represented as agents

2. Each agents has its own local optimization problem, different mathematical programming approaches are investigated to obtain initial solutions.





3. Based on the solutions from each agent's local optimization problem, mechanisms of how agents coordinate and negotiate in order to resolve conflicts are proposed.



Possible users

- Inland vessel operators
- Terminal operators
- Port authorities

Research outcomes

- Efficient scheduling of inland vessels
- Better organized vessel visits in ports
- Possible ways to improve the communication and collaboration between inland waterway users

Publications

- S. Li, R.R. Negenborn, G. Lodewijks. Survey on planning problems in inland waterway transport: Current status and future perspectives. In *Proceedings of the 16th International IEEE Conference on Intelligent Transportation Systems* (IEEE ITSC 2013), The Hague, The Netherlands, pp. 1231-1237, October 2013
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- S. Li, R.R. Negenborn, G. Lodewijks. Vessel rotation planning: A layered distributed constraint optimization approach. Submitted for *the 5th International Conference on Agents and Artificial Intelligence* (ICAART'15), Lisbon, Portugal, January 2015

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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 inside one port, research on the optimization and control of inland waterway trans- port is rare. 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 certain integrated optimization methods that can be used to improve the efficiency and usage of inland waterway transport, different communication mechanism and optimization techniques will be incorporated and tested, 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 trans- port 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 develop a 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.

For each single agent in the system, it has its own problem and objective, which will be formulated as mixed-integer programming problem, and different mathematical programming heuristics will be used to obtain solutions. Communication and collaboration between individual agents is based on distributed con- straint optimization (DCOP), which 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 maxi- mized [11]. 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 Possible application

In literature, there are not many research focus on the inland waterway transport and inland vessels. Our research provides certain methods that can help to improve the negotiation and collaboration between different inland waterway users, such as vessel operators, terminal operators, ..., etc. For the vessel oper- ators, they can use the solutions generated from our model to decide their visiting sequence and time of arrival/departure at each location on the waterways in a time-efficient and economic way. For the terminal operators, they can use the different communication mechanism and model to better schedule the activities inside the terminal. For the ports, arrange the inland vessels in a more organized way, more cargo can be transported within less time, and thus can help to improve the throughput.

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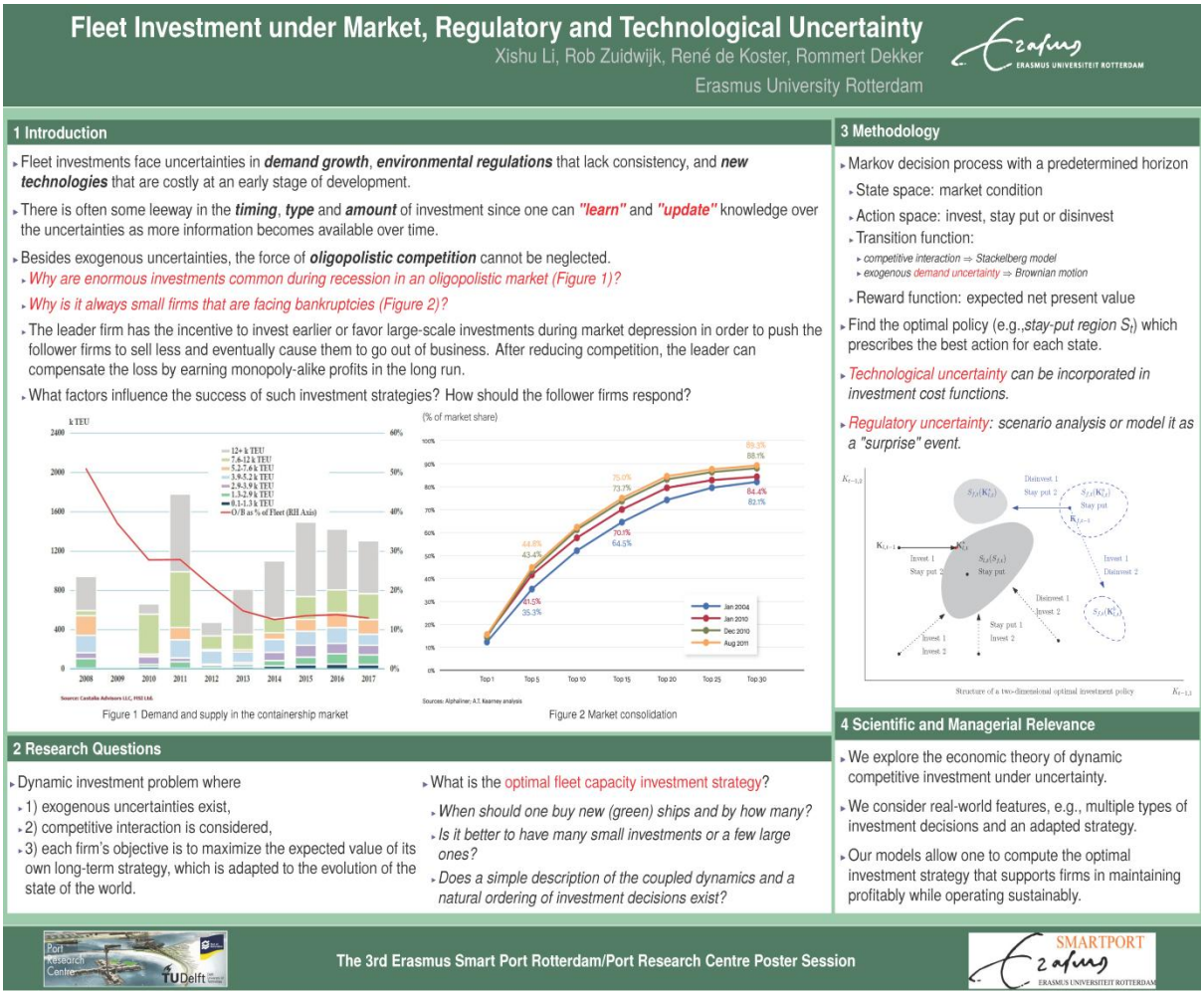

Xishu Li, Erasmus University Rotterdam, Rotterdam School of Management

Fleet Investment under Market, Regulatory and Technological Uncertainty

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Supervisors: Prof. R. de Koster, Prof. R. Dekker, Prof. R. Zuidwijk

a. CV

Xishu Li is a PhD candidate at the Department of Technology & Operations Management, Rotterdam School of Management, Erasmus University. In 2013, she graduated from the research master program (MPhil) in the domain of Logistics at the Erasmus Research Institute of Management and started her PhD in October in the same year. Her supervision team includes Professor René de Koster (promoter), Professor Rommert Dekker (promoter) and Professor Rob Zuidwijk (daily supervisor).

Xishu is specialized in operations research, quantitative logistics, and modeling. Her current research focuses on dynamic investment under uncertainty in an oligopolistic market and evaluation of green port & shipping initiatives. Her latest (upcoming) publication will appear in Decision Sciences.

b. Research contents

i. introduction

The shipping market is uncertain, regarding the demand growth, (environmental) regulations that lack consistency and new (green) technologies that are costly as they are still at an early stage of development. An investment in ships is partially or completely irreversible as capacity or technology costs cannot be fully recovered should one have a change of mind. However, there is often some leeway in the timing, type and amount of investment, as one can "learn" and update one's knowledge over the uncertainties as more information becomes available over time. Besides the resolution of exogenous uncertainties, firms should also condition their investment decisions on the (re)actions of their competitors. This is because the shipping industry, which is dominated by a small number of shipping lines, is a good example of an oligopolistic market. With few sellers, each oligopolist is likely to be aware of the actions of the others. The decisions of one firm therefore influence and are influenced by the decisions of the other firms. Due to the interdependence in decision-making, the leader firm usually has the power to force the follower firms out of business by preventing them from profiting for a period of time. As the leader firm follows a long-term strategy (i.e., a sequence of investment decisions which will be made at each time period), he has the incentive to invest earlier or favor large-scale investments during market depression in order to push the follower firms to sell less and eventually cause them to go out of business. After reducing competition, the leader firm can compensate the loss by earning monopoly-alike profits in the long run. In this research project, we explore such a dynamic investment problem where 1) uncertainty exits in exogenous demand growth, regulation and technology respectively; 2) competitive interaction is taken into account; 3) each firm's objective is to maximize the expected net present value of his own long-term strategy, which is an adapted process to the evolution of the state of the world. Rather than merely finding an optimal investment solution, we are interested in a description of the dynamics and ordering of investment decisions by finding the optimal investment policy according to which a firm invests. Furthermore, we will investigate the factors that influence the advantage of the first mover (leader), i.e., the benefit of commitment power, and when preemptive investments will most likely to happen.

ii. Methodology

Considering demand uncertainty only, one of the most promising approaches to model our research problem is to use the Markov decision process (MDP) framework from decision theory. A major advantage of using the MDP is the Markov assumption, which entails that future states and rewards depend only upon the present and not on the sequence of events that preceded it. An MDP encompasses a state space, an action space, a transition function, a reward function and a horizon. The state space consists of states, which in our case represent the market condition i.e., the capacities of different types of ships for all shipping companies and the corresponding customer demands. The action space is a set of investments decisions. Here, we assume that there are only three types of investment decision: invest, stay put and disinvest. The difference exists in quantities, i.e., different changes of capacity. The transition function outputs the probability for a transition to a successor state after taking an action in a state. The Stackelberg model, which is widely used to describe oligopolistic competition, can be adopted here to implicitly model the transition probabilities regarding what possible reactions of the other players will be and how companies' decisions will transfer the state and change the reward. The reward function describes the reward associated with a state, which in our case corresponds to the firm's expected net present value.

Finally, the horizon corresponds to a predetermined time-period. For a defined MDP, the goal is to find the strategy that accrues the most expected total reward over the horizon. A policy for one shipping company is a decision rule that prescribes a specific action in each state given the company's current capacity level. An implicit assumption in the MDP approach described above is that the other players will always take the best response, for example, solutions according to the Nash equilibrium, and the decision-making firm knows that. However, we should realize that one can only anticipate this behavior from his competitors, but that it cannot be ensured. In other words, there may be some uncertainties in the decisions of the other players. Instead of modeling this stream of uncertainty as a separate Markov chain or stochastic process, the best approach is to incorporate it into the current MDP by allowing a partially observable environment, i.e., firms do not have the perfect information regarding the current state. For that purpose, a partially observable Markov decision process (POMDP) could be used.

c. Scientific and managerial relevance

The shipping business has had a difficult ride in recent years, with many companies going bankrupt. This battle for survival of shipping companies cannot be exclusively attributed to the recession as there has actually been a considerable improvement in shipping demand since 2009; it is probably more related to the fact that the global fleet have expanded disproportionally to trade value growth by as much as 144 percent from 2005 to 2014. Leading carriers happened to largely increase their capacity one after another as if by prior agreement, especially in those tough years. For instance, the Maersk spent $3.8 billion in 2011 to build twenty of the world's largest ships (Triple-E-class), starting deliveries in 2013, while the market was and still is characterized by overcapacity. Larger vessels are more cost efficient as they result in lower cost in many categories e.g., capital cost, operating cost and bunker cost. However, this advantage can only be realized when the capacity is appropriately utilized. Under a market condition with severe overcapacity, the economy-of-scale of large vessels is often lost. Besides cost savings of large vessels, it is also argued that this order of many big ships is a gamble, on Maersk's part, that Chinese exports will continue to grow.

Nonetheless, another explanation could be that taking advantage of the occasion of market depression, the leader further lowers the freight rate by increasing his capacity and thus leaves fewer customers to his competitors. The competitors with strong financial background can survive by increasing their capacity likewise, while the weaker companies may close down as they lack customers to balance the cash flow. It has been shown that, following the Maersk's investment, China Shipping Container Lines has ordered 5 ships with a capacity of 18,400 TEU, topping the Triple-E-class and United Arab Shipping Company has also ordered 5 ships larger than the Triple-E-class. In a situation like this, the strongest carrier will have a long-term strategy in place. Cutting the weeds in the winter in order to harvest more when spring comes may be used here to describe this oligopolistic behavior. In the shipping industry, a company's profit can easily swing from a ten-million-dollar loss to a hundred-million-dollar profit within a year depending on the market condition. The large difference in returns may be the motivation behind such oligopolistic behavior. This may also explain why it is always smaller companies that are facing bankruptcies and why enormous investments continually occurred during market depression, which seems to deviate from common sense.

There are many factors that will influence the success of such investment strategies. For instance, it depends on the investment costs, the current market condition (demand and supply conditions), when the demand will pick up and whether by that time the company can actually benefit more

after pushing some competitors out of the market. However, this question has not yet been answered successfully by academic research. The literature of transportation planning with respect to fleet size and mix issues concentrates on determining the optimal fleet composition to satisfy customers' demand. It fails at explaining why shipping companies are now betting on building larger ships while overcapacity prevails in the industry. Moreover, many other uncertainties, such as regulatory uncertainty, have been overlooked. As for the field of capacity investment research that determines the size, timing and location of buying additional capacity, the literature mainly focuses on a perfect market. Our research belongs to an emerging branch within the stream of dynamic capacity models, which often use the approach of option games to address the intersection of investment under uncertainty and industrial organization. The difference between our research and the majority in this research branch is that we incorporate more real-world features, such as allowing three types of investment decisions and an adapted long-term strategy. Overall, our research question originates from an abnormal investment phenomenon and instead of only questioning the rationality behind such investment decisions we explore the economic theory of dynamic competitive investment under uncertainty. Our models will allow one to compute the optimal investment strategy that supports ship owners and operators in maintaining profitably while operating responsibly and sustainably. Finally, our results will benefit other areas, such as real estate, which are also influenced by the three types of uncertainties and share the attributes of an oligopolistic market.

The 3rd Erasmus Smart Port Rotterdam/Port Research Centre Poster Session, Rotterdam, October 2nd, 2014

VERY LONG TERM DEVELOPMENT OF THE DUTCH INLAND WATERWAY TRANSPORT SYSTEM

Policy Analysis, Transport Projections and Shipping Scenarios up to the year 2100

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

About the project

Rijkswaterstaat is responsible for the development and maintenance of the Dutch Inland Waterway System. Most hydraulic structures have an expected lifetime of about 50 to 100 years. One by one substitution of these structures would be like ***"Replacing all parts of an old car and obtaining a good as new old timer".*** Rijkswaterstaat therefore desires to develop a more visionary integrated infrastructure development strategy, that considers the necessary replacements of the hydraulic structures as an opportunity to improve the network at a systems level.

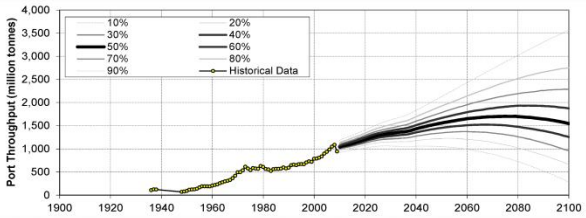
This requires a very long term view on the development of the inland waterway system, but there lacked scenarios that look much further than about 20 to 40 years ahead, and in addition it was also unclear to what extent the existing models and policy methods are capable of taking very long term effects into account. This unconventional PhD study addresses the required 'building blocks' for the development of a new policy evaluation method, that is capable of taking such very long term effects into account for a single sub-system of the inland waterway system, namely the inland waterway transport (IWT) system.

The primary objective of this PhD project is to address the main research question: ***How can Rijkswaterstaat develop a workable method for taking the very long term development of the Dutch IWT system into account in the evaluation of integrated infrastructure development strategies with a very long term impact?***

However, during the execution of this PhD project two additional research objectives were added:

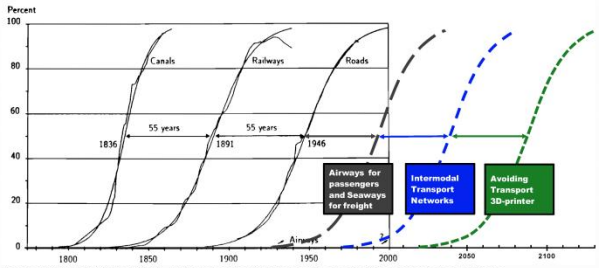
- The 1st additional research objective followed from new insights that ***there is something fundamentally wrong with the present neo-classical paradigm of ongoing endogenous exponential economic growth***. I propose a new post-neo-classical economic growth paradigm in which growth of the state-of-the-art labour productivity in technological frontier countries is constrained by physical limits and therefore bound to follow an s-shaped logistical transition curve that moves towards an unknown (and still unpredictable) horizontal asymptote on the very long run (say a few hundred years from now). This new paradigm has amongst others major implications for the outcome of the obtained transport projections in this study.
- The 2nd additional research objective concerns the development of ***the very long term Shipping Scenarios for the Dutch Delta Programme up to the year 2100.*** This objective was added in the year 2012 after a request to contribute to the Delta Scenarios. I personally drafted the Shipping Scenarios for the Dutch Delta Programme (https://deltaprogramma.pleio.nl/file/download/15938322).

Snapshot of the results



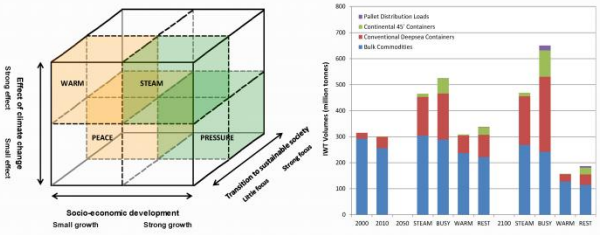
Source: Historical Data from Ports of Antwerp (1936-2007) and Rotterdam (2008, 2009).

At the start of this PhD project a method for developing probabilistic very long term transport forecasts with a time span of almost 100 years did not yet exist. I proposed a new forecast method that is based on a strong causal relation between economic output and transport. This method was used to develop ***probabilistic very long term transport forecasts***.



Source: Grübler (1990, p.187), updated and extended on the basis of our own personal views.

The development of major transport infrastructure networks is related to the about 50 years lasting Kondratieff waves that occur in the world economy. The pervasive drivers of these long waves provide valuable insights in the development of new transport infrastructure networks. The last two physical transport infrastructure networks were identified to be related to ***intermodal transport*** and ***avoiding transport***.



On the basis of these insights a total of ***six qualitative and quantitative scenarios*** was developed of which four of them have now been adopted as the formal Shipping Scenarios of the Dutch Delta Programme.

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Very Long Term Development of the Dutch Inland Waterway Transport System

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Curriculum Vitae

Cornelis van Dorsser was born in Amersfoort, The Netherlands, on 8th October 1977. He studied at two universities simultaneously. In 2004 he graduated at the Erasmus University Rotterdam as an Economist specialised in the field of transport economy and logistics. In 2005 he graduated at the Technical University Delft 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 (an engineering consultancy firm) where he worked as a port consultant, transport economist, and inland waterway transport specialist on many interesting port development and IWT projects all over the world, such as in: Nigeria, Gambia, Guinea, Egypt, Israel, Jordan, Thailand, Trinidad, and Costa-Rica. In these projects he was mainly responsible for the forecasting, master planning, as well as the financial- and economic evaluation stage. In 2009 he started his PhD project at the Technical University of Delft on the *"Very Long Term Development of the Dutch Inland Waterway Transport 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 the meanwhile he remains working on his PhD project for which he is now finalising the draft of his thesis.

Research Project

This PhD project is conducted on behalf of Rijkswaterstaat, the authority responsible for the hydraulic structures on the Dutch inland waterway system. Hydraulic structures, such as locks and bridges, tend to have a lifetime of about 50 to 100 years after which they need to be replaced. The current practice is to replace the structures on a one by one basis, 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 a more proactive integrated replacement strategy that considers the necessary replacement of hydraulic structures as an opportunity to improve the network at a systems level. The development of a proactive very long term replacement strategy does however require insight in very long term development of the main inland waterway transport system. This research project investigates the options to evaluate the very long term effects of proposed policies and external developments on the very long term development of the Dutch inland waterway transport (IWT) system. It not only addresses the direct needs of Rijkswaterstaat, but also provides a broad view on the development of the world economy and the West European transport system, that is for instance also relevant for port planners.

The primary objective of this PhD project is to address the main research question: *How can Rijkswaterstaat develop a workable method for taking the very long term development of the Dutch IWT system into account in the evaluation of integrated infrastructure development strategies with a very long term impact?* However, during the execution of this PhD project two additional research objectives were added. The 1st additional research objective followed from new insights that there

is something fundamentally wrong with the present neo-classical paradigm of ongoing exponential economic growth. The 2nd additional research objective concerns the development of the very long term Shipping Scenarios for the Dutch Delta Programme up to the year 2100. This objective was added in the year 2012 after a request to contribute to the Delta Scenarios.

Policy Framework

The starting point for addressing the primary objective of this research project is the development of a clear policy framework. This framework is indicated in Figure 1.

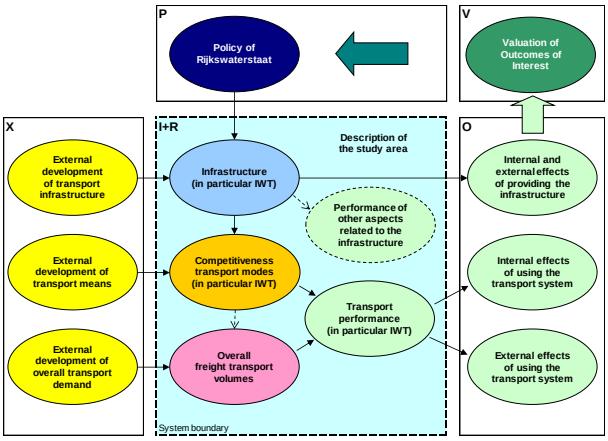


Figure1: Structure of Proposed Policy Framework

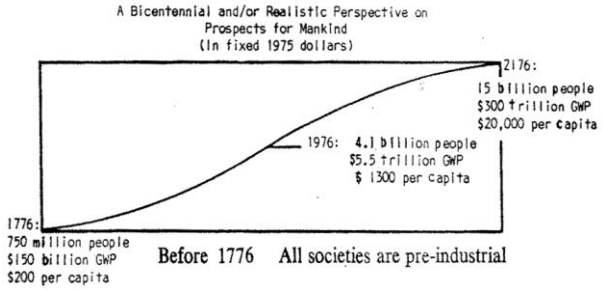
The structure of the proposed policy framework is similar to the structure that would have been obtained for the evaluation of policies with a long term time horizon of up to about 30 years ahead. This implies that the structure of the policy evaluation framework is not affected by the length of the very long time horizon. What makes the evaluation of policies with a very long term impact complicated is the fact that: (1) it is difficult to gain insight in the expected very long term external developments; (2) there still does not exist a model for taking the very long term effects of proposed policies and external developments into account; and (3) there also seem to be some issues with the valuation (i.e. future discounting) of the very long term effects.

This research project is primarily focused on the external developments (X in the figure) and the options to model the system domain (I+R in the figure). Prior to addressing the external developments, I studied the broader development of the world economy, because this seems to be the primary driver for the development of the transport infrastructure as well as for the development of the overall transport demand.

Economic development

The very long term development of the wold economy can be described by means of the about 50 years lasting Kondratieff (1926) waves and the secular trend (i.e. the trend over the ages). The Kondratieff waves are closely related to the major social, technological, and economic changes that take place in the world economy. They are important because empirical evidence shows that they can be closely linked to the development of new transport infrastructures. According to several authors the 2009 crisis marked the downswing period of the 5th Kondratieff that was driven by the broad concept of *'globalisation'*. The upswing period of the next 6th Kondratieff wave, that is likely to be driven by *'sustainability'*, is roughly expected in the period from about 2030 to 2055.

Empirical evidence shows that the Kondratieff waves have little effect on the overall development of economic output (i.e. GDP). The development of the GDP should be seen in the light of the secular trend, that showed an exponential growth of population and economic output since the begin of the industrial revolution some 200 years ago. In the 1970s the development of economic output was still considered to be related to an about 400 years lasting transition s-curve (see Figure 2).



Source: Kahn et al. (1977, p.6).

Figure 2: The Great Transition of Herman Kahn

However, in the 1980s the economic society shifted towards the development of endogenous growth models, that no longer regard labour productivity (and economic output) to be bounded by any physical limits. Based on 200 years of exponential growth (since the begin of the industrial revolution) these models now presume labour productivity to remain growing at an exponential rate for at least another very long period of time.

In my opinion there is something fundamentally wrong with the present neo-classical assumption of ongoing exponential economic growth. In line with a few others such as Van Duin (2007), Ayres (2006), and Gordon (2012) I do not consider it likely that this exponential growth trend can be continued throughout the 21st century. I have therefore proposed a new post-neo-classical paradigm on economic growth that departs from the same neo-classical Solow (1956) model, but imposes one additional restriction namely the restriction that the state-of-the-art labour productivity (and economic output) in technological frontier countries is constrained by physical limits and follows an s-shaped transition curve that moves towards a still unknown (and still unpredictable) horizontal asymptote on the very long run (say a few hundred years from now). This paradigm restores the previous view on economic growth that was still mainstream in the 1970s, namely that economic output gradually moves towards an ever advancing equilibrium output (after which it may fall into decline).

An interesting side conclusion of this new post-neo-classical growth paradigm is that, in absence of economic growth, the risk free discount rate is also likely to go down to zero on the very long run (over a time period of a few hundred years). This implies that lower discount rates will have to be adopted for the evaluation of very long term effects.

Exogenous developments

Figure 1 indicated that the primary exogenous developments relate to: the development of the overall freight transport demand; the development of existing and new transport infrastructures (including the effects of climate change on the IWT infrastructure); and the applied means of transport (including the modal split).

Insight in the very long term development of the overall freight transport demand is obtained by developing a new probabilistic forecast method, that has first been applied for the development of a

very long term forecast of the port throughput volumes in the Le Havre – Hamburg range (see Van Dorsser et al., 2012; and upper figure in poster). It should however be noted that this forecast was made in line our new post-neo-classical paradigm on economic growth, if the mainstream endogenous paradigm on economic growth would have been adopted, the forecast for the year 2100 would have presumably been 2 to 3 times higher.

Insight in the development of new transport infrastructure networks is obtained by investigating the (expected) primary drivers of the present and future Kondratieff waves (see also Grübler, 1990). On the basis of this analysis I concluded that the last two major physical transport infrastructure networks developments can be related to *intermodal transport* and *avoiding transport* (see figure in the middle of the poster).

Insight in the effects of climate change on the performance of the IWT system is obtained by converting the available very long term hydrological projections into very long term projections for the available water depth on two important sections of the river Rhine. On the basis of this analysis I conclude that IWT is not much affected in the period up to the year 2050; but that all year round navigation on the Rhine will, presumably, no longer remain possible in the more extreme climate scenarios (e.g. in the KNMI06 W+ scenario), unless far-reaching response measures are taken to mitigate the effect, such as the full canalisation of the river Rhine.

I finally looked at the possible effects of major changes to the cost structure of transportation on the modal split, for which the largest uncertainties are related to the development of continental container transport (in 45 foot, pallet wide, high cube containers). I concluded that, depending on the applied scenario assumptions, continental transport has either a strong potential to develop in the high-end scenarios (in particular in combination with a strong focus on low carbon emissions) or hardly any chance to develop in the low-end scenarios.

Transport Modelling

The very long term effects of proposed policies and external developments can presumably be modelled by a combination of aggregated foresight models (that define the general very long term trend at a very aggregated level) and detailed transport forecast models (such as applied in present transport scenario studies). In theory the output of the aggregated foresight models can be 'projected' onto the structure of a classic four stage transport model such as NODUS or TRANSTOOLS. In practice there do however remain a number of major issues that need to be resolved before a useful very long term transport model can be obtained. The detailed modelling of very long term transport flows at the network level is therefore left for further research.

Delta Scenarios

In absence of a workable transport model, that takes the very long term effects of proposed policies and external developments into account, it was still possible to develop six qualitative and quantitative very long term scenarios for the development of the port throughput- and inland waterway transport volumes in the Dutch seaports and on the Dutch inland waterways (see Van Dorsser, 2012; and lower figures in poster). Four of these scenarios have now been adopted as the official Shipping Scenarios of the Dutch Delta Programme (see Bruggeman t al., 2013).

Acknowledgement
This PhD project is conducted at the section Ports and Waterways at the department of Hydraulic Engineering of the Faculty of Civil Engineering and Geosciences at the TU Delft; funded by Rijkswaterstaat; supervised by Han Ligteringen (1st promoter), Bert van Wee (2nd promoter), and Milou Wolters (daily supervisor from Rijkswaterstaat); and supported by Tiedo Vellinga (professor at the section Ports and Waterways).

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The 3rd Erasmus Smart Port Rotterdam/Port Research Centre Poster Session, Rotterdam, Oct 2, 2014

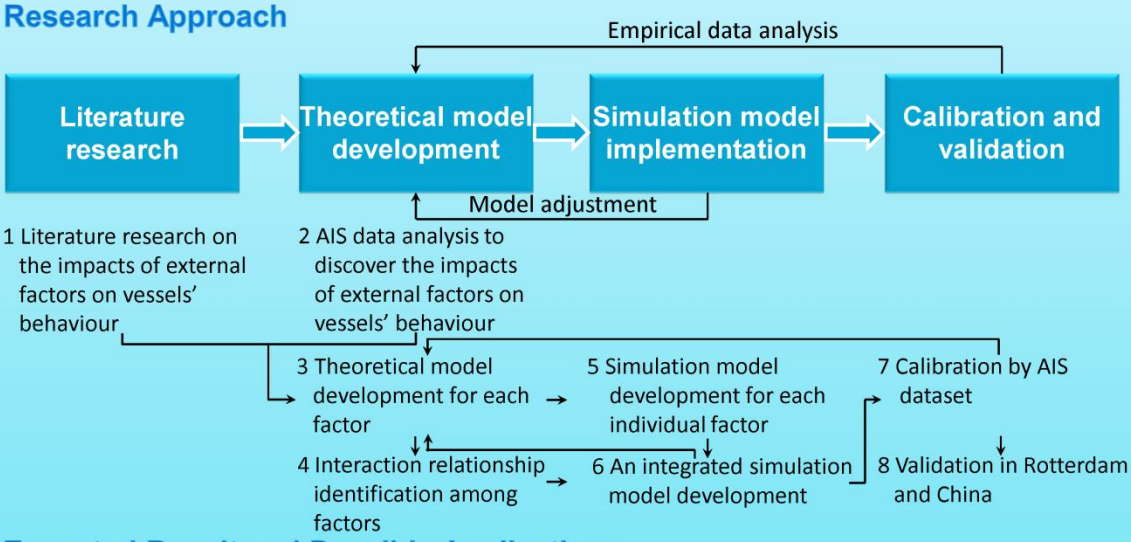
Nautical traffic modelling for SAFE and EFFICIENT ports

Yang Zhou, Winnie Daamen, Tiedo Vellinga, Serge Hoogendoorn

Research Motivation

To reach the highest port efficiency without vessels' safety as a sacrifice is the objective of the design and operation of any port, e.g. Maasvlakte in Rotterdam. Simulation modelling is a proper tool to do this. However, the existing models focus on individual vessel's behaviour or the whole port operation for safety or efficiency only.
This research focus on the interaction between vessels. The expected model will contain vessels sailing individually and simultaneously in a water area to assess both safety and efficiency of a port.

Research Approach



Expected Result and Possible Applications

AIS data analysis — For the port authority, the result helps to recognize the impacts of some external factors theoretically. The pilots can also be aware of the impacts when sailing in Maasvlakte area.

Calibrated model — The simulation result of the calibrated model should be close to the real-life data in Maasvlakte area. It can simulate and predict the vessels behaviour in accordance with the local navigational characteristics.

Validated model — The simulation model , after validated in two different cases, can be applied in both newly designed ports and the existing ports for traffic status prediction.

Further application — The developed model can be applied as a tool in the further assessment of safety and efficiency of a port. The system of assessment methodology is being developed, but not included in this research.

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Nautical traffic modelling for safe and efficient ports

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Supervisors: Dr. Winnie Daamen, Prof. Tiedo Vellinga, Prof. Serge Hoogendoorn

Curriculum Vitae

Yang Zhou (1989, Chinese) started her PhD research at Delft University of Technology from September 2013. In June 2014, she graduated as a master majoring in Traffic Information Engineering and Control from Wuhan University of Technology in China. And she got her bachelor degree with the major Maritime Management in June 2011. During the undergraduate and postgraduate study, she has a solid knowledge foundation in the field of vessels navigation technology, especially in collision avoidance of vessels.

Her PhD research topic is nautical traffic modelling for safe and efficient ports. The aim is to develop a maritime traffic model which can simulate the vessels behaviour in different external conditions, including natural environment, vessels encountering situation and human factors. The simulation model is expected to be further applied in the assessment of safety and capacity for both newly designed ports and existing ports. This PhD research is based on the project 'Simulation model to improve safety and efficiency of port traffic' coordinated by Netherlands Organization for Scientific Research (NWO) and the Chinese counterpart National Natural Science Foundation of China (NSFC).

Her promoters are Prof. Tiedo Vellinga from Department of Hydraulic Engineering and Prof. Serge Hoogendoorn from Department of Transport & Planning, and Dr. Winnie Daamen from Department of Transport & Planning is her daily supervisor. Since Prof. Tiedo Vellinga is also the director of environmental monitoring in Maasvlakte 2 in port of Rotterdam, he is familiar with the characteristics of this port area, which is also the study area of this PhD research. Prof. Serge Hoogendoorn and Dr. Winnie Daamen specialize in the simulation modelling of vehicular traffic and pedestrian behaviour, which is similar with the vessel behaviour in port area.

Research Contents

Research problem

To reach the highest efficiency of a port without safety of vessels as a sacrifice, an appropriate method is required for the design and operation management of a port. Among different research methods, simulation modelling would be time- and money- saving and also convenient to acquire the results under different external conditions, which determines it to be a proper tool for research of this issue. However, existing simulation methods focus on individual vessel's behaviour or the operation of a port as a whole for safety or efficiency only. In order to reach the aim of assessing both safety and efficiency, a model simulating several vessels sailing individually and simultaneously in a water area is a method.

The newly developed model by Yaqing Shu, a PhD candidate at TU Delft, has been able to realize the route-choice of a vessel as an individual in a waterway. But the operations of vessels under all of the external conditions are indispensable to be considered, and further to simulate the real sailing environment and acquire the performance of vessels in it, which is the aim of research.

Research objectives

To be more explicit in details, the research objectives are stated from two aspects, being theoretical and practical goals.

Theoretical goals

- Analyse the current theories or models which can describe or simulate the impacts of external factors on vessels behaviour.
- Identify the external factors yielding strong impacts on vessels behaviour and analyse the impacting mechanism of each factor.
- Analyse the interaction relationship among different factors.
- Develop the theoretical or mathematical model for the impact of each external factor and the interaction mechanism.

Practical goals

- Develop the traffic model which can simulate and predict the vessels behaviour as closely to the real-life behaviour as possible.
- Calibrate the model in Rotterdam and validate it in another case study water area, possibly part of Yangtze River in China.

Research approach

The research will start with an extensive literature study in both the existing Maritime Traffic Models and the impacts of different external conditions on vessels behaviour. This is to investigate the factors considered in the models with their influencing mechanism, resulting effect, measuring criteria.

In the theoretical model development, the data of the vessels' on-board Automatic Identification System (AIS) over a span of time will be analysed to discover the real-life navigational characteristics of the research area, Maasvlakte part in port of Rotterdam. The navigational information is including but not limited to vessels' heading, course, velocity, position, and distance to one bank. With the data of environmental factors and other vessels' information, the actual impact of different factor could be found out by comparing the vessel's behaviour. The theoretical models for each factor and the relationship among factors will be developed based on the literature study and AIS data analysis.

With the developed theoretical model, simulation models for each factor will be developed accordingly, which can predict the vessels behaviour under a single external factor individually. Considering the discovered interacting mechanism among factors, an integral model to simulate the vessels behaviour under the overall external conditions is the research result of this phase.

Finally, the developed simulation model will be calibrated by the dataset that generates the navigational characteristics initially. Some extra influencing factors not considered might be identified, which will give a feedback on the development of the simulation model.

For the calibrated model, two case studies in different ports will be performed as validation to improve the accuracy and the universality of the model. The first case is still in the Maasvlakte area in Rotterdam, but with different time duration. The second case will be in China, possibly the Yangtze Estuary water area.

Possible application in the real world

In the initial stage of this research, a consultation and discussion was held with the port authority of Rotterdam. Based on both the requirement of this PhD research and the demand of development in port of Rotterdam, the Maasvlakte area is chosen as the research water area.

According to the theoretical and practical objectives of this research, the achievements of different phases through the whole research process can be applied in port of Rotterdam. The final developed simulation model is also expected to be applicable in other ports.

- AIS data analysis. In this research, the AIS data analysis in the Maasvlakte area is to compare the vessels behaviour in different external conditions and further to discover the impact of each factor. However, from the perspective of the port authority, the AIS data analysis result also help to recognize the impacts of some external conditions in this area theoretically. For the officers on board or the pilots, they can be aware of such kind of impacts when sailing in Maasvlakte area. From the perspective of the port authority, some positive impacts from the environmental factors, e.g. current or tides, can be put into better use than at present. On the contrary, for the factors which yielding negative impacts to safety of vessels, some countermeasures need to be considered accordingly.
- Calibrated simulation model. Since the theoretical models in the research generate from the AIS data analysis result in Maasvlakte area and the literature study, the developed model is expected to be applicable in this area. After the model calibration, the optimal parameter set will be acquired to make the simulation result close to the real-life data. Therefore, the calibrated model can be applied in Maasvlakte area to simulate and predict the vessels' dynamic motion and the traffic situation.
- Validated simulation model. The validation is planned to be carried out in two case studies to improve the applicability of the simulation model. Then the validated simulation model can be applied in both the newly designed ports and the existing ports for traffic status prediction.
- Further application of the final simulation model. As this research is part of the project 'Simulation model to improve safety and efficiency of port traffic', the developed model is designed to be adopted in an assessment methodology of safety and capacity of port. This way, the model can be further used to assess and improve both safety and capacity. In port of Rotterdam, due to the development of Maasvlakte 2, the simulation model can also be a method to assess the prevailing safety and capacity and to find out the best timing of widening the channel to increase the capacity.

The 3rd Erasmus Smart Port Rotterdam/Port Research Centre Poster Session, Rotterdam, Oct. 02, 2014

'Did lessons-learned improve your organisational readiness for port development?'

By Hester Engelsman

The developed framework

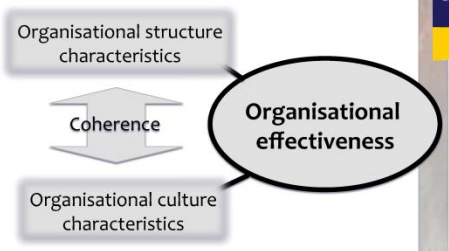
Function 1

Identifying the characteristics that determine organisational effectiveness

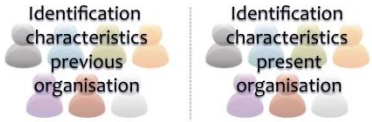
Function 2

Investigating the effect of internal lessons-learned on these characteristics

Characteristics



Application



Comparison

Which lessons-learned are kept to improve organisational effectiveness?

Potential of the framework

- Tool to investigate **'effective organisational profile'**
- Tool to formulate **strategic transition pathways** for improvement of organisational effectiveness
- Tool **to indicate match** with other organisations
  - → Industrial symbiotic initiatives
  - → Merger & acquisition
  - → Establishment of consortia

Relevance of framework

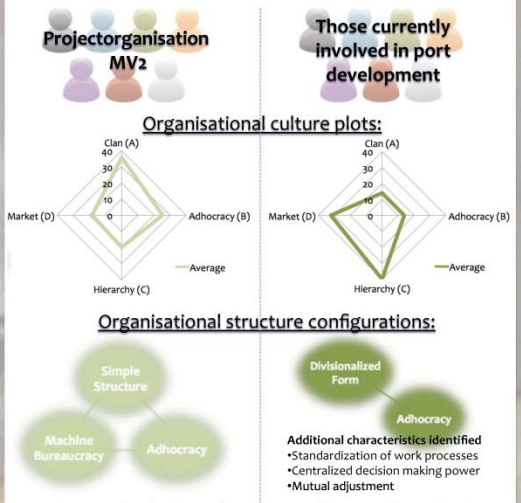
For Port Authorities & other organisations

Improve anticipation on possible internal and external resistances with economic and image consequences (*i.e.* extra costs due to delays and damage of trust from potential clients), and to be able to yield successes from internal organisational strengts

Application Findings

Case: Port of Rotterdam

'Did the Port of Rotterdam Authority improve its readiness with the lessons learned from the Maasvlakte 2 project?'



Identified main effects of the MV2 project

- → Roll-out of standardized work processes (PRINCE2)
- → Integration of project phases
- → Increase of mutual adjustment between disciplines

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Robust vehicle dispatch rules for automated container terminals

Andrejs Tabuns, Jelmer van der Gaast, René de Koster
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Introduction

- Container freight has grown continuously over the past fifty years
  - *Automated container terminals (ACTs) have begun operating in the world's largest ports*
  - *Rise of advanced unmanned equipment, such as automated guided vehicles (AGVs)*
- We propose/develop
  - *a simulation model for studying seaside operations at ACTs*
  - *a framework for testing robust vehicle dispatching rules*

Practical Relevance

Robust design and control of AGVs in ACTs is essential;

- High levels of uncertainty due to variation in the distribution of workload over time
- Multiple objective criteria, such as minimizing total sojourn time and quay crane waiting times
- The exact order and arrival time of containers to be loaded and unloaded cannot be controlled

Automated Guided Vehicle Dispatching

- When and how to dispatch AGVs to containers in the terminal
- Eight dispatching rules have been implemented
- Vehicle initiated dispatching
- AGVs can be reassigned to a different destination on the way

Methodology

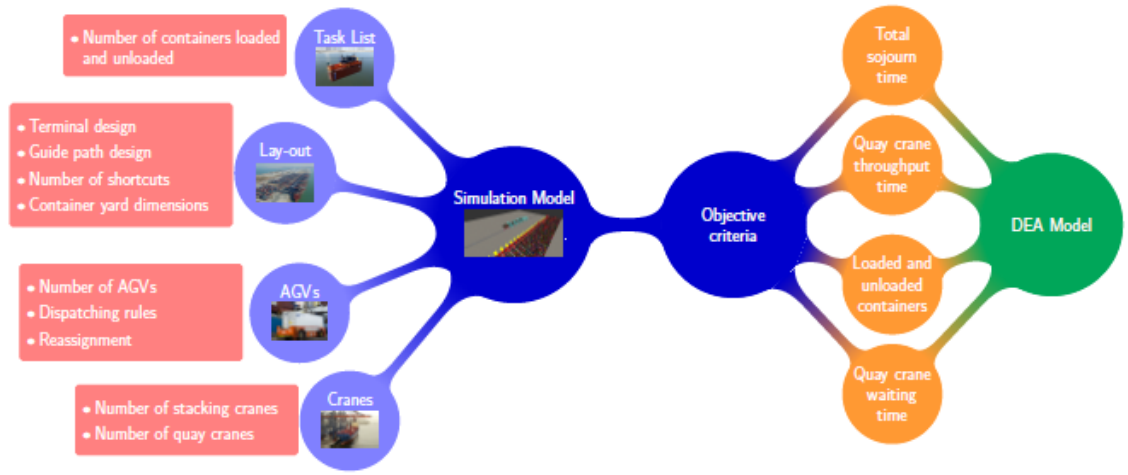
A scalable 3D simulation model has been developed to test various dispatching rules and terminal layouts:

- *Integrated system of terminal seaside operations*
- *Test the loading and unloading of a single large container ship*
- *Special focus on the different loading/unloading stages*

Robustness for multiple objective criteria is studied using data envelopment analysis (DEA)

- *Determines the relative efficiency of the dispatching rules*
- *Assigns efficiency scores as percentage values compared to the best performing dispatching rules*

Robust Framework for AGV Dispatching

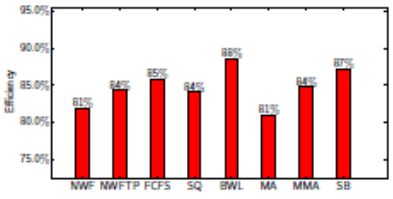


Results – General findings

Two best performing dispatching rules:

1. Balanced-Workload (BWL)
   - *Assigns more AGVs to cranes with a larger workload to avoid bottlenecks*
   - *Highest throughput rate and lowest quay crane waiting time*
2. Staged-Based (SB)
   - *Different dispatching rule depending on the loading/unloading stage of the ship*
   - *Achieves the lowest throughput time*

Results – Dispatching rule efficiency



Results – Reassignment

- The performance of the dispatching rules is improved by reassignment

Rule	Container throughput rate per hour (Improvement by reassignment)	Throughput time minutes (Improvement by reassignment)
BWL	74.05 (+2.58)	25.46 (−1.45)
SB	73.84 (+4.44)	25.41 (−0.72)
MMA	71.76 (+4.54)	27.05 (−0.81)
NWFTP	61.21 (+1.16)	27.85 (+0.02)
NWF	58.91 (+1.12)	27.91 (−0.52)

Conclusions

- We developed a simulation model for studying AGV dispatching in automated container terminals
- Balanced-workload and staged-based are the most robust dispatching rules
- Our research shows a possible 7% increase above using NWF, one of the best performing rules in the literature
- Future research topics would be integrating advance storage strategies in the container yard and investigating how robust dispatching rules can improve current operations in ACTs

The 3rd Erasmus Smart Port Rotterdam/Port Research Centre Poster Session

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