WHITEPAPER

# Integrated Synchromodal Transport System Analysis

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Provincie Zuid Holland · TKI Dinalog

# INTEGRATED SYNCHROMODAL TRANSPORT SYSTEM ANALYSIS

THE ISOLA PROJECT IS DEVELOPED AND SUPPORTED BY:

**This whitepaper was made with contributions from:**

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- Lori Tavasszy, Delft University of Technology
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The ISOLA project is supported by TKI Dinalog and NWO under grant number 438-13-214.

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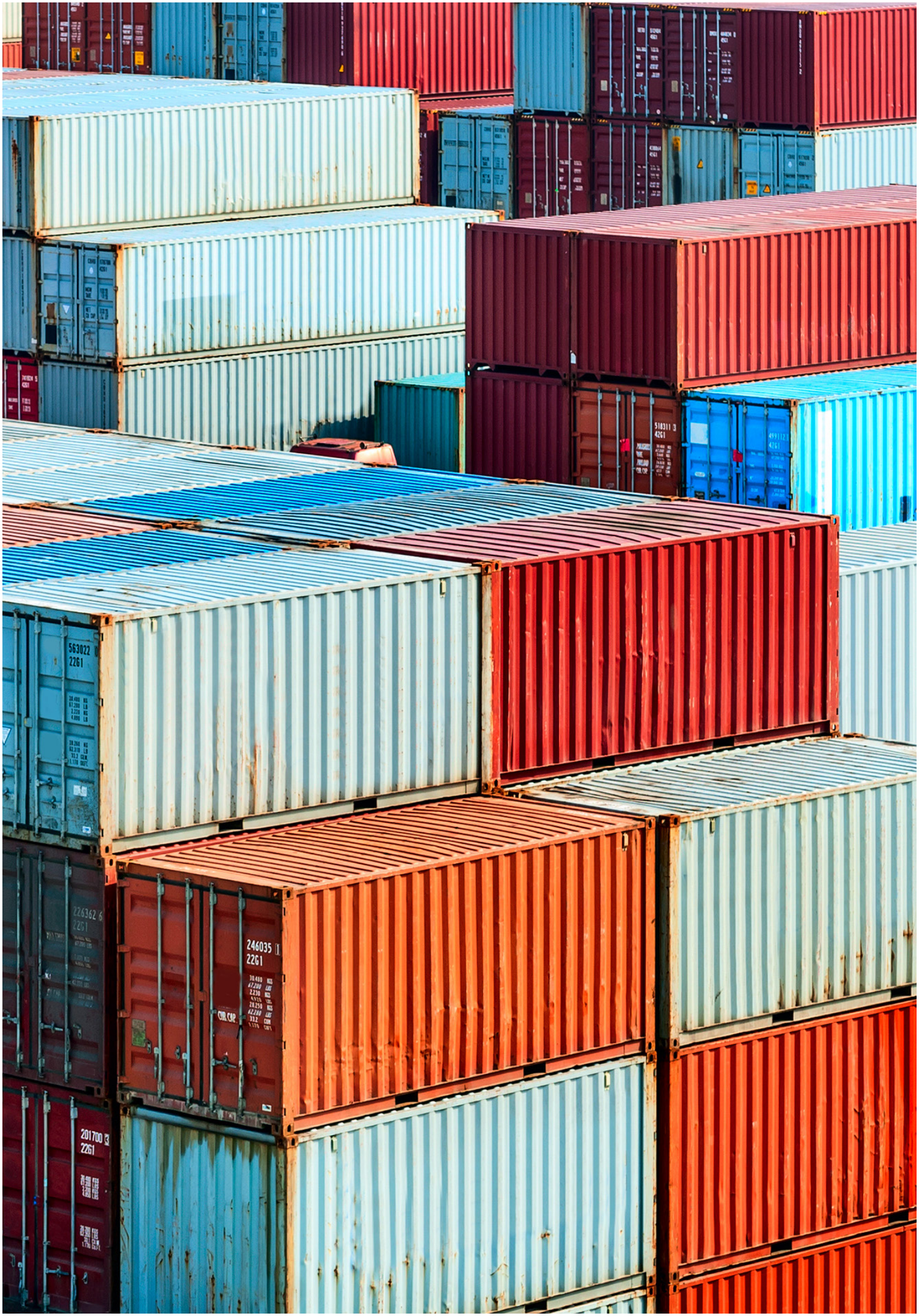


# -01-
# Introduction

Synchromodality has evolved in the past years as an innovative technological and organizational concept for freight transport services, presenting itself as the next stage after the intermodal freight system that is now in place within the Netherlands. Building on physically interconnected networks and interoperable services, the actual synchronization of intermodal operations would now be achieved by strongly improved information and communication technology, supported by automated planning and booking systems. The Netherlands is an ideal testbed for the synchromodality proposition, because of the dense network of infrastructure of 3 modes of transport, and over 30 transshipment terminals in the intermediate hinterland of two of Europe's major ports. Together, these could potentially offer a robust and flexible network, once operations would be synchronized along and across the different multimodal corridors.

However, to offer synchromodal services a collective synchromodal network with users and suppliers must be realized This means that the shipper/client orientation must be investigated as well as the relations with the underlying network management.

These vertical aspects were the object of study of the ISOLA project and we present the main in this white paper. The exposition of results is not necessarily a comprehensive account of academic findings; it rather aims to foster application of selected results obtained in the research project. Specifically, we focus on:

1. The conditions under which shippers are willing to use synchromodal services.
2. A model for capacity management in a synchromodal transportation network.
3. The role of information exchange for reducing the costs of synchromodal services.

These three areas were investigated by the universities participating in ISOLA. Masoud Khakdaman of Delft University of Technology carried out freight demand modelling research to understand the different market segments and their attitude towards synchromodal service offerings. These services are characterized by additional flexibility or lower costs, but require the shipper to yield full control over mode choice at the operational level to the synchromodal service provider. Hobbs White of the Rotterdam School of Management focused on the supply side problem of creating the synchromodal service by connecting constituent services into one network. His work identifies the circumstances under which carriers may find it profitable to connect such networks, concerning uncertainties in demand volumes and uncertainties in transport costs. Volkan Gumuskaya of Eindhoven University of Technology presents the results of an combined simulation-optimization study into the effects of dynamic and stochastic properties of the system on performance of synchromodal transport. He finds that both are important to recognize and significantly influence the costs of the system and the modal split.

Together the 3 works provide new landmarks in research on synchromodal transport systems. By providing new information about missing links in demand and supply analysis, agreement between service providers and shippers on business models is more and more becoming a matter of "when", not "whether" the convergence will materialize. We hope that subsequent practical application of these models will pave the way for new business offerings and experiments.

-02-

# Shippers' willingness to use synchromodal transportation services

**Masoud Khakdaman**, Delft University of Technology

We studied the willingness of shippers to use synchromodal transportation services, delegating their control over mode selection at the operational level to a logistics service providers (LSP). Our data originated from a large survey among 556 firms chosen from Global Fortune 500 companies and major customer firms of the 40 largest global LSPs, including different industries and commodity types, that together account for the majority of global transportation volume and value. Altogether, 296 professionals from 194 unique firms responded to our survey, which is the largest sample for a survey on this research topic to date.

Based on choice experiments and subsequent econometric analysis we identified the service preferences of shippers concerning different performance criteria of a door-to-door transport chain, including costs, time, reliability and flexibility. Additionally, we gave shippers the option to delegate the control over the mode of transport completely, in order to receive benefits on one or more of these service dimensions.

We find four different market segments for cost and service level improvements toward the global community of LSPs, freight forwarders and carriers (Figure 1). The horizontal axis indicates whether firms are willing to yield control over the mode of transport, the vertical axis shows the inclination of the firm towards a high performing or low-cost services. The percentages indicate the share of the firms sampled.

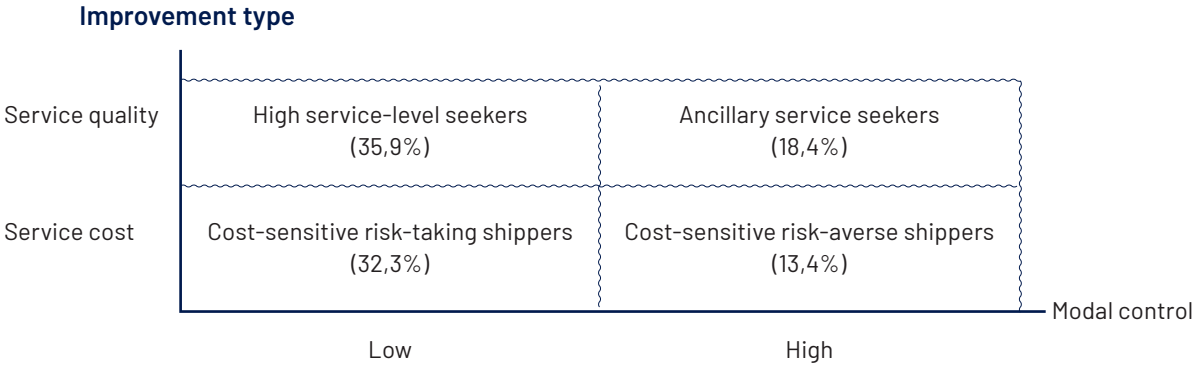
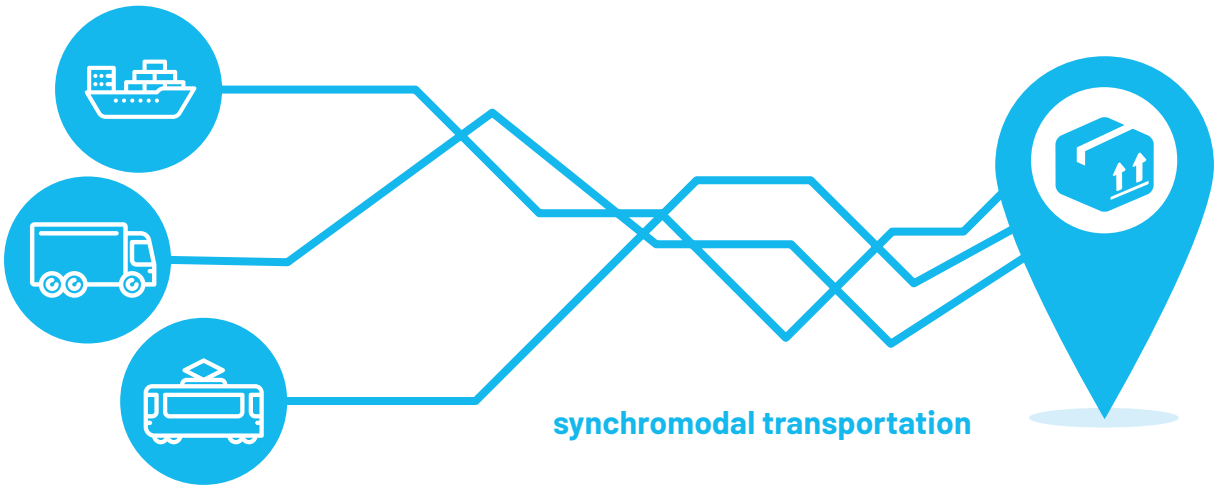



***Figure 1.*** *Service improvements sought by shippers based on their modal control*




The potential demand for synchromodal transportation can be found in the "low modal control" part of the figure (left column). The main conclusions of importance for the synchromodal services market are the following:

1. More than 2/3 (68%) of the shippers surveyed are willing to delegate their modal control to the LSPs, in order to receive benefits in service or price.
2. The High service-level seekers need to be rewarded with service improvements while the Cost-sensitive risk-taking shippers want price reductions in return. We find a near 50/50 split between these categories of demand for premium and basic synchromodal services.

We also investigated shippers' willingness to choose flexible (changeable, adaptable) logistics services as one of the service requirements in modern era of logistics services. We find that shippers operating in markets with highly volatile demand are willing to choose LSP-driven flexible services to strengthen their capability to address demand uncertainties. We consider flexible logistics services as an external flexibility for shipper firms, and investigate which related internal flexibilities in shippers' supply chains drive their choices. In particular, shippers choosing flexible services will themselves exhibit high volume flexibility, and to a lesser extent other internal flexibilities i.e., product, launch, sourcing and postponement flexibility. This indicates that firms today mostly see synchromodal services as a tool to strengthen volume flexibility.

Our results may be important for LSPs where they can use this characterization of freight transportation demand to design tailor-made service packages that will meet the demands of global supply chains. Having a better understanding of customers' requirements in different business conditions will support LSPs in the design of customized logistics service packages, with the potential of improving their and their client's competitive advantage.

-03-

# Capacity Investment for Synchromodal Transportation

**Hobbs White,** Rotterdam School of Management

Synchromodality poses unique challenges for capacity sourcing compared to established intermodal transportation. It also poses opportunities for capacity planning. Cargo allocation and investment decisions can be decoupled to some extent, and cargo flows can be assigned in such a way to take the best advantage of prior investments in capacity. A synchromodal operator has a greater ability to direct the flow of material through its network. The operator can attempt to direct this flow in as efficient and advantageous a manner as possible, within the various commercial and service constraints determined by market conditions.

However, the operator can only take advantage of the opportunities present in a synchromodal system when they have access to a network with sufficient route and mode alternatives. The operator must tailor their effective network structure to meet these requirements, and can accomplish this by building a portfolio of varied transportation capacity to serve prospective demand.

For exposition purposes, we elaborate on a specific capacity planning problem here. We investigate how an operator can make optimal investment decisions in such a synchromodal system. We have created an analytical tool that leverages cost parameters and forecasted demand distributions to identify an optimal capacity investment to respond to eventual demand cost-efficiently.

This has been analyzed in a series of stylized and generalizable networks. We have found that even simple cases with one origin terminal and two destination terminals result in interesting patterns of when and how to invest in corridor capacity (Figure 1).

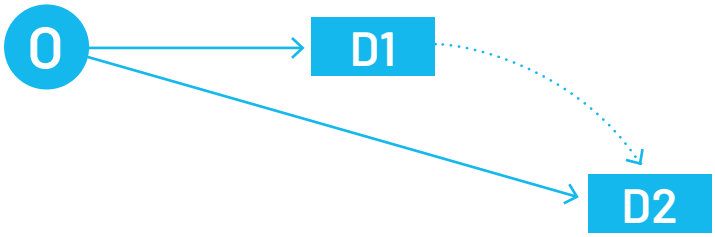



***Figure 1.*** *Stylized transportation network*

Our approach has differentiated setting-specific cases in which contrasting capacity investment strategies are advisable, and when the optimal investment strategy changes from one of over-investment to one of under-investment. Our numerical simulations show that the transition from one state to the other can be quite sudden (e.g., Figure 2). This helps identify when transportation procurement is particularly sensitive to and can be used to hedge against external factors.

For example, in a market configuration with imbalanced demand uncertainty across destinations, uncertainty can in one case be viewed as a risk that must be hedged against with robust investment in networked transportation capacity. As relative transportation and transfer costs vary, however, this can become an opportunity to limit significant novel capacity investment and instead rely on existing route options.

Furthermore, there are cases in which it may not be cost-effective to integrate services across a network, and our numeric results can be used to identify the relative cost and distance conditions under which a destination is suitable for integration into a synchromodal network. This illustrates when it is cost-effective to ignore potential network connections when planning capacity investments, and when it is reasonable to open connections between destination terminals and daisy-chain a network together. Such regions of opportunity are sketched in Figure 3. We look forward to opportunities to continue to add complexities to this program and systematically apply this approach, so as to further inform optimal decision making in different and more realistic network structures.

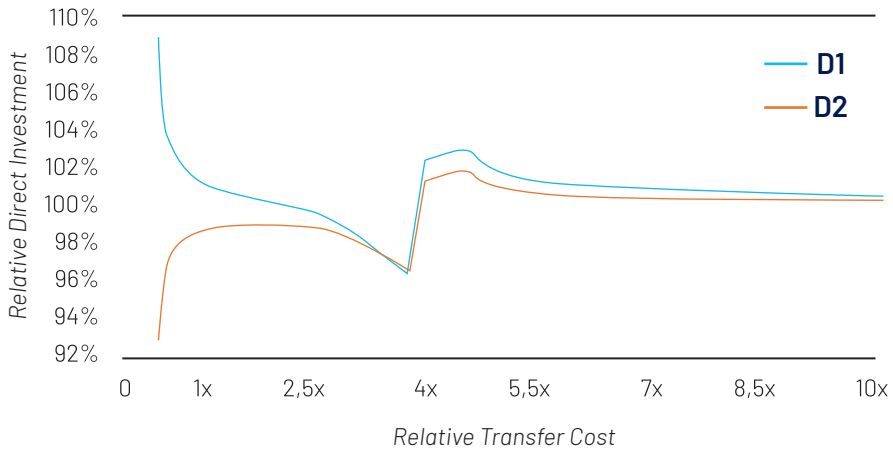



***Figure 2.*** *Overview of investment strategies.*

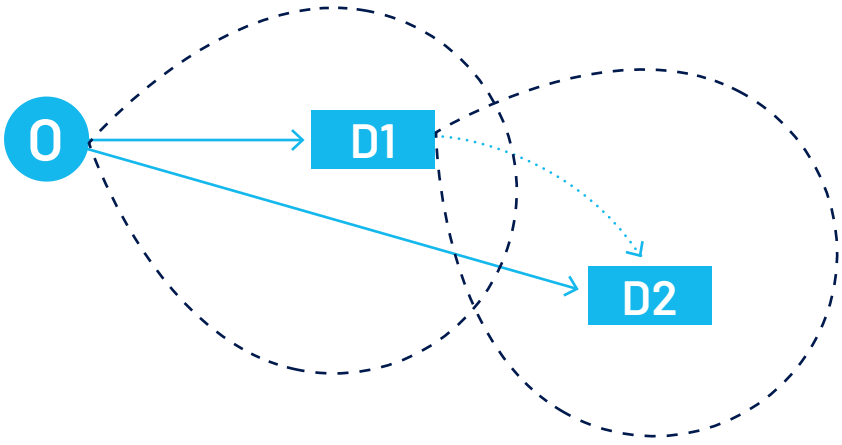



***Figure 3.*** *Daisy-chaining a transportation network.*

-04-

# Information exchange as key mechanism for synchromodal transportation

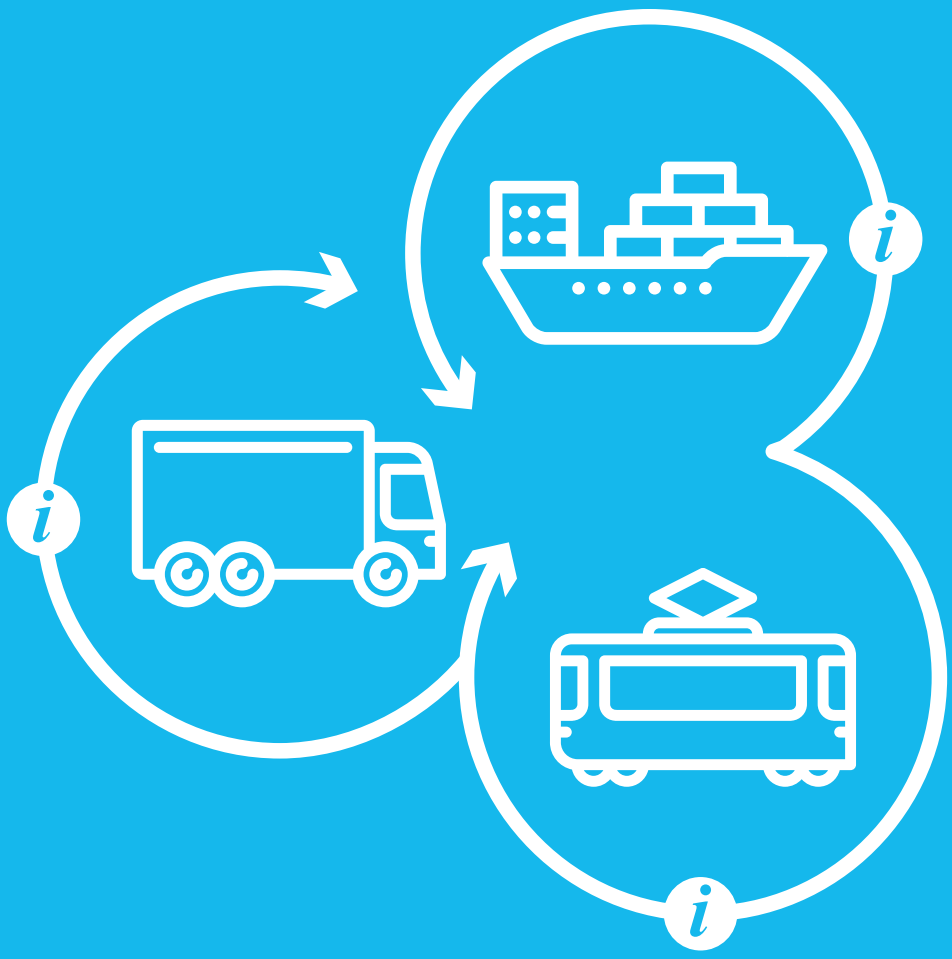
**Volkan Gumuskaya,** Eindhoven University of Technology

Information exchange can be used as a mechanism for reducing uncertainty, and consequently costs, in sychromodal transportation. To show this, we did a quantitative study that provides an analysis of the impact of uncertainty, focusing on uncertainty and dynamism in barge planning. By uncertainty we mainly refer to the delays in container arrivals, for example the delays in deep sea vessels. By dynamism we refer to the fact that new bookings may be received after a plan has been made. These bookings also need to be handled, which may necessitate trucking. As part of the computational analysis, we also study the impact of the maximum number of calls that a barge can make in a port visit and the number of days a barge operator should plan ahead. For the analysis, we used real data of an inland terminal for a whole year. Main KPIs used are the total cost for a year and the modal split.

The computational study shows that:

- The uncertainty in container arrivals has an impact of up to 53% on costs and 55% on modal split. This is important as it shows how big the impact is. Barge operators and shipping lines can try to minimize this uncertainty, for example by real-time information sharing.
- Dynamism, leading to limited information on bookings, has a significant impact varying between 9% up to 22%. This is a problem arising from the relation between a shipper and a barge operator. The shippers can be incentivized to make their bookings earlier, which will increase the information that the barge operator has.
- Best results are usually achieved when the barge operator plans 3 days ahead (see Figure 1).
- The number of calls that can be made at a port visit is crucial. For example, when a barge makes 3 visits per call 41% of the orders must be trucked on average, while with 6 visits trucking becomes less at 35%.

The main method used consist of an iteration-based algorithm consisting of simulation and mixed integer programming. Each week, a barge plan is made by the operator based on the information they have. Based on the barge plan, actual events are simulated and KPIs are recorded. This corresponds to an iteration, which is repeated for the whole year.



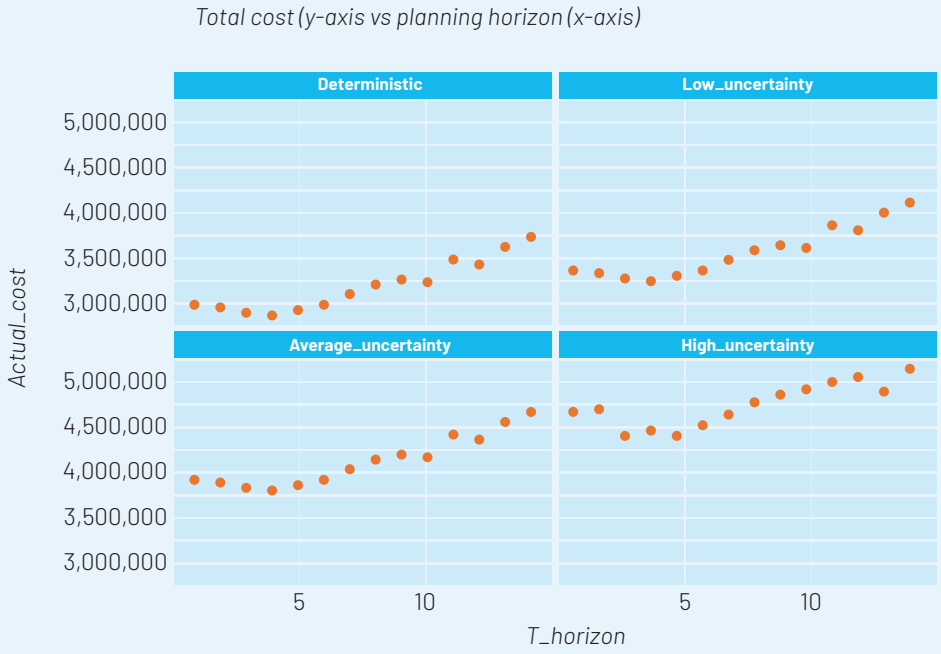


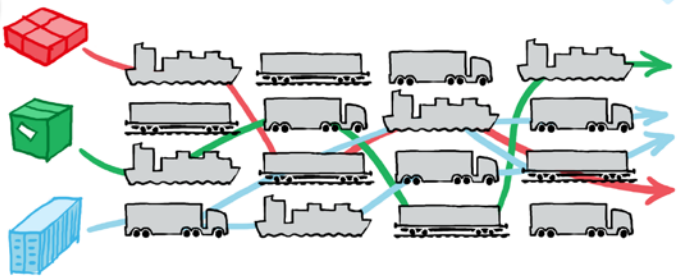

***Figure 1*** *Impact of planning horizon on total costs for different uncertainty scenarios*

# ISOLA

Integrated synchromodal transport system analysis

## IMPACT

CAPACITY PLANNING FOR DEPLOYMENT OF ASSETS



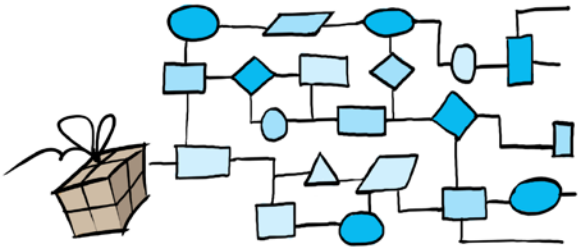
SYNCHROMODAL TRANSPORTATION MADE MORE ATTRACTIVE TO SHIPPERS

WIDER DEMAND FOR SYNCHROMODAL TRANSPORTATION LEADS TO MORE EFFICIENT TRANSPORTATION

## OPPORTUNITIES

A BETTER PICTURE OF THE NEEDS OF THE RECEIVERS OF THE CARGO

IF WE KNOW THE NEEDS, WE CAN BETTER MATCH THIS SERVICE WITH TRANSPORT DEMAND



ALGORITHMS FOR PLANNING SYNCHROMODAL TRANSPORT

## RESEARCH

WE WANT TO BE ABLE TO SWITCH MORE AGILE BETWEEN MODALITIES BASED ON DEMAND AND CAPACITY

1. WHAT ARE THE CUSTOMER'S CONDITIONS?

2. WHAT ARE THE PRICING MECHANISMS:
CAN PRICES VARY BASED ON, FOR EXAMPLE, SPEED OR SUSTAINIBILITY OF THE CHOSEN TRANSPORT METHOD?

3. HOW CAN WE OPTIMIZE THE TRANSPORTATION NETWORK TO BALANCE PRICE, CONDITIONS AND COSTS?

## CHALLENGES

AVAILABILITY OF DATA & INFO FROM SHIPPERS AND RECEIVERS OF THE CARGO

ADOPTION OF THESE TYPES OF CONCEPTS

FROM THEORY TO PRACTICE: OPTIMIZING THE PLANNING

## PARTNERS

NWO

TU Delft Delft University of Technology

Port of Rotterdam

TU/e

RSM Erasmus University

HUTCHISONPORTS ECT ROTTERDAM

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juni 2020

Ontwerp: IJzersterk.nu
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