



Delft University of Technology

## **Synchromodal transport: From theory to practice**

### **Case study port of Rotterdam: Identifying the success/fail factors**

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**SYNCHROMODAL TRANSPORT: FROM THEORY TO PRACTICE  
CASE STUDY PORT OF ROTTERDAM: IDENTIFYING THE SUCCESS/FAIL  
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**ABSTRACT**

Container port competitiveness is generally conceptualized as being driven by straightforward criteria, such as port costs, handling efficiency, hinterland connectivity, and the quality of infrastructure and services. Sychromodal freight transport service is an emerging and developing concept of freight transport operations, as shippers and carriers consider hinterland, short-sea, and deep-sea connectivity as major port choice criteria to run these port operations smoothly. Although scientists claim that sychromodality is a promising concept with a lot of potential advantages sychromodal transport is currently implemented at limited scale.

In this study a survey is carried out among 30 different small/medium enterprises (SMEs) in the field of port logistics to identify the success/fail factors of using sychromodal transport in practice. Companies are classified as experienced or inexperienced users of sychromodal transport. The experienced users have a stronger attention to the operational factors of sychromodal transport. Their experiences with flexibility, availability of infrastructure, damage-control and specific data sharing seems to be determining factors in their usage of sychromodal transport. The non-experienced companies are hindered by ignorance of sychromodality and focus on issues such as lack of knowledge, how to start knowledge, lack of transparency and complexity of sychromodal transport. Our findings suggest that to increase the share of sychromodal transport it is necessary that companies and policy makers who want to encourage the use of sychromodal transport should make different action plans considering the level of experience of the enterprises.

2019 TRB Annual Meeting Paper

## 1. INTRODUCTION TO SYNCHROMODAL TRANSPORT

Transport plays a crucial role in modern societies. A well-functioning maritime transportation system facilitates the process of globalization and ongoing economic growth. Much of the world's welfare today has been produced or is at least facilitated by ports and its related activities: ports are the locations where trade, logistics and production converge. The crucial role is especially reflected in the increase of container transport over the last decades and can be considered as a reflection of the economic dynamics whereby ports became a motor for economic progress. UNCTAD [1] forecasts world seaborne trade to increase by 2.8 per cent in 2017, with total volumes reaching 10.6 billion tons. Projections for the medium term also point to continued expansion, with volumes growing at an estimated compound annual growth rate of 3.2 per cent between 2017 and 2022. Cargo flows are set to expand across all segments, with containerized and major dry bulk commodities trades recording the fastest growth.

Container port competitiveness is generally conceptualized as being driven by straightforward criteria, such as port costs, handling efficiency, hinterland connectivity, and the quality of infrastructure and services [2]. The more efficient and cost-effective a port's operations are, the better should be its competitive position. As shippers and carriers consider hinterland, short-sea, and deep-sea connectivity as major port choice criteria [2, 3], it is in the interest of all stakeholders in the port that these processes are running smoothly and reliably, or else the port risks losing its position in these supply chains. More and more port authorities have focused on a modal shift towards more environmentally friendly transportation modes. As a result the European ports of Rotterdam, Antwerp and Hamburg have stated modal split requirements for the hinterland transportation of containers [4].

To run these port operations smoothly and to improve hinterland's accessibility synchronodal freight transport service is an emerging and developing concept of freight transport operations. In literature likewise concepts are seamless supply chains in Rodrigue [5] and integrated information-material flow [6,7]. Van der Horst & De Langen [8] explain that a mind shift is needed to install an integrated hinterland. The following definition of synchronodality is adjusted from Somers and Tissen [9]:

*'Synchronodality is the transport of maritime freight flows from port to hinterland destination or vice versa - without changing the load unit - whereby real-time changes can be made in the flexible and sustainable use of different transport modalities in a network. The logistics service provider has the control to offer optimally integrated solutions for all parties'.*

The real-time aspect is the most important addition to the definition of intermodal or multimodal transportation. This corresponds to the definition given by Van Riessen [10] who considers synchronodality as intermodal planning with the possibility of real-time switching between the modes or online intermodal planning. Based on the latest information with respect to order information, infrastructure conditions and congestion real-time decisions can be made to optimize the transport more efficiently and/or more environmental friendly. In practice it means that a shipper agrees with a service operator on the delivery of products at specified costs, deliver quality, and sustainability but gives the service operator the total freedom to decide on how to deliver according to these specifications.

The concept of synchronodal transport has gained a lot of interest due to its potential to benefit from the advantages of intermodal transport without sacrificing the quality of service. Intermodal transport emphasises the utilization of rail or waterborne transport capacity in order to benefit from economies of scale, economies of scope (the supply variety in transport modes) and to achieve lower transport costs and emissions. Synchronodal transport instead aims at the integration and cooperation among transport services and modes, in order to give the service operators more possibilities to provide better transport alternatives (with improved reliability) to the shippers by utilizing multiple services of multiple modes. The scientific literature on synchronodality starts growing towards maturity [11 - 14]. Especially in the field of operations research many research focused on efficient network planning in a synchronodal setting [15 - 22].

Although scientists claim that synchronodality is a promising concept [23] with a lot of potential enablers, there is still a lot of resistance to integrate in practice. One can observe at least a reluctant attitude by many companies. There is a strong development of synchronodal platforms such as Nextlogic (Brein), TEU Booker, Container monitor, IXSuite (PTV) and 'the best in class' EGS (European Gateway Services) for the customers of Hutchinson/ECT. To illustrate the 'best in class' EGS transported around 800,000 TEU in 2016 this volume has grown every year since 2012. In 2016, EGS further expanded the possibilities for synchronodal planning with the Synchronodal Trip Optimizer (STO). The transport corridors with the largest synchronodal volume for EGS are those between Rotterdam and Venlo, and Rotterdam and Duisburg. The terminals can be operated with three modalities: rail, inland shipping and road. Outside these transport corridors, synchronodal transport of maritime containers takes place within the 21-terminal network of EGS across Northwest Europe. These current synchronodal platforms facilitate synchronodal planning between multiple parties. All these platforms exclude opportunism in order to prevent self-gain and, as far as possible, take into account the trust between the carriers and the customers. Currently mainly large companies use these platforms, as there is hesitation among SMEs to participate in these initiatives

Therefore knowing and understanding the success and fail factors of synchromodality could contribute to release the practical thresholds that still exist. This has led to the following research question:

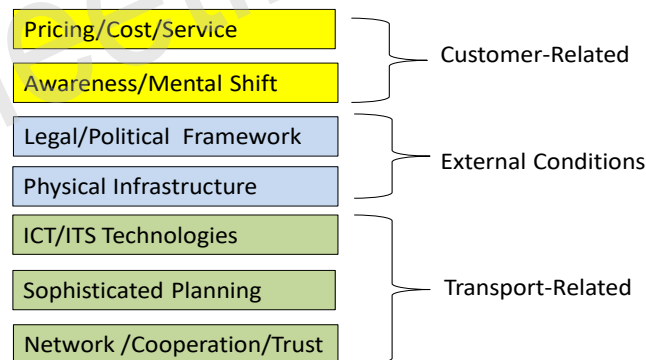
*What are the key success/fail factors of using synchromodal transport in practice for SMEs?*

After this introduction on synchromodal transportation, the framework of critical factors on synchromodality by Pfoser et al. [24] is introduced in Section 2. In Section 3 our survey is explained and shows our results compared to the framework of critical factors on synchromodality by Pfoser et al. [24]. The conclusions of this research are presented in Section 4.

## 2. EVALUATION FRAMEWORKS TO SURVEY ON SYNCHROMODAL TRANSPORT

As shown in the introduction the concept of synchromodal transport is an emerging topics in scientific publications, i.e. almost 25 publications over the last 6 years [1-25]. However in practice one can observe just a few papers on the evaluation of implementing synchromodal transport. Lucassen & Dogger [11] described the first experiences on a synchromodal transport pilot study in the Netherlands in 2012. They pointed out that the design of the network, the necessary changes in collaboration and business models, and the central coordination of the overall transport system are the most important factors to succeed. The pilot study showed to be a success in terms of a favourable outcome in modal split, a better utilization of infrastructure and a substantial reduction of CO<sub>2</sub> emissions. These positive effects have led to the starting up/maturing of synchromodal initiatives such as EGS, NextLogic, TEUbooker.

Evaluation papers on synchromodal transport are still scarce in literature. Agbo et al. [25] performed a feasibility study for the introduction of synchromodal freight transportation concept in a developing country (Ghana). Their main findings showed that it is possible to introduce the concept in their country. At the same time they have to improve the current transportation and ports infrastructure considerably for a successful synchromodal transport system. They also emphasize education for the stakeholders involved. Like us they also used in their study the framework of Pfoser et al. [24]. Based on a literature review of several studies relating to the concept, they identified 7 factors related to synchromodality. These factors are explained below (see Figure 1).



**FIGURE 1 FRAMEWORK OF CRITICAL SUCCES FACTORS IN SYNCHROMODALITY[24]**

### *Pricing/Cost/Service*

Pricing, cost and service are the most important aspects for the customers of a synchromodal transport. Transport must be provided at a lower or at least at the same price. Due to consolidation lower prices can be realized. Still the prices must be waiting for penalties to compel service providers and customers to be on time in supply and delivery of transport services. Advanced pricing and timing are greatly affected by real-time switching between modes hence caution is needed to reduce extra costs (based on extra transshipment). The pricing of synchromodal services is quite complex. Since the transport mode and the specific route are not determined in

advance (and therefore also the related costs), it is difficult to set a price. On the other hand, customers require security to know the price in advance. Similar problems arise in terms of insuring the transport operation. Quality and the offered service (such as on-time delivery, reliability and flexibility) must also fit customer's needs, otherwise synchronomodality is no competitive logistics concept.

#### *Awareness and mental shift*

For all users and customers it is necessary to make a mental shift from the traditional modal-booking to mode-free booking. The awareness for this mental shift has to be created by the synchronomodal logistics service providers through systematic and strategic education among the users of the system. This also supports the trust between the partners.

#### *Legal and political framework.*

A legal and political framework are extremely important for the success of the implementation of synchronomodal services. An effective and efficient functioning of the synchronomodal business is set by the application of a firm legal and political framework in place. Legal issues such as risk and gain sharing will arise among the many stakeholders involved in the synchronomodal business. It should be made crystal clear who is paying for resources and infrastructure and who is responsible for liabilities, such as delays, damages, losses. A bundling platform (such as synchronomodal transport often is organized) can play a role in both the horizontal relationship between the partners and in the vertical relationship with the carriers. In each of the two relationships, four different types of commitments can be distinguished for a proper functioning of the platform [38]. In addition, description of the platform itself in the agreement is not decisive. Courts have a wide discretion to qualify the agreement. The following four commitments are needed:

1. the commitment to disseminate the information provided in a correct manner;
2. the commitment to disseminate correct information / to inform correctly (the platform has checked the information);
3. the commitment to make good transport matches;
4. the commitment to carry out transport properly.

#### *Physical infrastructure.*

The transport modes considered for synchronomodal transport are barge, road, rail, coastal transport. Availability of physical infrastructure is of course crucial for the success of a synchronomodal transport system. Availability of all transport modes are required to maximize the potential of synchronomodal transport. The connecting points in the hinterland, so called hubs, should be smartly connected to ensure a seamless transportation process.

#### *ICT/ITS technologies.*

ICT/ITS technologies and their application in the synchronomodal transport are the so called engines running behind the scenes. The employment of ICT and ITS technologies supports the offering of high quality and standardized data. They will also help in sharing and exchange of relevant transportation and other related data in the synchronomodal process. The numerous players and actors involved in the synchronomodal business imply that there must be fast and accurate means of sharing and exchange of real-time data. Real-time information is also needed for the efficient and effective utilization of transport resources and also for the enablement of switching between transport modes in a dynamic way by optimizing the synchronomodal operations (see also sophisticated planning). Still the willingness to share data among other users is often a serious issue.

#### *Sophisticated planning.*

Sophisticated and dynamic planning is the next important pre-requisite for a workable and robust synchronomodal freight transport network. Critical evaluation and examination of customer preferences, conditions of the routes and available transport resources and modes are vital for a real-time planning. Complex mathematical planning algorithms are needed to generate a planning that ensures deadlines and realizes cost savings.

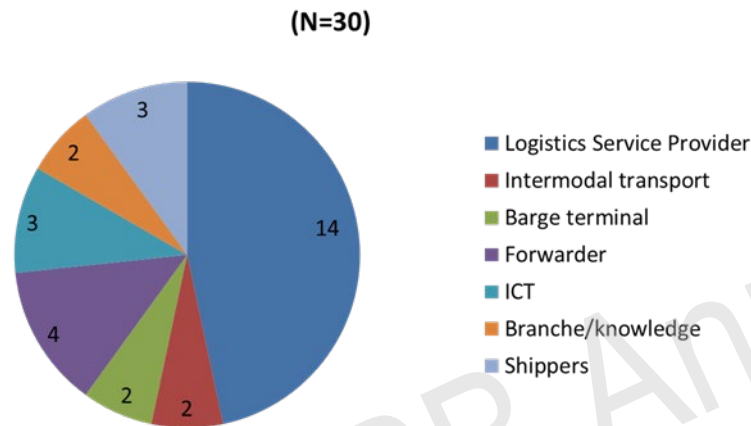
#### *Network generation based on mutual trust and collaboration*

This factor is identified as a major success factor for the implementation and operation of the synchronomodal transport business. Trust and collaboration are very necessary because many companies and business entities feel reluctant in cooperating with each other due to the fear of market competition. To achieve win-win situations in the synchronomodal business, coordination among the many actors and players is very essential. This could be enhanced through fair cost savings sharing and risk sharing.

### 3. SURVEY ON SYNCHROMODAL TRANSPORTATION: CASE OF ROTTERDAM

#### *Participating companies*

In our survey the selection of enterprises was done by applying the rule that each company must play a role in the hinterland connections of the Port of Rotterdam. The companies were interviewed in semi structured interviews without knowing whether companies have experience with synchromodality. During the interviews it was explicitly checked before whether they had experience with synchromodality in order to be sure that a representative person provided the right information. This has reduced our set of interviews to 30 interviewed companies (see Figure 2).



**FIGURE 2 OVERVIEW OF PARTICIPATING COMPANIES**

#### *Case-study research*

It is important to realize that the number of interviewed companies (N=30, see Figure 2) is too small to allow for a statistical analysis of our findings. Each interview can be seen as an individual case-study. The definition of the case study is ‘an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident’. This relates to the preferred empirical approach suggested by New and Payne [27]. Yin [28] further specifies the nature of case studies as follows: ‘the case study inquiry’:

- copes with the technically distinctive situation in which there will be many more variables of interest than data points,
- relies on multiple sources of evidence with data needing to converge in a triangulating fashion,
- benefits from the prior development of theoretical propositions to guide data collection and analysis.’

This description of case study research connects well to various perspectives of the actors involved. The research itself focuses on the most dominant issues deduced from the actor perceptions and the technical aspects of the (synchro)modal processes. Multiple cases should never be used for statistical generalisation, the statistical inferences based on empirical data [29]. Instead the cases are used to formulate a template of a theory, developed earlier in the research process with which the empirical results of the individual cases can be compared.

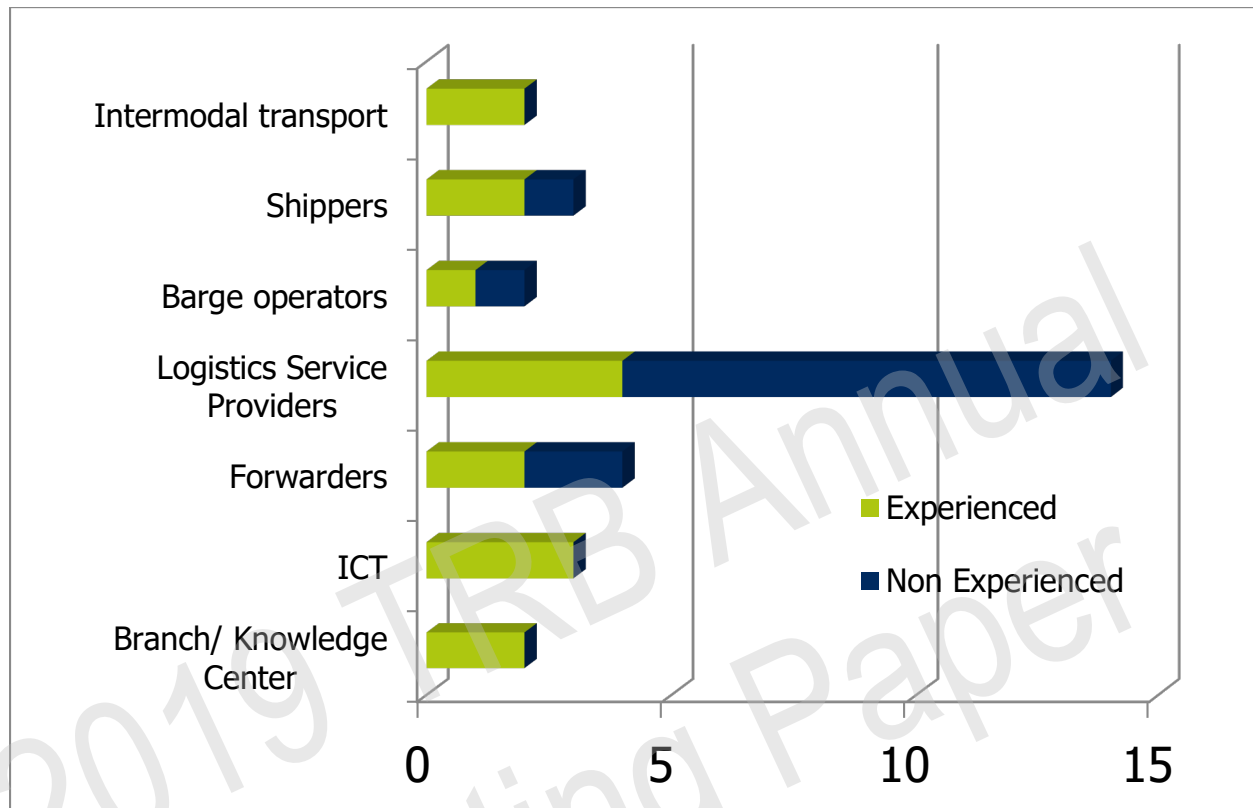
For the unstructured part of the interviews the handbook by Vogt et al. [30] was followed (asking “informational questions about matters of fact and interviewees’ interpretations”). Therefore the interview notes may suffice. Furthermore, to mitigate the potential inaccuracies when using interview notes only, a draft of this paper was presented to our respondents to verify whether their viewpoints have been represented accurately. This validation round did not yield major discrepancies.

In our research the framework of critical factors on synchromodality by Pfoser et al. [24] is used as a reference template. All case studies had an identical case study protocol in which identical (ranking) questions were raised. Additional information could be provided to obtain richer picture on the success and fail factors. Our analysis makes a distinction between the research outcomes of companies having experience and no experience with synchromodality.

#### *Companies that have experience with synchromodality.*

First of all it is important to identify which type of companies has experience with synchromodality (see Figure 3). It seems obvious that ICT and branch organisations are familiar. They are the knowledge providers of planning tools for synchromodal transport. An interesting group of non-experienced companies is the group of

logistics service providers. From these companies it can be observed that they have been working for many years with the same road carriers and they still have a lack of knowledge about the potential and advantages of the other transport modes. One of the logistics service providers pointed that out of a 100 companies still 20 percent of the companies would organize their own transport despite they would know all the benefits of choosing other transport modes.



**FIGURE 3: EXPERIENCE WITH SYNCHRO MODALITY**

Among the experienced companies we asked them to rank their factors that obstruct synchro modal transport. In the interviews they came up with the factors themselves. Factors that were mentioned most often (2 times or more) were selected. The following factors are brought forward and explained by the interviewed companies:

- Data sharing with customers;
- Infrastructure;
- Inflexible product;
- Customer requirements.

#### *Data sharing with customers*

Most companies explain that they do not have any problems with sharing their data with other companies. They know and trust their suppliers and the companies they work with. Everybody is well informed where to pick up the goods at what time. Still many of the companies prefer that the customers do not know where the goods are. With the provisioning of the data the customers are able to eliminate the position of the middle men and the traders. Sharing data among the whole logistic network is perceived as a problem due to the sensitivity of the information. At the same time they foresee that ICT-connection between the different information systems is easier facilitated. They also believe they could benefit from these platforms by giving the network the required visibility.

#### *Infrastructure*

Synchro modal transport options are blocked if availability of services and availability of the infrastructure are not efficiently organized then a transport mode could be out of range. This situation arises for inland shipping when for example inland vessels have to deliver containers at various terminals in one port. Due to the average small call sizes and the frequent change of vessels in front of the quays, this quickly leads to congestion. This puts the delivery reliability of the synchro modal service at risk. Because different window times are used at terminals, waiting times can arise. Supporting planning apps are now being used to provide insight into the expected traffic on the quays for inland navigation skippers, but still congestion situations have occurred in the past year.



### *Inflexible product*

Information sharing is not always optimal. In order to plan synchromodal, not only the ETAs (*Estimated Time of Arrival*) of deep sea vessels should be known and precise, also the ETAs of inland vessels and trains should be known and precise. In practice the ETAs are not available and seldom precise and therefore it is hard to plan full loads. In case real time problems arise the trucks are always the final flexible answer to deliver on time. The other transport modes cannot offer this degree of flexibility. Here our practical findings seem to be contrary to the theoretical findings as suggested by Lin [31]. They suggest that the market for inland container transportation can be segmented in groups of customers with different characteristics. These groups are sensitive to different incentives that may persuade customers to allow flexibility for planning purposes by the synchromodal transportation operator. In circumstances where flexibility and speed really is needed, the trucks seem to be the only solution.

### *Customer requirements*

Since the load falls under the responsibility of the transport companies many customers do not want to transport with too many transshipments. The fear for damage is realistic and the related fines are high. Also the on-time delivery is often an argument not to choose for other transport modes, because every transshipment can cause extra transit time. From a juridical perspective, however, there is no difference between synchromodal transport and multimodal transport since the same law and rules are applied [32].

### ***Companies that have no experience with synchromodality.***

Among the inexperienced companies we asked them to bring up their obstructing factors and to rank these factors. The following factors are brought forward in sequence of importance (mentioned more than 2 times):

- Lack of knowledge;
- No knowledge how to start;
- Lack of transparency;
- The complexity of synchromodality.

### *Lack of knowledge*

Sjoerdsma [33] indicates that skepticism prevails among companies, especially at forwarders and shipbrokers. Few companies have already found affiliation with a synchromodal platform. For many companies, the emergence of synchromodality feels much more as a threat than potential progress, especially for brokers and forwarders who perceive it as competition. This type of business often relies on traditional ICT applications and has insufficient expertise or financial resources to link up with this development. Many forwarding agents do not have the knowledge to grasp the advantages of different modalities.

### *No knowledge how to start*

Many (small) shippers want to use transport modalities that are more sustainable than road transport from a customer socially responsible business (CSR), but the volume of their transport is often insufficient for a train or boat to drive/sail and therefore often not enough to make it profitable. At present, there are still too many relatively small volumes resulting in a low capacity utilization rate. Low utilization ultimately results in a transport price increase. Related to this issue is also the fact that companies bring forward another obstacle, namely the lack of a return flows. They are absolutely needed to make intermodal and synchromodal transport more efficiently.

Although a couple of synchromodal platforms are operational nowadays, a very reluctant attitude from many forwarders and shippers has been observed. The rules and procedures how to find these platforms, how to connect with these platforms are not familiar. New initiatives like TEU-booker try to avoid this and develop for instance easy access interfaces with low thresholds.

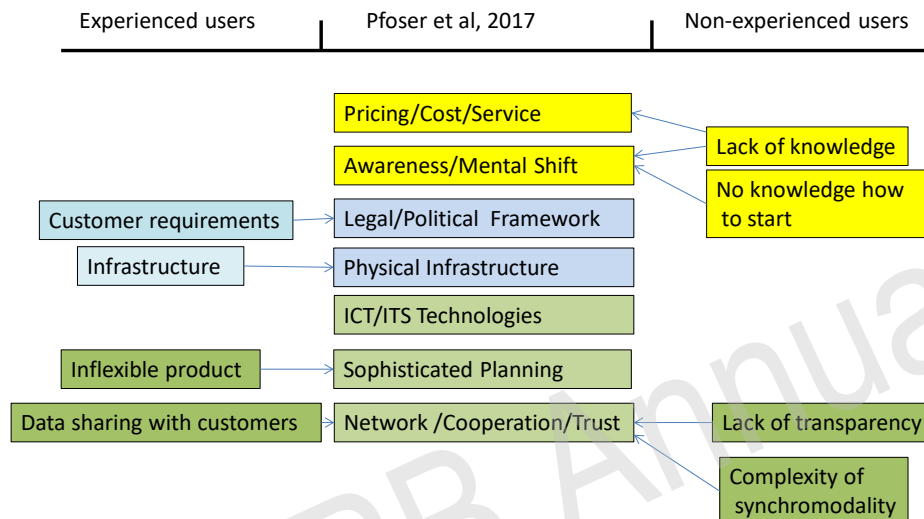
### *Lack of transparency*

The lack of transparency is best reflected in a fear on the application of privacy- and decision rules. Synchromodality requires cooperation based on mutual trust between stakeholders, including the exchange of information between the organizations. Many of the parties involved are often reluctant to share information because of privacy and customer-sensitive information. It is also important that the procedures, transfers and liabilities are properly organized. The program manager Sjoerdsma of the Nextlogic synchromodal platform [33] does not have elaborated yet a set of decision rules of decision rules for all conflict situations. With respect to transparency the fear seems to be realistic, although it is also hard to foresee in all conflict situations.

### *The complexity of synchromodality*

The complexity of synchromodality is strongly related to information exchange among the stakeholders that must be coordinated. One of the key issues that hinders the coordination between the different actors of the supply chain is the lack of information exchange between the actors both in horizontal as well as in vertical level.

This lack of information exchange is partly due to the lack of collaboration between the stakeholders [33]. To achieve the optimal level of synchronized services and collaboration it is necessary to achieve the optimal collaboration between all the stakeholders in the supply chain [34]. On the other hand logistics and freight transport in general is a very complex and competitive environment [35].



**FIGURE 4: (NON) EXPERIENCED CSF FRAMEWORK (EXTENDED [24])**

Reflecting on the CSF framework of Pfoser et al. [24] the experienced users do mention more the operational factors of synchronomodal transport. Their experiences with flexibility, availability of infrastructure, damage-control and specific data sharing seems to be determining factors in their usage of synchronomodal transport.

As expected the companies without experience are reluctant to use synchronomodal transport. They have a serious lack of knowledge which leads to almost an aversion of synchronomodal transport. Forwarders and logistics service providers work for many years in the same manner with their partners with the current ICT systems. Moreover it should be mentioned that the investments in the ICT systems are high compared to the extreme small profit/loss margins in these sectors. From this point of view it is understandable that these companies show almost no interest in synchronomodal transport. These findings are represented in Figure 4.

Since the field of synchronomodality is still in the immature phase for most SMEs, it is clear that most identified factors are mostly classified as failing or blocking factors instead of success factors. Solving these factors give directions to stimulate the use of synchronomodal transport. The differences between experienced and non-experienced users ask for the development of a synchronomodal transport maturity model that divides this large change going from non-experienced users to experienced users into several stages that companies can go through when developing synchronomodal transport [37][38].

#### 4. CONCLUSIONS

Despite the fact that many scientists argue that synchronomodality is an emerging and promising concept [23], there is still a lot of resistance in practice. Literature about the success and failure factors in practice could contribute to reducing the thresholds and better acceptance of this new concept.

Implementing effective synchronomodality depends on various requirements. As the concept fundamentally builds upon cooperation between all stakeholders along the transport chain, establishing close cooperation is the main requirement to ensure efficiency and the flexible use of resources. They do not only have to collaborate, but they must also participate in a mental shift to grant the necessary freedom for fulfilling a-modal transport services. , Creating more planning flexibility is vital to enable synchronomodal planning. Therefore, the network operator has an incentive to introduce a range of transportation services with varying levels of flexibility. Such new product ranges have been studied recently by Lin [30]. This argument holds even for the experienced users with respect to specific issues such as data sharing, damage control and infrastructure availability. Levels of flexibility can create improvements on these issues.

The lack of knowledge seems to be the biggest obstacle for companies without experience with synchronomodality. These companies should be supported with easy access, good information and understanding of the value and way of working with synchronomodal transport. These companies can be supported by the use of a

simulation and gaming tool like SynchroMania [36]. SynchroMania lets you play as transport planner, who has to process a large number of transport orders from different customers. The game shows that giving degrees of freedom enables synchromodal planning and execution with benefits for parties throughout the chain. Playing SynchroMania has been an eye-opener for various customers and service providers [36].

For companies with(out) experiences The Port of Rotterdam has developed a Navigate routeplanner. In Navigate all deepsea and shortsea schemes of 550 ports worldwide are connected with rail and barge connections between Rotterdam and more than 150 European inland terminals. Showing the duration and the CO<sub>2</sub>-emissions Navigate is one of the most complete route planner of its kind. This tool can help companies at least to consider (multi-)/(synchro-)modal transport.

Our study shows a clear distinction on the CSF-framework [24] for the experienced user companies and the inexperienced user companies. The experienced user companies are more focussed on the operational transport processes with customer requirements, infrastructure, inflexible product and data sharing with customers. The non-experienced user companies struggle more with the unfamiliarity of synchromodality, and in particular issues such as lack of knowledge, how to start knowledge, lack of transparency and complexity of synchromodal transport. Framing our conclusion in comparison to the study of Agbo et al. [25] awareness, mental shift and network/cooperation/trust remain critical enablers instead of viable enablers, no matter whether companies have experience with synchromodality. To bring synchromodality steps further to implementation it is clear from our research different actions plans are needed considering the level of experience of the enterprises [37][38]. As shown in Pfoser et al. [24] and Agbo et al. [25] synchromodality can be interesting to any port in the world as long as there are more transport modes available for hinterland connections.

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#### AUTHOR CONTRIBUTION STATEMENT

All authors, J.H.R. van Duin, P.M.J. Warffemius, P.C.J. Verschoor, A.de Leeuw and K.M.R. Alons-Hoen, confirm full responsibility for the following: study conception and design, data collection, analysis and interpretation of results, and manuscript preparation. All authors reviewed the results and approved the final version of the manuscript.

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