Effects of a Digital Platform Within Container Shipping - Master Thesis

Scenarios for the Reconfiguration of the Container Shipping Ecosystem

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by

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Master thesis submitted to Delft University of Technology
in partial fulfillment of the requirements for the degree of
MASTER OF SCIENCE
in Management of Technology
Faculty of Technology, Policy and Management

Master Thesis
To be defended in public on July 14th 2021

at the Delft University of Technology,

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July 7, 2021

TU Delft Delft University of Technology

Acknowledgements

This research was written as part of my Master degree in management and technology. Within these acknowledgements, I would like to thank some people who have been most important in my master and the writing of this thesis, who without this thesis would have never been written.

First, I would like to thank my supervisors. Roland, a little more than a year ago you gave an inspirational speech on the use of data and the developments of platforms. The discussions and meeting we had after this guest lecture inspired me to combine my previous knowledge of navel engineering and my interest in digital innovation. Without that push, I would not have gone in this direction for my thesis. Secondly, your positive approach throughout the thesis has helped me in many cases to further develop my core ideas into the writing. I understand that the COVID outbreak has not made supervising easier, but nonetheless, I want to express my sincere gratitude towards the way you performed the role. Boriana, as my external supervisor, you have far out-performed what is expected of this role. Within our meetings, you really supported me in understanding the mechanics behind the supply chain and the concepts of digital information infrastructure. Thanks for the commitment and feedback you provided. Yao-Hua, as chairperson and second supervisor you have given me much of the expertise on the TradeLens platform. The interview we had with you were very insightful and constructive. Your mix of criticisms and advice has been of great value during the writing of the thesis.

Also, I would want to thank my fellow MOT student, Florian. He has been of help with discussing the core ideas of the thesis. Your advice, opportunities to work/study together and the relaxing time between those sessions has helped me to unwind.

Lastly, I want to express my thanks to my fiancé, Selma. While she was not a student of innovation management, nor digital information infrastructure, she did listen to the many problems I was experiencing while writing the thesis. Without her support, the process of writing this thesis would have been far less enjoyable.

Jan Hoek
Delft, July 7, 2021

Executive Summary

Since the introduction of the shipping container as early as 1968, the shipping industry experienced great increase in trade and efficiency. The shipping container revolutionised the way goods are handled within the ports and enabled the growth of international supply chains. However, as this growth of trade continued into the late 1900s and early 2000s, both customs and the organisations within this chain experienced an increased administrative burden. This administrative burden was experienced within the different information streams to get the goods smoothly from the selling actor to the buying actor. Additionally, many actors within the supply chain perceive opportunities to greatly increase trade efficiency. Improving their business model through the addition of information-based new services, expanding business through integrating other actors, and lowering costs through the development of cost-effective in-house capabilities. Early digitisation efforts have only produced limited results, as these mainly focused on automating internal business processes. These internal processes were often not able to automate communication with other actors. Processes still relied on a significant amount of paper communication.

The introduction of digital platforms has greatly affected different industries, for example enabling direct booking within the air travel business. Replacing paper documentation with an electronic equivalent can enable an increase in efficiency, through reduced administration costs and improved planning and operational capabilities. Efforts in introducing a digital platform within the shipping industry have been taking place using different governmental research efforts. However, as a possible additional effect, the digital platform may put reconfiguration of the network in motion. This reconfiguration enables certain actors to partake a bigger role, whereas other actors might lose control of the supply chain process.

The TradeLens platform launched in 2018, is such a digital platform. This platform allows sharing both documentation (e.g. the commercial invoice, packing list, bill-of-lading) and supply chain events (e.g. lodging ENS, the actual time of arrival) with the other actors. The platform uses a blockchain infrastructure. This structure is used to increase the trustworthiness of the data. Firstly, the auditability hinders documentation fraud as the actors within the network can trace the exact moment and actor that placed uploaded a document. The immutability of the blockchain infrastructure allows the automation of information processes. When the information is uploaded it cannot be changed. It was developed by a co-operation between a shipping carrier and a technology developer. The platform was tasked with alleviating the pressure on the administrative systems of the different actors within the supply chain. This research investigated possible scenarios due to the introduction of a digital platform using the TradeLens platform as the main research case.

Research Question and Objectives
This research aims to address the different possible future configurations of the network and roles within the container supply chain. To address this, the following main research question was developed: *What is the possible supply chain configurations that come with a digital information infrastructure?*.
In addressing this research question a number of research steps and clarifications have to be answered. Firstly, the research has to determine what is considered an actor within the supply chain ecosystem and what are the key activities performed in that ecosystem. Secondly, the research aims to perform an analysis of each actor and thus explain the different roles to be able to perform this analysis a theoretical model has to be developed. Thirdly, the research will evaluate the ecosystem using this model. Fourthly, the different scenarios will be developed using the developed model.

Research Method
The research employed three main methods of data collection. Firstly, a literature review is performed to identify the important information and innovation concepts to be used throughout the research. Secondly, through analysing many different public sources, the research gains company insights and information for constructing different roles, activities, and resources. Thirdly, through interviews with experts on the TradeLens platform where careful attention is given to the shifting activities, resources and control within the configuration of the network.
The used approach can be defined in four steps. First, the researchers developed an initial meta-framework using the findings from the literature review. Secondly, the different concepts within the meta-framework were combined into constructing a model for the assessment of the ecosystem. Thirdly, a generic container shipping case is construed from the information gained from the different public and academic sources. Lastly, a comparison is performed between the construed case and a test case of a Dutch tyre importer. The main findings within these steps will be discussed in the following paragraph.

Main Findings
The research identified five key theories to be of importance within the model. These are **1.** Ecosystem theory, **2.** Stakeholder theory, **3.** Diffusion theory, **4.** Control Point theory and lastly, **5.** Barriers and Stimulating Factors. Firstly, the concept of the business ecosystem. An ecosystem describes how different actors within a business domain influence and interact with the other actors outside and within the direct business network. This research investigates the effect of digital platforms on ecosystem reconfiguration. The chosen system of analysis for this ecosystem reconfiguration is the blockchain-enabled platform, TradeLens. This platform enables information sharing between the different actors using a trusted blockchain structure. The TradeLens ecosystem can be considered a service ecosystem, as the main value creation is intangible and the many different actors within the ecosystem co-produce the final value within the system. Secondly, stakeholder theory describes when someone can be considered a stakeholder and how to evaluate motivations and incentives. Thirdly, diffusion theory described how an innovation such as TradeLens goes through different phases before mass-market adoption. Fourth, the control points theory explain how different actors within a business process are able to exercise control on that process. Control points were used to describe how different actors are able to perform certain roles within the ecosystem. Lastly, barriers and stimulating factors describe how certain factors can enable or disable a certain development to progress further. In the case of TradeLens this was used to investigate further growth barriers and stimulating factors.

This meta-framework was converted into a six-point assessment model. This model uses a comparison between different states of an ecosystem, to evaluate possible scenarios. The first case

is that of the generic constructed benchmark. This benchmark has been developed from cross-referencing a selection of public and academic sources. The main task of the constructed case was to show a generic and common supply chain structure. To assess the enhanced version of the supply chain, a case study of a Dutch tyre importer was selected. This case was selected due to the extensive documentation around this case. Additionally, this case has ships of non-hazardous and non-perishable goods that do not require additional certificates and documentation that might be applicable for other goods. The constructed benchmark case and the tyre importer case were both evaluated using the six-point assessment. With regards to key activities, the main difference found was that the tyre importer self-organises its land transport as the organisation owns its own transportation vehicles. Secondly, the tyre importer case performed the import declaration itself. This in contrast with the benchmark case, where this task was delegated to a freight forwarder who organises both the land transport and the lodging of the import declaration. This main difference becomes more visible when assessing the second point, the key actors. Here it was observed that the freight forwarder was missing on the importing side within the tyre case. This was possible as the buyer/tyre importer performed the activities of the freight forwarder. Within the value exchanges and the key information, it was observed that the buyer was able to directly lodge the required data for the import declaration. This automated the customs lodging process and increased cost-effectiveness. Secondly, within the TI-case the buyer had its own land transport capabilities and did not rely on an intermodal operator to collect the goods from the port. This allowed the buyer to redevelop its strategy with regard to the supply chain. The effects of the digital platform allowed the process of lodging the customs declaration to be more efficient as the commercial invoice and HS-codes could be directly gathered from this platform. This was made possible due to the API and blockchain data pipeline architecture of the digital platform. The API-structure allowed the data to be automatically collected, whereas the blockchain structure enhanced the trustworthiness of the submitted data. Regarding, intermodal transport. The digital platform allowed the buyer to have an accurate and actual time of release and arrival of the container. This allowed the buyer to improve the planning of the collection of the container. When observing the control points it was identified that the main control points of the freight forwarder are two-fold. First, it has the expertise and capabilities to be able to perform the customs lodging. Secondly, it has the capability of gathering and forwarding logistics data within the network. Within the tyre case, both of these control points were absorbed by the buyer.

Using the control point evaluation a set of four different scenarios were identified. These developed scenarios are not comprehensive, but a combination of these scenarios are likely to be observed in the near future. For every scenario, it is evaluated how the actor could use its current control points and the digital infrastructure to increase its control on the process and thus enable reconfiguration. Firstly, the status-quo scenario. In this scenario, there is not a clear actor who absorbs the activities of other actors. The main benefits of the digital infrastructure are experienced throughout the chain as the different actors increase their efficiency using automation and digitisation of the communication processes. In this case, no reconfiguration is thus observed. The second scenario is the development of capabilities to perform more logistical tasks within the supply chain by either the buyer, the seller or both. As observed within the tyre case, the buyer is able to more efficiently perform the customs lodging and the arrangement of land transport due to having access to the commercial invoice and the actual time of arrival and release of the container. An identified stimulating factor within the capability development of the buyer/seller is the standardisation of the data and the development of a market solution to booking and tracking logistical transport. The third scenario is where the carrier becomes a one-stop shop for logistics. Using their central position within the supply chain, they are able to redevelop their value offering. This offering is expanded with the logistical support of lodging customs data and providing intermodal transport.

The fourth scenario is that of the freight forwarder expanding its value offering. Here the freight forwarder expands into managing the customer's warehouse and perform a larger set of logistic services towards the customers.

Executive Recommendations

The research identified that the introduction of a digital platform may enable a reconfiguration of the ecosystem. Executives working within the container supply chain are advised to adapt their strategy to the following aspects.

- *Develop a strategy on automation using digital platforms*: Digital platforms enable effective and high-speed data sharing. The data is captured at the source through the data pipeline concept. This enables different organisations to work with the same data. This data can be extracted using APIs. These APIs in conjunction with in-house software can enable quick automation of different business processes. One such example would be forwarding the estimated time of container release at the port of discharge to the intermodal operator. The risks of these automated processes are acceptable, due to the auditable nature of the blockchain platform. This hinders tampering with the information and in cases of tampering, it is easy to track the exact organisation that performed it. However, the practitioner should be aware of the challenges of incorporating such an infrastructure. To exploit this digital platform, the actor requires collaboration among its supply chain partners. This collaboration requires every actor within the chain to be willing to share data with the other actors. Also, the practitioner should be aware of the required knowledge and organisational flexibility. The value of this development is maximised if the practitioner has the availability of knowledge on how to automate processes, how to use the data, and the organisation has sufficient agility to adapt its internal processes to the digital infrastructure. Lastly, a lack of integration between the different internal and external processes could mitigate the positive effects of such a platform.
- *Look for business opportunities within the supply chain*: The supply chain has two types of key activities. These are the physical activities and the informational activities. The former requires a physical service such as transporting the goods, loading the goods, et cetera. This requires a physical resource to be performed. The latter requires access to information. As the digital platform enables the development of informational capabilities, it is advised to investigate how to expand the service offering of the organisation through using these new-found information capabilities. Also, it is advised to be aware of possible reconfiguration within the ecosystem. As digital infrastructure can enable a shift of activities between the different existing and potential new actors. Awareness will support the firm to proactively avoid the negative effects of digital innovation from other actors within the chain.
- *Standardise information*: Important in both automation and expanding into different supply chain roles is the ability to effectively process information. A significant barrier within information handling is the format of that piece of information. Currently, many organisations work with many different formats of the same type of document. This hinders the development of cost-effective software to automate these processes. It is recommended, that the information should be standardised to the maximum extent and push for standardisation within the wider network. This allows both internal and external efficiency to increase as the processes are most cost-effective to automate.

Secondly, there are two general applications of this research. These recommendations can be used by an organisation inside and outside of the researched domain. First, practitioners can use the model to increase their understanding of the business ecosystem they partake in. Through employing the method described within the thesis, a better understanding of the network, its actors,

the roles of these actors and the key activities will be developed. This enables the practitioner to be more aware of the current role of its own organisation and thus be able to investigate possible growth opportunities. Secondly, using the method developed for extracting control points, the practitioner is able to evaluate the distributed control within the network. It aids in understanding the value proposition of the organisation and can be used to either pro-actively negate threats due to innovation or re-actively adapt to new market realities.

Scientific Contributions

This research has two main contributions to science. These are the systematic methods to assess the supply chain configuration and the approach to acquire stable control points.

The systematic method to assess the supply chain is developed using the five theories. These theories are used to develop the six-point assessment method. This assessment method looked into identifying the actors, the information flows, the activities, the value exchanges, the time of evaluation and the control points. This is in part a research contribution within the domain of transformative effects through digital platforms. This research contributes by showing that control points can be used to identify possible network reconfiguration.

The second contribution is that of the identification approach of control points. In their research, Rukanova et al. [41] explain the difficulties of identifying domain-specific control points due to the changing nature of the value exchanges between the different actors. This research has shown a method to identify the control points through decoupling the value exchanges from the actors. This is the second research contribution.

Contents

Glossary

API Application Programming Interface.

ATA Actual Time of Arrival.

BoL Bill-of-Lading.

CRM Customer Relationship Management.

DI Digital Infrastructure.

DII Digital Information Infrastructure.

DTI Digital Trade Infrastructure.

ENS Entry Summary Declarations.

ERP Enterprise Resource Planning.

ETA Estimated Time of Arrival.

FCL Full Container Load.

FF Freight Forwarder.

FOB Free on Board.

FSP Financial Services Provider.

HRM Human Resource Management.

HS Harmonised System Classification.

IT Information Technology.

LCL Less than Container Load.

LoC Letter of Credit.

PoD Port of Discharge.

PoL Port of Loading.

RQ Research Question.

SQ Sub-Question.

TEU Twenty-Foot Equivalent Unit.

TI Dutch type importer.

WCO World Customs Organisation.

1 Introduction

In this chapter, the main research is introduced. First, the main research problem is introduced in chapter 1.1. Secondly, the background of the research is discussed in chapter 1.2. In this chapter both the practical and scientific issues of the main subject are discussed. Following this, in chapter 1.3 the main objectives of the research will be proposed. Chapter 1.4 discusses the scientific, societal and academic relevance of the research. In chapter 1.5 the main perspectives of addressing the issues will be discussed. Furthermore, chapter 1.6 develops the research questions. Chapter 1.7 will discuss the scope of the research. The last chapter, chapter 1.8 will show the roadmap of the research and the main structure of the thesis.

1.1. The problems of digital information infrastructure innovation

Implementing or radically changing the information structure has on multiple occasions caused a reconfiguration within the ecosystem around such an information structure. Ciborra [4] argues with regards to the internal dynamics of IT infrastructure that the effect is unpredictable as the different actors involved will try to exert changes on the infrastructure establishment or development. Secondly, a battle of standards takes place. This battle is the establishment of standards within through collective decision-making. Lastly, unique events have a determining effect on the direction of the development of the infrastructure. These three points make the development of the infrastructure inherently somewhat chaotic. Additionally, Tilson et al. [49] describes that digitisation has could have the ability to disconnect the information types from the way the information is gathered, forwarded. Thus processing technologies might have the ability to disrupt an existing service model and the wider stability of the organisation within the industry. This reconfiguration has been observed as a new arrangement of activities between the different actors, the introduction of new actors, and the development of new activities. Examples of such developments have been observed in other domains. E.g. within the mobile payment, it was observed how the activities of identifying the user were transferred from the banks to the telecom operators [41].

Starting from late 2018 IBM and Maersk launched the TradeLens platform. This platform would change the way information would be shared within the container supply chain[23]. However, as soon as 2018 different issues were raised by different actors. Firstly, some actors perceive the platform as a possible threat [50]. This platform might potentially disrupt their business model. Secondly, innovation within digital information infrastructure will move control between actors [41]. This new configuration may cause roles to shift within a market. Lastly, digital trade infrastructure will enable new value-added services to be developed [43].

As the data-sharing platform is developed for the container shipping supply chain, it mainly affects those that perform functions within this chain. These are parties such as the freight for-

warder, the shipping carrier, but also the end-customer. However, the biggest party to be affected is that of the freight forwarder. This party performs a vital function of orchestrating the shipping process, through arranging the physical transport, clearing the goods through customs, and giving support and advice through leveraging the network of business contacts. It is exactly these tasks that have come under threat of the TradeLens platform.

With regard to the issue of perceived threat, Maersk has adapted its governance structure to include members from all different parts of the supply chain [54]. Here Maersk was understood that to become an industry-wide solution, they had to get other carriers to join the platform. This seems to have solved the issue of the perceived threat, as the platform has been adopted by other carriers. However, the second issue remains unsolved. As the market disruption is still active. It did not solve the root issue of control being moved between the different actors.

The main research problem is thus formulated as to how the emerging platform affects the roles and functions within the supply chain ecosystem. Here the research will address the following aspects. Firstly, what are the important functions performed by the different actors within the ecosystem? Secondly, how do these functions transfer between the different actors and what is the mechanism behind this transfer? Lastly, how could further adoption of the platform affect the ecosystem in the future?

1.2. Background of the research topic

The next step in developing insights into the developing roles is through expansion of the background of the problem. Four answers have to be given. Why the container supply chain? Why is digital trade infrastructure required? Why is understanding role shifts important? Why is it important to develop a systematic method of identifying these shifts?

1.2.1. The container shipping supply chain

This research investigates the container supply chain, as sea container transport is responsible for around 60% of all sea-based trade[1].A diverse set of actors are required to enable a shipment to process from the factory or seller to the buyer. This has been shown in the cases of the international transport of avocados and roses [22, 24] Containerisation has enabled standardisation within this shipping process as many different types of goods can be processed using the same uniform twenty-foot transportation unit. A few critical processes can be identified within this supply chain. Firstly, the goods have to be processed by customs. Vital for importing and exporting the goods is to have permission for loading and unloading/discharging the container. Without that permission, the goods are not allowed to leave the different ports. Secondly, the physical transportation of the goods by the different train, truck and shipping operators. Lastly, the information gathering and sharing processes within the supply chain. E.g. customs is reliant on the information from the commercial invoice and the packing list. Both are used for risk assessment of the goods and the former is secondly used for collecting the due export/import tariffs. Within this information transfer, traditionally the freight forwarders perform an important function as information intermediator. He gathers the original information from the factory/seller, carriers and other relevant documentation and forwards this information to the actors that require the information. In the case of import customs, this process enables the container to receive permission to be discharged within the accepted time frame.

1.2.2. The necessity for digital trade infrastructure

The container supply chain has two main tasks. It has to move the good from the supplier or factory, towards a designated location of the buyer. However, it also has to make sure that these shipped goods are compliant with the exporting and importing nations rules and regulations.

[1]According to Statista https://www.statista.com/topics/1367/container-shipping/

This second task requires a significant amount of information and introduced an administrative burden within the chain. As Jensen and Vatrapu [24] shows that the international trade of roses has at least 20 different physical documents which are to be processed in different systems from different organisations. By introducing digital trade infrastructure, this administrative burden can be reduced. This is achieved through automation and disintermediated data sharing.

1.2.3. The need for understanding role shifts

The second part of understanding the research issue is the necessity of understanding role shifts. Within this research, a role shift is defined as the moment an actor takes on key activities that were used to be done by different actors. Here it is important to understand that this transfer of activity is identified as a trend and not an isolated event. The actor expands its role within the supply chain. This creates a certain disruption, where the business model of one actor becomes potentially more valuable or profitable and the business model of another actor is threatened. As the world is ever-increasing dependent on information technology, it is of great importance to be able to predict which services, business models, and type of companies are more likely to gain or lose power within the different business ecosystems. This predictive capability is largely dependent on knowledge of the different mechanisms behind the general developments. This research identified the shifting of roles of actors to be one part of understanding wider business implications. In figure 1.1, a schematic view is provided for such a role shift. Here it is observed that technological innovation allowed an actor to take over one of the key activities (in this case activity Y) from the other actor. This changes their relationship and the value exchange between the actors.

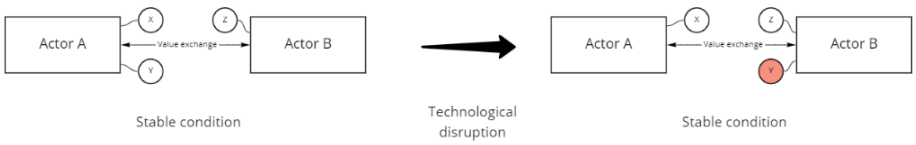


Figure 1.1: A schematic view of a role shift between actors, here actor B takes over activity Y of actor A.

1.2.4. The importance of having a method to analyse the ecosystem

Digital infrastructure might decouple the information from the current actors and processes [49] and enables reconfiguration within the network. This would enable actors to decrease the administrative burden of the shipping process and increase the overall efficiency of information-dependent processes. What started as a method to speed up and digitise trade, is affecting the configuration of the container shipping ecosystem. However, as the industry is changing different actors within the supply chain are getting concerned about their role in the process, such as the freight forwarders[26]. Their position is largely dependent on the ability to process information. To assess whether these concerns are correct, a method must be developed for analysing the ecosystem and develop different reconfiguration scenarios. These scenarios can be used to develop different strategies for adapting to new realities within the ecosystem.

The proposed research will investigate the emerging ecosystem of the Tradelens platform. Currently, as part of the industry 4.0 developments, many companies face a changing corporate environment. In their review, Pereira and Romero [37] show the implications for the industry. Firstly, there are three dimensions of activity integration. These are (**1.**)horizontal integration of activities through the value exchanges, (**2.**) vertical integration of actors, and (**3.**) an end-to-end integration of digital activities along the complete value chain. The resulting environment is a more streamlined and connected ecosystem. In the end business demand more complex and smarter services from the companies. E.g. tracking transport in real-time, API enabled information sharing. These developments force companies to either adapt or succumb to these rapid changes. Within the shipping industry, these effects are also seen as companies start to develop digital infrastructures to

enable new processes and services. However, for a company to be able to anticipate these changes, it requires some knowledge of the effects the digital infrastructure innovation. The main problem definition that follows is that there is a lack of knowledge on the emergence of a new ecosystem through the introduction of digital infrastructure and the effects that this will have on the different actors within the ecosystem.

1.3. Objectives of the research

The next step is to understand, what this research tries to achieve. The main goal of the research is to increase the understanding of how digital infrastructure impacts the wider ecosystem around the container shipping supply chain. These impacts are defined as the development of roles and responsibilities, control, and relationships within the ecosystem. To achieve this main goal, a number of objectives are defined. Firstly, this research will assess the main actors and activities within the supply chain. As the research will focus on the transformation of different aspects of the actors, it is necessary to answer the following two questions: **1.** When is someone considered an actor? **2.** What is considered an important activity? The first question will help to understand when an actor will be considered within the research and the second one helps to understand which activities should be more closely investigated to understand. The second objective is to create a deeper understanding of the specifics of each actor. This is achieved through the exploration of theoretical concepts surrounding roles, responsibilities, the connections between stakeholders, and other factors that stimulate or block development. After developing this deeper understanding, the following objective is to use this to evaluate the transformation of the ecosystem within the context of different cases. The fourth objective is to explore alternative set-ups of the digital infrastructure, which exist within the supply chain domain. These alternatives generate insights into how roles can shift when different actors are given control. The fifth objective is to explore different scenarios using the findings of the other objectives. These objectives and the chapters where they are discussed are shown in the table 1.1

Table 1.1: An overview of the different research objectives.

	Objective	Deliverable	Chapter
1	Develop an overview of relevant actors and activities of the container supply chain	1. A list of activities and the most important actors within these activities. 2. A description of the relevant actors	5
2	Explain the different roles of actors, the connection between actors, and other factors that stimulate or block development	1. A theoretical framework to assess the different specifics of the stakeholders. 2. Model of assessing the ecosystem surrounding different cases.	4
3	Evaluate the transformation of the ecosystem through the introduction of the TradeLens platform.	1. Application of the model within different cases with their main findings.	6
4	Explore future scenarios of the TradeLens platform	1. An overview of possible future developments of scenarios, based on findings during the research.	6

1.4. Relevance of the Research

In this chapter the relevance of the research will be explained. This will be done through three distinct areas of relevance. The first question to be answered is, how does the research aid man-

agement? In this chapter, chapter 1.4.1 the relevance to business will be explained. The second question to be answered is, how will this research aid wider society. In chapter 1.4.2 the implications are discussed for society as a whole. Lastly, the academic question will be answered. Chapter 1.4.3 will discuss the relevance of the research in the wider academic context.

1.4.1. Managerial relevance

In chapter 1.2 a description is given of the need to understand the role shifts. This chapter will describe more in-depth the relevance of this specific research to management. The research identifies the following two parts: **1.** Business model evaluation and **2.** Ecosystem dynamics.

As Wernerfelt [59] describes in his article, a company is able to have a significant advantage, as long as it can control a resource that is valuable, rare, inimitable, and non-substitutable. However, within supply chains, information has an important function. Information is captured, stored and shared in different documents, processes and communication. Often specialised actors perform these function through leveraging their expertise, networks, or both. This specialisation is what offers some actors the ability to perform value-added services. With the introduction of new information technology, this position might be threatened. This research will address the mechanism of how information activities are transferred and relates this to TradeLens in specific. These insights could be used to evaluate the effect of further innovations in information management. These insights can both be used pro-active as well as reactive. Both managerial relevances will be discussed next.

Firstly, pro-active use of the knowledge. As innovation might have the capability to disrupt markets [3]. It is important for management to understand and envision how innovation can affect the business position of the different companies within an ecosystem. Before one can envision the effects of innovation, one needs to understand which different factors enable or disable this innovation. This research will contribute to identifying relevant factors inside a business ecosystem. This knowledge can be used in assessing this ecosystem and thus generate several plausible scenarios and their requirements. These scenarios can be used to generate company strategies in pursuing business opportunities or ensuring business survival.

Secondly, reactive use of the knowledge. Whereas the pro-active approach enables management to develop strategies to analyse possible future scenarios, the insights can also be used to identify weaknesses within the current ecosystem. Through careful analysis of the different aspects that determine the configuration of the ecosystem, a manager could assess which of its resources are future-proof. This research will investigate a number of these aspects and develop a method to assessing these. Understanding these aspects supports the development of different strategies to process different market developments.

1.4.2. Societal relevance

There are two considerations for societal relevance. As this research aims to explore the effects of digital information infrastructure on the ecosystems it supports further adoption of the underlying technology. About 90 per cent of world trade is transported over the sea and 60 per cent of the volume of international trade is performed as container cargo[2]. Technology that affects this transport might have far-reaching effects on the daily operation of businesses. When research is performed within this sector, one has to be precise in what the implications might be for society. This research looks into the development of the business ecosystem of container shipping. The knowledge gained from this research might be used to enable or block the transformation of the network. Societal relevance will be defined for a number of actor groups.

[2]According to Statista https://www.statista.com/topics/1367/container-shipping/

The first group are the consumers. Consumers are often the end of the supply chain. There is a number of implications the TradeLens technology could have on consumers. First, it might greatly reduce the administrative burden and thus make the process cheaper, which could result in lower prices for container shipping. These lower prices allow goods to be sold for a lower price, raising the average standard of living. Secondly, the transparency of the platform allows greater governance on certificates for materials and goods. Such as recycling, green earth, and animal protection certificates. As these certificates can be added to the platform, it allows the consumer to have better-informed decisions regarding products carrying these.

The second group are the corporations. The introduction of the TradeLens platform is aimed at reducing administrative burden and increase the efficiency of the shipping process. Part of these gains in efficiency allows products to be shipped to increase cost-effectiveness. The implication for corporations is that international trade becomes more suitable. This could lead to new business opportunities as the supplier market grows. However, it might also increase competition in certain markets, as this increased cost-effectiveness enabled overseas suppliers to offer competitive prices within the existing market.

The third group is the government. As international trade keeps growing[3], it is vital for the government to develop systems to perform the necessary border checks and duty collections[4]. TradeLens enables part of these processes to be automated and more efficient. These will be important drivers in supporting customs to ensure effective control.

Additionally, this technology enables organisations to have an increased amount of transparency and information sharing within shipping. This development might enable new business models and value-added services to enter the market. However, an issue of the research is that understanding the mechanisms behind the transformation could enable more direct blocking actions from actors who might be negatively impacted by the transformation.

1.4.3. Academic relevance

There are two main scientific contributions. In their article, Tiwana et al. [51] explain different theoretical lenses on how a platform-based ecosystem evolve. However, as Tsujimoto et al. [56] explains, knowledge on the exact evolution of an ecosystem is limited. Also in their research agenda, de Reuver et al. [6] state that the transformative effects of platforms on industry need further research efforts. This research will try to investigate the mechanism behind ecosystem evolution through role shifts and the wider transformative effects on this ecosystem. This will in part fill this research gap in understanding the reconfiguration process.

Secondly, within the area of control point theory, further research is required. The concept relates to the distribution of power on a process distributed among the different actors who perform a role within that digital ecosystem [51]. Control is seen as a significant factor in understanding the relationships between these different actors. A control point is thus defined as the ability of an actor to exercise control and generate value within the digital ecosystem[10]. Within the mobile payment

[3]For the last decades, international trade has steadily kept growing with some minor exceptions such as the Covid-19 Crisis in 2020 https://www.imf.org/en/Publications/WEO/Issues/2021/03/23/world-economic-outlook-april-2021

[4]The IMF has indicated for four key aspects for customs to develop. These are **1**. Establish a clear supporting policy, **2**. Develop towards modern and simple solutions, **3**. Shift procedures towards self-reliance on the declarant and shift to post-release control, and **4**. Develop incentives and structures to ensure effectiveness and integrity within customs https://www.imf.org/external/pubs/nft/2003/customs/

research of Rukanova et al. [41], some identified control points were the ability to hold the required funds for the transaction, or being able to securely identify and validate the user. Control point theory as used by Elaluf-Calderwood et al. [10] and Rukanova et al. [41] show that understanding where control on the process is located, significantly influence the different ways of ordering a process. However, identifying what entails a control point is difficult as the systematic ways of identifying these are limited. For example in the research of Rukanova et al. [41] control points are identified using a value model of the network. Here the main approach was identifying the control points through expanding the different exchanges. One difficulty observed within that approach, was the lack of stable value exchanges as the network was shifting. This research will develop a systematic method of identifying these control points. The main method will use deconstruction of the activities of the different actors. This deconstruction process will give what resources are required and what control the actors have on the process. E.g. the sea transport activity will require the goods, a port of discharge, a port of loading and the ship itself. The carrier has control over the ship and thus has a control point on the sea transport process. Thus the second significant contribution is a systematic method of decoupled control point identification.

1.5. Selected framework for analysis

A framework narrows the focus of the researcher on the topic. It takes certain aspects into account while ignoring others[48]. The analysis will use three main frameworks. Firstly, it will use ecosystem theory to establish the foundation of the stakeholder model. This framework allows the researcher to include not only the directly linked stakeholders but also those that do not directly use the platform but are affected by it through effects such as competition. Secondly, it will use Digital Infrastructure and control point theory, to connect to previous research into the mode. Lastly, the research will use breakthrough technology and pattern innovation framework to define contextual factors that might enable or block further development of the platform. The main concepts of the theoretical framework will be described in chapter 4.

1.6. Research questions

The research questions aim to achieve the objectives discussed in chapter 1.3. The research is considered successful if the method and analysis are able to answer this research question. The main research question (RQ) is defined as:

What are possible supply chain configurations that come with a digital information infrastructure?

The main RQ has two distinct parts which need to be elaborated upon for further clarification.

- **Digital information infrastructure (DII)** - The first working definition is that of the digital infrastructure. Digital infrastructure is defined as a connected collective of multiple information systems, this in contrast to a singular information system [19] or as a collection of elements such as: "the basic information technologies and organisational structures, along with the related services and facilities necessary for an enterprise to function"[49]. Furthermore, from the supply chain perspective, a more precise definition is acquired. A supply chain digital infrastructure, is a tool and method for different actors within the supply chain to use interfaces to enable an organisation to process and share information gathered from the different supply chain actors to develop new knowledge[30]. An important part of this digital infrastructure is that of the digital platform. Digital platforms can be defined into three different disciplines [18]. Firstly, the economical market-based discipline [36]. Secondly, technology management discipline [51]. Lastly, the socio-technical discipline [6]. Within this research, the socio-technical definition of de Reuver et al. [6] is used, which states: "Technical elements (of software and hardware) and associated organisational processes and standards"[6]. This

definition is chosen as it describes not only the technology of the platform itself but also the information processes of the different firms connected to the platform. In conclusion, this research uses the working definition of digital infrastructure to be the collection of different information systems connected using a digital platform.

- **Supply chain reconfiguration** - Reconfiguration can be defined as a novel arrangement of the collection of parts or elements from a previous configuration[5]. Within this research, the supply chain reconfiguration is defined as the redistribution of (some) activities and roles within the supply chain to different actors. E.g. actors develop new services or responsibilities, integration of activities from multiple actors to a singular actor, or activities being combined or split into different activities.

1.6.1. Research sub-questions

Using the main RQ the sub-questions (SQ) will be defined. Firstly, before one can understand the effects of Tradelens, an analysis approach will be developed where it focuses on: (1) What was the configuration of the network, (2) which control points are held by which stakeholder, and (3) which information sharing processes tie the different stakeholders together, and (4) what are the main barriers and stimulating factors outside the direct stakeholders. Afterwards, a time zero review will be performed. This time zero review will look into the traditional situation of the shipping process, where Tradelens has yet to be developed and implemented. Afterwards, the research will track the developments of the platform on the earlier mentioned factors. Using the found factors a set of scenarios will be proposed.

The first step is developing the assessment model and thus the first SQ becomes:

SQ 1 - What is the history behind the container supply chain and its developments with regard to digital infrastructure? To answer this question, the research will perform a literature review on the background of container shipping, digital information infrastructure, digital platforms and TradeLens in specific. The main deliverable is an overview of the main motivations behind developing digital infrastructure and the pros and cons of further digitisation.

The background of the main issue to investigate is helpful in generating a view of what factors are important to consider. The next step is identifying how ecosystem theory and the container supply chain are connected. This is done through the next research question.

SQ 2 - How can the ecosystem of the container supply chain be described and which ecosystem concepts are important to consider? The second question is the first step in defining the theoretical framework which to answer the main RQ. Within this research, ecosystem theory is considered vital. Thus a detailed literature review in ecosystem theory must be performed. Here the research will deliver the main elements of ecosystem theory, a distinction of different types of ecosystem, and which of these ecosystem types has the best fit with the TradeLens platform .

As ecosystem theory describes the main elements of the research, this is however not enough to assess the transformation. Important is to consider how the platform diffuses, how control is moved between different actors, which actors are considered and other relevant factors.

SQ 3 - How can control, actors, diffusion and other relevant barriers and stimulation factors be described within the ecosystem? This research question will be answered using a literature

[5]Adapted from the definition provided by Merriam-Webster https://www.merriam-webster.com/dictionary/reconfiguration

review on the aforementioned concepts. These concepts will be added to the framework defined through answering SQ 2. The main deliverable is a complete framework with the different concepts described.

Using the defined framework of SQ 3, a generic model of the container shipping process has to be developed.

SQ 4 - What is the configuration of a generic container supply chain ecosystem? The fourth research questions will be answered using desk research on both public and academic sources. The deliverable is a collection of models which describe the configuration of the network. E.g. value models, information flow diagram.

SQ 5 - Which elements are transformed through the introduction of the TradeLens platform The fifth research question will be addressed through a case study on companies that have used the TradeLens platform to enable innovation. The main deliverable is to develop a comparison between the generic model and the TradeLens adopted model. This comparison will show where digital infrastructure might transform the supply chain.

After addressing the configuration and reconfiguration of the ecosystem the next SQ to be addressed is the future situation. Through the insights gained from the analysis of the platform, a scenario prediction will be developed to make predictions on future ecosystem developments.

SQ 6 - Which future scenarios can be derived for the TradeLens platform? To answer this question, multiple scenario models will be developed using the important factors uncovered through the research. This model will show how the different main factors could affect the development of the Tradelens case. The key deliverable of this sub-question will be to provide multiple likely scenarios and explain how these could come to be.

To conclude, through analysing both the pre-platform and current situation, valuable insights are gained. These insights can be used to develop multiple scenarios of what future ecosystem developments could be. The research will be able to answer the main RQ on how DII enable supply chain innovation through the ecosystem.

1.7. Scope of research

The scope describes the self-imposed limits of the research. These limits are aimed at increasing the likelihood of answering the main research questions. Scope supports the research in making judgements regarding data collection and data analysis.

1.7.1. Unit of analysis

The research will focus on the development of the inter-dependencies between different stakeholders within the ecosystem. The chosen unit of analysis is that of the firm/organisation. This unit will enable the researcher to gather organisation-wide functionalities without focussing on the internal specifics of each company. It also allows the research to generalise actors. For example the freight forwarder DAMCO could be generalised into the generic role of Freight Forwarder.

1.7.2. Relevant case

To achieve the main objective of the research, a relevant case has to be selected. This case will be used throughout the research as the main point of focus and data collection. There are two distinction within the case that have to be developed. Firstly, the case of which digital platform or platforms is chosen. Secondly, the case of which data sources within those platforms will be chosen.

For the digital platfrom selection, this research uses the case of TradeLens. TradeLens is observed as a mature market ready application for the shipping industry and is currently growing[6]. The selection of this digital platform allows the research to investigate companies who have already adapted to the digital infrastructure.

Selecting the relevant cases within the platform are more difficult. This research experienced that not many organisations are willing to share their usage of the platform. The selection of the sample was somewhat limited. This research wants to compare the developments between the digital platform enhanced organisation and the generic non-digital structure. For the non-digital structure, a generic case will be constructed using insights from different public sources. A detailed explanation of this approach is given in chapter 2.2.2. For the enhanced case the researcher was able to gain access to information regarding a Dutch tyre importer. In this case the usage of the digital platform was well documented.

1.7.3. Boundary of the research

The boundary of the research describes which cases are being researched. Firstly, as the research will focus on the development around the role of the orchestrator, it is essential that the main supply line is being captured. On the part of the seller, the research will not consider any processes that happen before the export from the factory/seller to the buyer overseas. Thus any resource streams from different factories towards a factory will be seen as a separate buyer-seller process instead of one bigger process. In extension, on the part of the buyer, any further sales of the buyer will not be considered within the model. For example, a process where factory A sells raw materials to factory B, where factory B sells the finished product to buyer A, who sells this product to a different buyer B. In this case, only the exchange between factory B and buyer A will be considered.

As the research will focus on the information streams within the supply chain of the container, many suppliers and services will not be directly considered or will be simplified. For example, within the supply chain a number of different financial institutions perform a set of activities (e.g. issueing the letter of credit). However, the role in the ecosystem of these financial institutions are limited. Thus, these different actors will be simplified into a singular actor. Other actors who perform supporting tasks for the other actors but do not directly interact with the supply chain as a whole will be omitted.

1.7.4. Level of detail

The next part to consider is the level of detail of the different elements. The level of detail describes how concrete the detail is of the information. In the case of actors, the research will generalise to general roles within the supply chain. In this case, specific companies will be generalised where possible.

In the case of activities, different actions within one actor will be simplified to one key activity. When elements of this key activity are transferred, the activity will be separated. In the case of information, the research separates three layers of information. Firstly, the element layer. This is where specific information is recorded, such as weight, quantity, and location. This is used to identify the type of information within a document. These documents are the second layer. The third layer is general information flow, where the main information is simplified into a flow, which moves between the different actors. The distinctions are given in figure 1.2

[6]May 2021, TradeLens expanded it services into China https://www.seatrade-maritime.com/technology/tradelens-launches-service-china

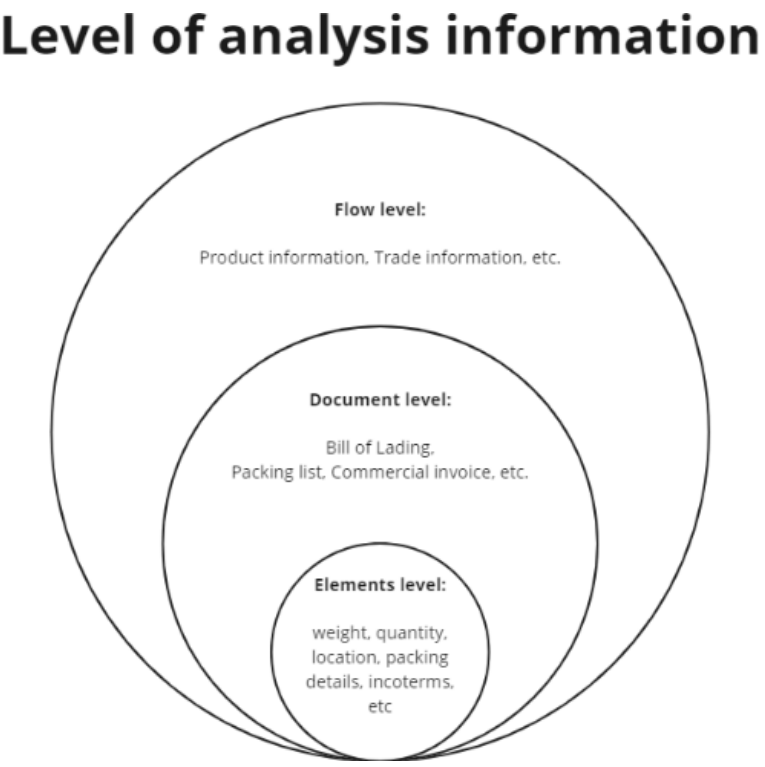


Figure 1.2: An overview of the three different level of analysis used throughout this research, regarding information and documentation.

1.8. Structure of the research

Lastly, the structure of the research will describe how the main thesis is structured and in which sections which research questions are answered. The thesis consists of 8 chapters. In table 1.2 the different chapters and main deliverables are listed. This structure shows the main deliverables of each chapter using the sub-question structure defined in chapter 1.6

Table 1.2: Structure of the thesis

Chapter	Research Questions	Deliverable
Chapter 1. Introduction		The research problem, background, scope, research questions, and the organisation of chapters.
Chapter 2. Research Methodology		The main approach of the research, a discussion on the variety of tools and strategies used within the research.
Chapter 3. Background on the TradeLens Platform	1	The main developments towards the Pre-TradeLens ecosystem, background on digital information infrastructure, and the developments of the platform itself.
Chapter 4. Theoretical Concepts of the Model	2,3	Discussion on the different theoretical concepts of the meta-framework. The construction of the model.
Chapter 5. Generic Model of International Shipping	4	Models on international shipping. Such as information flow models, value models, activity models.
Chapter 6. TradeLens Ecosystem Transformation	5,6	Models showing the transformation of the ecosystem. A comparison between the pre-TradeLens and post-TradeLens situation. Scenario analysis for future TradeLens development.
Chapter 7. Discussion		The main limitation of the research. Recommendations for future research.
Chapter 8. Conclusion	Main RQ	The mechanisms that govern supply chain reconfiguration due to digital information infrastructure

2

Research Methodology

Research methodology describes the approach this research will take to solve the questions asked in chapter 1. The chapter is structured using the following main questions. Firstly, how is the main approach defined and why is this approach chosen? Afterwards, this main approach will be broken down into separate elements of the research such as the desk research and interview set-up. The main data uncovered through the approach will be discussed. Here special attention is given to how is the data structured, how the research will process the data and the limitations of the data. Lastly, a discussion of used tools will finalise this chapter. The goal of this research methodology chapter is to explain the type of research that is performed, which tools this research has used, and how data is collected and analysed. This will be performed such that it is reproducible for future studies.

In chapter 2.1, the main methodological approach will be explained including the motivation of this approach. Chapter 2.2 will explain more about the different sources of data and how these are collected. Following data collection, the data analysis will be explored in chapter 2.3.

2.1. Main approach

The goal of the research is to understand the effects of digital information infrastructure on supply chain innovation. This research tries to achieve that goal by gaining insights into ecosystem effects. The main approach is thus designed to achieve this. Firstly, a general understanding of the main domain is required. Through a literature review, the following supporting research questions will be answered. Firstly, why and how are container supply chains used? Secondly, what is considered digital infrastructure and what are the main goals? Thirdly, what is the history of the TradeLens platform and how does it use blockchain? These are answered in chapters 3.1, 3.3 and 3.4 respectively.

The chosen method within this goal is the case study method. As the research question is exploratory in nature, a case study is a suitable method to perform the research. The goal of the research is to understand the transformation of the TradeLens ecosystem through analysis of the stakeholders, control points and other relevant factors during different time points. To reach this method a combination of interpretative case studies and iterative theory building will be used. An interpretive case study is a method of exploring a case and using the obtained data to develop a theory on why the case has become such. As the research wants to reach an understanding, it will be considered successful if a theory is developed on the transformation of the ecosystem. Some challenges of the aforementioned method are discussed by Eisenhardt and Graebner [9]. Firstly, the decision of which sample the research will use will greatly impact the generalizability of the research. The derived theory will mainly be based on the chosen sample. Thus an ill-chosen

sample might result in building theory that is only applicable within the specific case. To solve this, the sample will be chosen to fit the following criteria. The sample must be part of **A.** a representative domain and **B.** a representative case within that domain. The chosen domain is that of the container shipping supply chain and the influence of TradeLens. The research wants to investigate the effect of digital information infrastructure on the reconfiguration of the network. Container shipping has been around for many years and included a wide set of actors from actors performing physical activities (e.g. trucking, sea shipping, packing) as well as actors performing informational activities (e.g. issuing documentation, gathering information). Similar activities can be observed within many branches of supply chains. All physical goods require some supply chain to transform from raw materials into the end-product at the store. Container shipping requires similar actors, activities, and documentation. Thus it can be justified that the selected case of TradeLens and the container shipping supply chain is a representative case for theory-building for the supply chain domain. Secondly, the selected cases within the research are that of a generic model and a Dutch tyre importer. To justify the second criteria, the former case must be representative for a general non-modified supply chain and the latter for a TradeLens impacted supply chain.

The generic case will be constructed from many different corporate and academic sources on container shipping. As the case is build up from many different supply chain cases, it can be justified that the generic case will fit the main objective of the non-modified case. Secondly, the impacted case must show how a digital platform is able to impact the flow of information. The tyre Importer is a widely researched case where the specific usage of such a digital platform has been well-documented. This case also involves international trade, where different modes of transport are used and shows many similarities to other well-reported cases. The two cases can be justified as being a correct sample for theory building.

Additionally the effect of bias from the interviews is considered. Since most of the interviewees will be experts or researchers on the TradeLens platform there might exist some retroactive sense-making within the results. To respond to this a semi-structured interview approach will be used where the focus will be put on uncovering as much objective information as possible. A more detailed explanation is given in appendix B. Lastly, presenting the results will be used by showing the findings of the different data sources together with the emerging theory. First, the outline of the theory will be presented in the introduction and supported through empirical evidence explained in the body of this master thesis.

The first part of conducting this approach is to develop a meta-framework around different theoretical concepts within innovation research and ICT infrastructure research. To develop this framework a focused literature review is used, where the main sources are identified through experts within these research fields and supplemented through a literature review. The main approach of conducting the literature review will be explained in chapter 2.2.1. The context of this framework will be that of the ecosystem developments. The second part of the approach is to identify the important actors within the supply chain. This is done through an iterative approach, where the first iteration starts with the buyer-seller relationship. Afterwards, important actors and activities will be added. The third part is to assess which value exchanges exist between the actors within the ecosystem performs within the supply chain. The fourth step is to identify the criteria why a certain stakeholder is able to have the ability to deliver these values. This will mainly be done through the context of the control point theory. Lastly, this process will be repeated for several cases to develop an overview of changing conditions.

2.2. Data collection

Data collection is the description of how data is retrieved, why it is valuable, and what its limitations are. Here a distinction is made between the method of gaining the data and the data itself. This research uses three methods of data collection. Firstly using existing data through public articles

and research papers within desk research. Secondly, using interviews with experts within the field. Thirdly, a case study, where the specifics of an example are explored in-depth.

2.2.1. Desk research

Desk research is the process of searching and finding secondary sources to develop and expand the knowledge contained within the paper. To perform this activity, a specific desk research strategy is developed. This strategy will enable the research to gather the necessary information. The main goal of desk research is to support the development of the research by providing articles. These articles will provide knowledge regarding the research problem, the different objectives, and other relevant theories required for completing the research. An important part of the desk research is the literature review [48].

The first part of the strategy is gathering the necessary theoretical concepts to develop the meta-framework. The second part of the desk research is gathering case-specific information. The case-specific part will be described in more depth in chapter 2.2.2.

Following meetings with experts on digital trade infrastructure and innovation management a selection of relevant theories and perspectives was developed. These relevant perspectives developed the theoretical base of the research. The research makes a distinction between two types of secondary data. Firstly, data generated through research. Within the filter process, the research will evaluate if the source has been peer-reviewed, is published in a high-quality journal or conference, or has other signals that mark a high amount of rigidity. Secondly, data from news articles or company press releases. This second type of data will be scrutinised using the sources of the articles, the location where it is published, and/or their relationship towards the platform.

Three main strategies can be derived for collecting the literature [58]. These are:

- **Major contributions** - Research the concept in articles from leading journals. This is achieved through using search engines that focus on these journals.
- **Backwards** - Using key articles, look into the reference list and extract relevant articles for this research.
- **Forwards** - Using key articles, look into the references that cite the key article.

It is important to note that this research uses both the concept-centric approach as well as the author-centric approach. The former focuses mainly on generating the sources through researching the main concepts, whereas the latter uses the main contributions of a specific author [58].

2.2.2. Case studies

The last employed method is the case study. A case study is where one or more examples are researched in-depth and where the specific case conditions are researched. The limitation of this approach is that the data is often collected through varying means and might not be coherent. Data from existing situations is collected. This is generally considered a qualitative and empirical research strategy. For this research, two different cases are used. First, the case of a pre-TradeLens shipment is used. Secondly, a case where TradeLens has been included within the business processes. The cases will be used to apply the conceptual model developed through the literature review.

Case: Generic container shipping model

The first case that is researched is the generic shipping model, later in this research referred to as the benchmark case. This is an artificially created situation where a shipment is sent from China to the EU. This case will act as a control state. To perform this control state function, the developed case has to be a realistic representation of a container shipment. This requires two aspects, realism

and representative. Firstly, this requires that the activities and actors mimic a real shipment. The main actors are accounted for and the main activities are included. To validate this process, the research uses two interviews with different experts. These experts are requested to check whether the important activities and actors are all included. The second part is representative. This implies that the used construct is commonly observed within international shipping. The developed case should not be the exception to the rule. To adhere to the representative aspect, the case will use multiple example cases provided by both public sources (e.g. freight forwarders, shipping logistics blogs, et cetera) and academic papers (e.g. [22, 24]).

The construction process of the case uses a three-step iterative approach. These steps are collection, construction, and validation. Within the collection step, the research will investigate a number of use cases provided by public sources and academic papers. Different activities, actors and information streams are gathered from these sources.

Using cross-referencing in the second construction step, the case will distil the important actors, activities and information into the benchmark case. The selection of relevant elements is done through carefully assessing both qualitative and quantitative factors. Qualitative factors use the description of the actor, activity or information. Here the description is checked whether this is representative (e.g. Is this actor normally within the supply chain when the shipment is non-hazardous?). Quantitative factors describe whether this element is commonly referred to in the other sources.

In the last step, this benchmark case will be presented to the experts within the interview to be assessed. This assessment will add or subtract activities and actors. The elements will be separately evaluated. Using the insights gained from the interview, the benchmark case will be adjusted.

Case: Dutch Tyre Importer

The second case is the Dutch tyre importer. The tyre importer has used the TradeLens platform to enable the automation of tasks that have been traditionally performed by different actors. The case has been extensively documented where the usage of the digital platform is shown. This practical application of the platform allows the research to gain insights into the effects of such a platform and allows for careful comparison between the non-digital platform supply chain and the digitally enhanced supply chain. This comparison will be done through evaluating different aspects which will be defined in chapter 4.

2.2.3. Interviews

The main research will be supplemented through interviews with experts. These interviews will mainly be used to remove any information gaps within the research and validate any preliminary findings. As the required information is known at the onset a structured interview approach will be used. Based on the answers given by the respondent, further probing will be used to uncover more details behind the information. As the COVID-19 measures will not allow physical interviews, the interviews will be conducted using video conference services. The following interview protocol is used within the research. A complete design of the interview, see appendix B.

Interview process

The interviews have the following objectives.

1. **Validate Pre-liminary findings**: The researcher presents the findings of the research. This will be used by showing the developed value models.

2. **Expand critical activities within the supply chain**: Important in understanding how key activities switch between the different actors, a comprehensive list is required. This list will first show the key actors, afterwards the key activities. Through evaluation on an actor-by-actor basis, the key activities that are missing will be added.

3. **Show transfer of these activities between the different actors**: The next step is to decouple the key activities from the key actors. The interviewee will be asked to show which key activities are performed by which key actors.

4. **Explain how this transfer is enabled**: A comparison is made between the earlier situation and the afterwards situation. The interviewee is asked, why in the new situation the actor is enabled to perform a key activity that he was not able to do prior.

5. **Extract barriers and stimulating factors**: Through probing the reasoning behind different transformations being enabled, it uncovers the main factors responsible for that transformation.

2.2.4. Limitations of different data sources

As described, the research uses three different sources of data. Every type of data has its limitations. Secondary data such as uncovered through desk research often suffer a variety of issues. Regarding scientific data, the goal of that specific research differs from the goal of this research. As the goal of a research impacts the strategy behind data collection, this might impact the usability of the data sets outside that specific research. Thus what is considered important for this research might not be included in that specific data set. The gaps in information and data have to be filled in by other sources. This overlapping can create an issue of coherence, where the researcher must decide which data is used to fill these gaps. The issue of secondary data from public sources, is that these are often biased in reporting. For example, in the case of researching the actors. Some actors will contribute more tasks to themselves, than what is generally performed in the supply chain. To address the first limitation, this research carefully investigates which data is explicitly given. To generate comprehensive image, the research will give the used steps and decisions in the appendices. The second issue is solved through careful cross-referencing many data sources and using more stringent criteria than when approaching scientific data sets.

2.3. Data analysis

Important in data collection is the correct analysis of the data. Due to the qualitative nature of the research, three steps have to be performed for correct data analysis. These are data reduction, data display and drawing conclusions [48]. The aim of these steps is to increase the validity of the drawn conclusions. The approach is mainly structured around the work of Miles and Huberman [31]. The data list used for this research can be found in table 2.1. The expanded version showing the different references is found in appendix A.

Table 2.1: The used data for this research gained from the performed desk review.

Type	Amount	Code abbreviation
Commercial Website	11	CO
Government Website	10	GV
Academic Paper (Other)	3	FF
Academic Paper (Jensen)	4	J
News or Blogs	4	NB
Interview Expert	1	NK
Interview Researcher	1	YT
Teaching Case	2	VB
TradeLens	2	TL

2.3.1. Data reduction

Qualitative data collection often governs a significant amount of data. The first step of reducing that data is through using the method of coding or categorising to reduce the data to a workable format. Collected data must be coded for easy and quick referencing. The coding scheme is shown in table 2.2. The data is coded through the following distinction. First the category of the source. This describes the main collection to which the source is ordered. Source code describes the in-text label the code receives. A statement can be expressed as: *"When customs receives the information, not on time, it will result in a delay for the shipment [YT]"*. The source type describes whether the source is an interview, academic paper, company website, or other. The description gives a short description of the source. The reference gives the reference number to the citation. This approach will support the main research in integrating the data and draw meaningful conclusions.

Table 2.2: An example of the categorisation method used throughout the paper.

Category	**Source Code**	**Source type**	**Description**	**Reference**
Interview	*YT*	Interview	Interview with TU Delft Digital Trade Infrastructure researcher	Appendix B

2.3.2. Data display

The next step in the data analysis is data display. Data display is the step in which the reduced data is generated in organised manners. In the case of this research, the data will be displayed using different models, such as value and information flow models.

2.3.3. Drawing conclusions

The last step in the data analysis approach is that of drawing conclusions. An important distinction are the drawing conclusions within developing the models and in evaluating the comparison.

In developing the model the main approach is identifying themes in results from the company websites, the interviews, articles and other relevant sources. In evaluating the main transformation, the main approach is that of comparing the models and describe the distinction through findings in the text.

3

Background Information on Container Shipping, Digital Infrastructure and TradeLens

An important part of understanding how TradeLens impacts the ecosystem is through exploring the main concepts which influence the international trade it tries to improve. Firstly, the supply chain itself, the main benefits and the issues of container shipping are discussed in chapter 3.1 Afterwards, the effects of digital information infrastructure will be explored in chapters 3.2 and 3.3. Lastly, a brief overview of the history of TradeLens will be provided in chapter 3.4.

3.1. The developments of container supply chains

In 1968 after two rounds of standardisation, the ISO committee developed the twenty- and forty-foot container[1]. Within the container supply chain, the twenty foot container is called the TEU, the Twenty-Foot Equivalent Unit. In chapter 3.1.1 a short explanation of the main development of container shipping is given. Chapter 3.1.2 follows and explains the main issues with the administration of international shipped containers.

3.1.1. Containerisation of international trade

Until the mid 20th century, goods were predominantly moved between ports using non-standardised containers. These containers could be loose packages, barrels or boxes. This was called bulk break shipping [52]. This approach hindered effective shipping. In prevention of damaged goods, a great amount of time and labour were spend on loading and unloading. Estimates on the cargo handling costs ranges from 37% up to 75% of the total shipping costs[52]. This hindered international trade as it made transporting goods between ports an expensive endeavour.

After the introduction of the standardised container in the early 1960s some of the major bottlenecks within port handling were solved. The main impacts of standardisation of the container were observed within ports, shipping and global trade[52]. The design of the container allowed for specialised loading and unloading tools. As every container is the same size, this allowed the port operator to invest into a standard infrastructure. This infrastructure can currently be observed within major ports. These are the large container cranes, specialised container handling trucks and the container rails. These investments enabled effective processing of the incoming ships. However, not every port was able to perform these investments. This greatly limited the amount of ports

[1]The container standard was developed within the ISO:668 norm. The modern equivalent can be found in: https://www.iso.org/standard/76912.html

being able to handle goods[17]. Within shipping, the effectiveness of ships were increased. The design of the container allowed it to be stacked, while retaining its stability. This stable stacking allowed for more containers to be placed onto a vessel, which resulted in more goods to be shipped onto one vessel[52]. Additionally, the most significant effect was observed within international trade. Due to the increase in efficiency in loading and unloading of the container, shipping costs were reduced significantly[52]. In many cases, this allowed for the development of international supply chains. However, this increase of international trade requires not only the physical transport of the container, but also the administrative processing of the container.

3.1.2. The administrative burden and efficiency issues within container shipping

As shipping containers became standardised shipping became cheaper. The increase in cost-effectiveness of shipping allowed the growth of international supply chain. It was no longer a necessity to have most of the construction and fabrication of goods centred in one nation. The effects of this can be observed when one assesses international container growth. The amount of containers being shipped has been growing at a rate of almost three times the global GDP growth since the 1990s [57]. Ocean containers perform a vital role within modern economies.

However, in transporting a container many different actors have to interact with one another. E.g. port authorities require goods clearance before being able to load a container onto a vessel. Every actor who requires a set of information to perform its tasks, will impose an administrative burden on the other actors. Thus the growth of container shipping has also grown the administrative burden within the supply chain.

In the case of avocado trade for each container a set of 20 to 30 paper documents was necessary [22]. This was mainly caused due to different documents that were required by the different actors within the ecosystem. Within the Kenyan roses case was found that the shipment spent one-third of the time waiting on clearance. This waiting period was approximately eleven days. These issues had two major causes, the reliance on paper communication and localised digital infrastructure [24]. Paper communication requires physical transport of information. This is mainly performed through postal or courier services. Additionally, every organisation had its own digital infrastructure. For the roses case a set of twenty different information systems were used in processing documentation. For every system information had to be processed manually [24].

In addition to the administrative burden, the roses case also show a different efficiency issue. The reliance on waiting.

3.2. Early digitisation efforts within container shipping

As the companies progressed into the late 1900s and early 2000s, more emphasis was placed on digitisation of the different processes. As part of the industry 3.0 efforts, companies aimed at automation of internal production/service processes through interconnection [53]. The emphasis within this time was to enable the sales process to be as efficient as possible. This resulted in the use of different information systems. A few typical examples are the use of Enterprise Resource Planning (ERP) systems, Customer Relationship Management (CRM) systems, or Human Resource Management (HRM) systems [34]. The main objective of these systems was to automate and standardise the processes through the use of IT infrastructure to increase internal efficiency. However, as Jensen and Vatrapu [24] showed within the rose-case, every actor developed there own information infrastructure silo. This silo-ed approach greatly reduced efficiency in information sharing between the different actors. Where in some cases electronic communication was possible, but in many cases the use of relative high cost paper couriers was still used. The internal administrative burden was decreased to a certain extent due to IT infrastructure. However, as container volume grow, it became more important for the different organisations to improve inter-organisational com-

munication to enable more efficient and effective processes [2]. As Torn and Vaneker [53] describe, one of the differences between industry 3.0 and industry 4.0 is "the interconnection of the whole value chain".

3.3. Digital infrastructure and its main applications

Digital information infrastructure is the collective term for the different applications and interconnected systems that enable information storage and sharing between different actors. The introduction of DI within the supply chain will affect the processes of information sharing. To understand the exact effects of this introduction, background on digital infrastructure and its core components is required.

Information Technology (IT) systems are designed and developed. At the base of this design, is the architecture. The architecture entails many different aspects of the components used for the development of the wider IT infrastructure [61]. This research defines architecture as the set of design decisions behind the developed policies, used technologies and employed standards within the wider infrastructure. Technology will refer to the specific IT components (e.g. APIs, blockchain, et cetera), policies will explore the governance model of the system (e.g. decision rights, information sharing policies). Standards are the enforced information standards for collection and sharing (e.g. Standardised commercial invoices, standard import declaration forms, et cetera).

3.3.1. IT architecture

In her research, Ross [40] argues that IT architecture should be viewed not only from the standards of technology but also from the business requirements. This is called enterprise IT architecture. This can thus be defined as the list of used technologies and their connection to the business requirements. An important factor is the ability of a firm to leverage new technology in the pursuit of its business goals [40]. This requires the firm to define its strategic objectives, define the key IT capabilities, and define the necessary policies and technical choices for developing those capabilities. This implies that the IT strategy is often seen as within one firm. In many firms, the development of the usage of IT within a firm starts with many systems which add local value, but gradually becomes more standardised, and finally ends in a modular approach with a focus on a solid digital infrastructure Ross [40]. As firms move between the IT development stages, the capabilities in IT architecture increase.

Knoweledge on the process of IT architecture development is required for understanding the effects of digital platforms. The TradeLens platform will integrate a singular architecture with the local architectures of the different organisations. The platform itself has a certain IT strategy and developments. This can be seen in the communication between the platform and the local infrastructure and the data-sharing technology used. To leverage this external technology, organisations will need to develop IT processes that interact with the platform.

The last concept to understand regarding IT architecture is that of governance. As Peterson [38] explains: "IT governance describes the distribution of IT decision-making rights and responsibilities among different stakeholders in the enterprise, and defines the procedures and mechanisms for making and monitoring strategic IT decisions."

Within the TradeLens case, the following conditions can be observed. Firstly, the platform is developed through a joint collaboration by IBM and GTD solution. Where the latter is a subsidiary of Maersk. Secondly, it uses a TradeLens Customer Advisory Board to advise on developments of

[2] In 2008 the World Customs Organisation (WCO) described six key challenges to the customs process. Among them are: increased security threats, more demands from society, increased trade volume, and an increase in revenue fraud. Here customs were tasked with one side providing security and controlling their borders, but on the other side enabling economic growth. The WCO describe "Governments require agencies of the state,including Customs, to be service-oriented and meet the expectations of societies and borders. http://www.wcoomd.org/~/media/wco/public/global/pdf/topics/key-issues/customs-in-the-21st-century/annexes/annex_ii_en.pdf

the platform. This board is comprised of a cross-section of many members who use this platform [54, 55].

3.3.2. The data pipeline

The next concept is that of digital trade infrastructure (DTI). DTI is a digital infrastructure that "supports information exchange related to international trade processes" [44]. A subset of DTI is that of the data pipeline. A data pipeline has a number of characteristics. Firstly, it uses timely capturing of information at the source. Secondly, it provides this information later in the chain. This enables the information to flow freely within the supply chain and to be available where it might be required. As TradeLens aims to accommodate information sharing between the supply chain actors, where information is captured at the source, it can be considered to be a data pipeline.

3.3.3. The technological platform

The third concept to understand regarding digital infrastructure is that of the digital platform. A platform can be viewed from either an economic perspective and the engineering design perspective [15]. In the case of TradeLens the platform is evaluated from the engineering design perspective. A second consideration is what type of platform this digital platform aims to be. In her article, Gawer [15] establishes three types of platforms placed on a continuum. On the closed and low innovative side, is the internal platform. On the open and highly innovative side is the industry-wide platform. And lastly, a hybrid version of both is the supply chain platform. The main determining factor in identifying which type the platform adheres to is through assessing the following four conditions. **1.** Design of the interface. Are the specifics of the interface shared only within one firm, or are these shared among many? **2.** The focus of capabilities. Does the platform focus on the firms' capabilities, the supply chains, or wider industry capabilities? **3.** How is the governance mechanism constructed? When evaluating these conditions for TradeLens, the following things can be observed:

1. The interface is shared between all firms who want to incorporate the platform.

2. The information-sharing protocols are easily adaptable to APIs of many different firms, and thus able to leverage many different types of organizational capabilities.

3. Governance is structured through a board of customers from all different ecosystem actors[3].

From these three points, it can be identified that the TradeLens platform is an industry platform. Within this platform the main focus points are ecosystem wide usage and accessability, a open designed interface and an ecosystem wide governance approach.

3.3.4. Opportunities and challenges of digitisation within container shipping

The majority of innovation offer a certain trade-off. The IT-consultancy firm Capgemini performed an early research into the benefits and constraints of digital supply chains [39]. In this research Raab and Griffn-Cryan investigated the digital supply chain strategy with regards to the execution. Their perspective is that " Digital supply chains, on the other hand, have the capability for extensive information availability, and enable superior collaboration and communication across digital platforms resulting in improved reliability, agility and effectiveness." [39]. Within the state-art-of-the-art review by Büyüközkan and Göcer [2], identifies eleven opportunities for digital supply chain applications. However, it should be noted that this review not only identifies digital infrastructure, but also different digital technologies such as augmented reality, Internet of things and drones.

[3]It should be noted that TradeLens developed the Customary Advisory Board which should include a cross section of the different customers of the TradeLens platform, however currently this is still limited to carriers, but there are plans to expand.

- **Speed**: The speed to which goods go through the whole process will increase. The different actors are able to develop a quicker response to demand.
- **Flexibility**: Traditional supply chains are quicker disrupted through events such as earthquakes, or political instability. Digital supply chains already have all the necessary information to quickly adapt to these changing conditions.
- **Global connectivity**:
- **Real-time inventory**: Digital supply chains allow different actors to limit the amount of stock that is necessary. This lowers the needed warehouse space and thus costs. In the case of the container shipping supply chain this can enable the buyer to keep a smaller stock on its warehouses, but also enable the container yards of the different ports to have a shorter container storage time.
- **Intelligent**: Newer generations of technology might enable digital supply chains to have smart applications. These applications might use different learning algorithms to automatically make decisions within the supply chain. The digital supply chain allows these kinds of developments.
- **Transparency**: Digital supply chains can force the different actor to increase the transparency within the chain. This enables better planning for disruptions through modelling the network and performing what-if analysis.
- **Cost-effectiveness**: The digital supply chain reduces cost in almost every domain. As it will provide the ability to automate to a large extent and have greater information overview for business decisions.
- **Scalability**: Digital process are inherently easier to scale up or down. When paper documentation is required, large fluctuations in the amount of shipments greatly increases or reduces the administrative workload. Due to automation, a digital supply chain will not experience the same fluctuation of workload.
- **Innovative**: Digital supply chains are more able in incorporating novel technologies within the process. Some examples might be the use of drones and autonomous shipping.
- **Proactive**: Digital supply chains offer proactive information to the users. Allowing them to perform risk assessments. These assessments allow the users to identify different issues in advance.
- **Eco-friendly**: The next generation of digital supply chain allow for better eco-friendly integration. For example, the digital platform can be used to track certifications of the products that are being shipped and thus hinder certification fraud.

However, as mentioned in the previous chapter. There is always a certain trade-off when implementing a new infrastructure. In the same review, a set of challenges of digital supply chains were identified [2]. These challenges are mainly defined around the implementation of the digital supply chain technology. These can be summarised into:

- **Collaboration challenge**: The digital infrastructure requires collaboration from all relevant actors. Without this collaboration the main benefits cannot be gained. This requires the actors to be willing to share their data. This willingness is not a given, as the traditional approach is data protective.

- **Knowledge challenge**: Knowledge on how to exploit digital infrastructures is required to achieve the maximum efficiency gain for the relevant actor. A lack of specific knowledge, might hinder the adoption of the platform and might not enable the potential benefits.

- **Flexibility and agility challenge**: The corporation requires a certain amount of flexibility within the company to adapt to the rapid changes that accompany the new digital infrastructure.

- **Integration challenge**: A lack of integration between the existing internal processes and the novel information sharing processes could hinder the corporation to effectively adapt the platform.

3.4. Brief history of TradeLens

In January 2018, the development of the TradeLens platform was officially announced at the THINK event in San Francisco [54]. In this announcement, IBM and Maersk spoke about the intention to collaboratively develop a digital platform for the shipping industry [54]. Later in the year in 2018, TradeLens was formally announced to the industry. A few months later in December, the commercial version was launched, which offered more product offerings.

According to Jensen et al. [23], both IBM and Maersk joined forces as early as 2016 to pursue initiatives to decrease the administrative burden. This technology would have to be blockchain-enabled. but the roots of the idea can be traced back to as early as 2006. One such example is the Beer Living Lab research project [13]. During this time period, Maersk was interested into finding methods to reduce the administrative burden and increase trade efficiency and thus performed several research projects into different digital infrastructures enabling these developments [23, 60].

Outside the developments of Maersk and IBM, similar projects have been performed regarding DTI. In her master thesis, Arman [1] performed a longitudinal study into four different EU-funded projects to develop digital trade infrastructure. These are ITAIDE, INTEGRITY, CASSANDRA, and CORE.

ITAIDE was the first DTI project. The European Commission experienced difficulties in balancing the requirements of international trade, while at the same time keeping the administrative burden at an acceptable level. In this research, the Living Labs project was researched from 2006 until 2010 [13]. This research project was used to test several IT-related tools and methodologies in the case of international trade.

The following project, INTEGRITY, worked from a logistics perspective. This research project aimed at increasing the efficiency of intermodal door-to-door container shipping. The efficiency of this supply chain was considered essential in enabling the business to improve. Their main development was a system to share information regarding intermodal containers. This project is considered to be one of the first data pipeline prototypes.

After this came the CASSANDRA research project. This project which was running from 2010 until 2014 aimed at improving risk assessment within the global supply chain. It tried to achieve this through having a greater and better-structured information availability for authorities who perform the risk assessment.

Lastly, the CORE project was a continuation of the CASSANDRA project. Its aim was to show the developed knowledge from the other EU-funded projects and increase efficiency and reliability, while at the same time lowering the risk. The project was demonstrated at the flower trade between Kenia and the Netherlands [24].

Two other precursors of the TradeLens solution were the beer living lab research and the GTD project. The beer living lab, was a project at increasing effectiveness of the beer trade of Heiniken [13]. First, the research illustrated how a trusted trade partner can be seen as a low-risk trader and thus use simplified trade procedures. An important component is that the trade partner has full control on his operations.

GTD was the precursor of the TradeLens platform in name. This was the platform where the initial developments took place. This platform was commercialised under the name of TradeLens. GTD was aimed at developing a blockchain solution to the administrative burden within shipping.

3.4.1. The main architecture of TradeLens

A few months after the CORE project held its final event in Brussels. The blockchain-enabled TradeLens platform was launched[4]. The platform has 5 key pillars in its architecture[54]. These are:

- **Permissioned Data**: The data is shared on a permission basis, where different rights can be given to view, edit and use data from the platform. These rights are set through the organisation's role and the data type. A permission matrix is then used to set which data an organisation can view.
- **Blockchain-Enabled**: The IBM Blockchain Platform is used to store the data. The main use of blockchain is to make the data trustworthy, due to the immutability of the data, the privacy of the user, and the traceability of the different changes to the documentation. Enabling auditable data streams. Lastly, the network users are not anonymous but work through cryptographic identities, where the identity of the firm is its key.
- **Standards-Based**: To increase efficiency in the communication and enable more automation, the platform promotes the use of standard document format. This format is aligned with the UN/CEFACT.
- **Enterprise Security**: The hashes of the keys, which allow the audit trail is published to the TradeLens platform. Critical data is only accessible for permissioned organisations. Thirdly, the security is of the considerable ISO27001 IT security certified level.
- **OPEN APIs**: Through the use of open APIs the platform can be easily integrated with the in-house systems of the different parties. It reduces the development cost of software and enables many creative uses of the service, which might enable new value-added services.

[4]The core project was launched to demonstrate how digital trade infrastructure could increase effectiveness and efficiency within trade https://http//www.coreproject.eu/

4

Theoretical Concepts of Model

4.1. Theoretical concepts related to the ecosystem model

The ecosystem model is constructed out of five theories. These are **A.** Innovation diffusion theory, **B.** Ecosystem theory, **C.** Stakeholder theory, **D.** Control point theory, and lastly, **E.** Barriers and stimulating factors. The logic behind the usage and selection of these theories are discussed in chapter 4.1.1. In sections 4.1.2, 4.1.3, 4.1.4, 4.1.5, and 4.1.6 these concepts will be discussed. Firstly, an explanation will be given for why the concept is important within the model. Secondly, the theory of the model will be presented. Thirdly, how the concept relates within the model will be explained.

4.1.1. The logic behind the meta-framework

The research will aim to observe supply chain reconfiguration within the ecosystem as an effect of the TradeLens platform. As described in chapter 1.6 supply chain innovation is defined as the improved flow of information, funds and/or processes within the supply chain. To observe this improvement, a selection of relevant theories must be included within the assessment model.

The concept of reconfiguration entails the changing inter-organisational roles and activities. This research tries to observe the organisational level changes. These changes become visible on the level of analysis, where the sub-unit are the different organisations. When a smaller unit of observation is used, such as the departments of the different firms. These effects are not observed. The first identified theory is the ecosystem theory.

An actor centred approach is chosen. This approach will make the actor the starting point for analysis. What exactly constitutes an actor is found through stakeholder and actor theory. This is supplemented through the inclusion of ecosystem theory.

The research requires some form of transformation or difference to be observed. This requires a time component which investigates how the innovation progresses on different time points. This is achieved through using diffusion and evolution theory within the model. These theories observe the different phases an innovation progresses through.

The reconfiguration of the network requires a configuring mechanism. For this research transformation of roles is defined as shifting control points of a stakeholder. The control point shift explain how certain actors are able to configure the network to a certain extent where they adopt roles of other actors. This control point theory will structure the mechanism behind the model.

For this research it is expected that certain effects are observed which are not able to be placed within any of the theories. To solve this issue of external or internal influences, the model will use a barrier and stimulating factor approach. Here the barriers are the causes of innovation progress to halt, whereas stimulating factors are reasons for innovation to progress faster then is expected.

4.1.2. Diffusion of innovation and supply chain evolution

The process of developing an innovation is vital in understanding how to view emerging technologies. An innovation will behave differently when it is still in development, when the first versions are put on the market, and when one or multiple designs become dominant. This change in behaviour will require a different view on the innovation during the assessment.

The first view is the three-phase approach of Ortt [35]. In his article Ortt [35] describes innovation as high-tech when the functionality, the principle or both are novel. In the case of TradeLens the functionality of using blockchain is new, as it has not yet become a known standard within the general market and many companies are experimenting with the implementation of blockchain within their processes. When innovation is first conceived and a prototype has been proven it enters the first phase of innovation, here new versions are developed until a "market-ready" version is developed. When the first version is brought to market, the innovation enters the adaption phase. In this phase, multiple versions of the innovation are tried or are only used in diverse niche applications. This phase continues until the innovation reaches a wider market. This last phase is called the market stabilisation phase as the innovation becomes a widely adopted standard.

Another view on innovation is that of Garud et al. [14]. It has a somewhat similar view as diffusion is described in three phases. First, the invention phase, where different mechanisms develop an innovation. Importance is placed whether the innovation is developed within a firm, a multi-actor network or within a community. In the case of TradeLens, the platform itself is developed by a joint project between Maersk and IBM. Afterwards, the innovation reaches the development phase. Here the innovation is developed from a prototype into a real product. It ends with the implementation phase, this is the phase where the innovation is brought onto the market.

The third view is that of supply chain evolution. As described by MacCarthy et al. [29]. This view focuses on the disruptive effects of innovation on the supply chain. It offers three phases, where it starts with the adoption phase, followed by the emergence phase and its disruptive challenges when fitting the innovation within the supply chain. Lastly, as it solves the major issues, it matures.

The three views are similar in describing that the time component is important in the analysis, as the goals and context of the innovation will differ significantly between every phase. Diffusion theory will aid the model in adding a time component. For every snapshot of the ecosystem, it will be evaluated whether the innovation as a whole is in a certain phase.

4.1.3. Ecosystem theory

Ecosystem theory, first coined by Moore [32], describes how business interactions go beyond a network. The business ecosystem theory expands the interaction of the different actors beyond that of network theory. One way of identifying a business ecosystem is through focusing on the interaction around a platform between the sponsors and the complementors [20].

There are three relevant parts of the theory on ecosystems. Firstly, an ecosystem is modular in nature. Every actor has a specific task and inter-firm relations and actions are coordinated through a form of standardised communication. This communication can be both formal as well as informal. Secondly, between actors there exist complementarities. The nature of these complements can be generic (many firms can perform the complement) or supermodal (more of product A makes product B more valuable). Thirdly, ecosystems are the result of process choices. The main developer of the modular technology thus has a significant influence on the overall shape of the ecosystem [20]. The theory of Jacobides et al. [20] states that generic complements are not part of an ecosystem due to the parties not acting as a group and have no vested interest. Thus working definition of an ecosystem is "a set of actors with varying degrees of multilateral, non-generic complementarities that are not fully hierarchically controlled" [20].

An important consideration is what Lusch [28] coins as a service ecosystem. Supply chains are often considered a service ecosystem as the value created is intangible. It offers services to make sure a good reaches its customer. It does not produce that good. As Lusch [28] explains: "A service ecosystem is a spontaneously sensing and responding spatial and temporal structure of largely loosely coupled value proposing social and economic actors interacting through institutions and technology, through: (1) co-produce service offerings, (2) exchange service offerings and (3) co-create value. A supply chain is nested in the service ecosystem." Within this context, it is important to understand the value network of the ecosystem. Consequently, as information plays a vital role in co-creating value, it can be concluded that the information technology and the value network are deeply connected.

In their article, Lansiti and Levien [25] explain that drawing the borders for an ecosystem is not possible. However, the systematic procedures to approach an acceptable result is to identify organisations that are most intertwined and determining the end result of the chain. Secondly, Lansiti and Levien [25] identify three factors to evaluate the health of an ecosystem. Firstly, productivity, which is the financial returns on investment of the different members. Secondly, robustness, the predictability of the ecosystem members. Thirdly, niche creation, the extent to which new technologies are incorporated within the ecosystem. The digital platform analysis will mainly focus on this last aspect, as the research will investigate the application of this new technology. An important member of the ecosystem is the keystone. The keystone is both the value creator as well as the value sharer and performs a pivotal role within the ecosystem [25]. Thus this actor performs the role of stabilising the ecosystem structure.

Lastly, it is important to understand how an ecosystem evolves. Tiwana et al. [51] offer four theoretical lenses to view platform evolution. Modular systems, Evolutionary Selection, Real Options, and Bounded Rationality. For the case of TradeLens, that of Modular Systems is relevant, as the platform ecosystem exists out of many systems interacting with the main data pipeline.

The following components of ecosystem theory will be used within the model:

1. **Type of complement** - What kind of value exchange does the actor perform with other actors?
2. **Role of Actor** - What kind of role does the actor have?
3. **Genericity of complement** - How unique is the offered service?
4. **Power of Actor** - How much influence does the actor have?

4.1.4. Ecosystem actors

The level of analysis of the model will be the individual organisation within the ecosystem. These organisations are described as ecoystem actors within this research. This requires an understanding of what exactly entails an actor and how to connect this actor within the wider model.

Stakeholder theory of Donaldson and Preston [8], Freeman [12]

Freeman [12] defines a stakeholder as: "any group or individual that can affect or is affected by an organisation". For the case of the digital platform, this will be an organisation within the supply chain or directly connected to the supply chain. Thus existing out of suppliers, customers, employees, companies, financiers and governmental bodies. The digital platform can be evaluated on three levels. The rational level where the fit within the larger environment is analysed. The process level, which describes how the standard procedures are related to the wider environment. The lowest level is the transaction level. This describes how the stakeholders interact with the platform. In the article of Donaldson and Preston [8] the implications for using stakeholder theory is to assess **A.** who are the relevant stakeholders and **B.** what are the stakes. This implies for the method to

work, the research should identify what the stakeholder is risking or gaining through the evolution of the ecosystem.

The concepts presented in the stakeholder theory will be included in the model through the following concepts:

1. **Stake** - What does the stakeholder have to gain or lose within the ecosystem?

2. **Stakeholder or Ecosystem actor** - Some stakeholders will not be part of the ecosystem as the complement it offers is generic in nature as explained in section 4.1.3.

3. **Platform interaction** - This will explore how interactive the stakeholder is with the platform. A stakeholder can control, interact with, or abstain from the TradeLens platform.

4. **Level of Stakeholder** - Is the stakeholder directly a part of the supply chain or is the stakeholder a supporting actor(e.g. supplier, financing).

4.1.5. Control points

An important part of the model is understanding which role every actor performs. These roles might change due to the disruptive effects of the incumbent digital infrastructure. Tracking these changes requires insights into the development of the network and the possible mechanisms behind these developments. To track these developments, this research proposes to use control point theory.

In essence, control points describe a certain power an actor has on processes within a system. This can either be derived from architectural design decisions or from value creation [10]. When an actor has power over control points, then that actor is able to steer some of the processes within the system. E.g. the buyer controls the funds used for the purchase. The buyer is able to use that control to either instigate or block further progress of the container shipping process. However, this is only possible until the contractual relations are defined and the buyer is thus obliged to further the shipping process.

4.1.6. Barriers and stimulating factors

Barriers and stimulating factors are a vital part of considering how the platform will evolve. Barriers will block further progress of the platform, whereas a stimulating factor will be able to boost the evolution considerably.

An evolving supply chain will face issues with the process of network creation [29]. These issues will express themselves in three distinct areas of barriers. Firstly, there are upstream barriers. These are barriers erected higher in the supply chain. For the case of the TradeLens platform, these are barriers placed on the exporting side. An example would be an unwillingness to work with the novel technology. Secondly, there are downstream barriers. With the service being adopted by customers. Lastly, there are institutional barriers, such as missing or blocking rules, regulations and standards.

Stimulating factors describe the opportunities that powerful actors perceive over the adoption of the new technology. When these perceived opportunities are strong, then the actor mightpush for further adoption of this new technology. These opportunities are derived from the main benefits of the technology. In their case Di Vaio and Luisa [7] researched the airport industry. This research found that the main benefits of adopting blockchain technology are: **1.** Decentralisation, **2.** Persistency, **3.** Anonymity, and **4.** Auditability.

The relevance to the model will be to categorise the stakeholders as being upstream, downstream and institutional. Secondly, the main benefits for powerful stakeholders will be taken into consideration.

4.2. Overview of the meta-framework

The ecosystem will assess four components. These are **1.** the configuration of the network, **2.** the existing control points of different stakeholders, **3.** the information sharing processes that tie the stakeholders together, and lastly **4.** the main barriers and stimulating factors outside the direct stakeholders. These four elements are shown in figure 4.1.

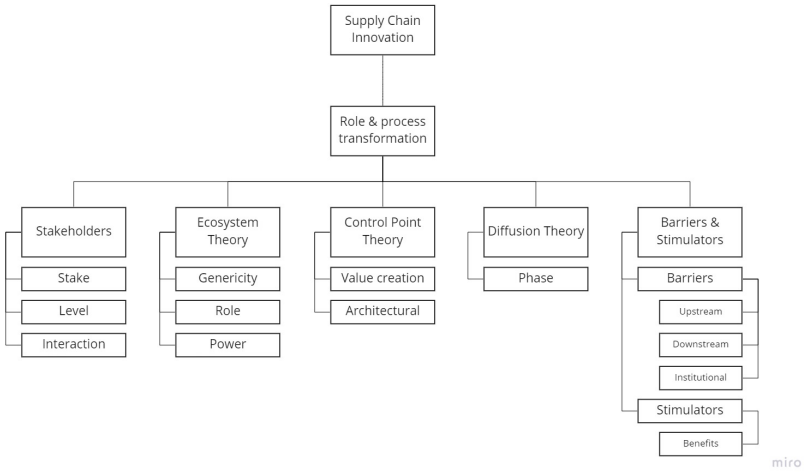


Figure 4.1: A schematic view of the proposed model

4.3. Identifying the actors

As the ecosystem further develops through the effects of the digital infrastructure, some changes within the ecosystem configuration might be observed. Some new actors might enter, some existing actors might perform more key activities, or some actors might lose their control points and leave the ecosystem. In identifying these relevant actors the network mobilisation approach of Rukanova et al. [47] is used. The analysis will develop the ecosystem network using three layers.

1. The layer of actors directly in charge of storing, moving or repackaging the goods to their final location/form.
2. The layer of actors necessary to enable the goods to be moved regulatory.
3. The layer of wider organisations that interact with the supply chain.

4.4. Control points within the supply chain

In chapter 4.1.5 the theoretical base of control points is discussed. However, this meta approach is not sufficient for analysing the ecosystem. This research requires a specific definition of the control point and how this research will observe this. The next step is to further derive where these powers to exercise control result from. Rukanova et al. [42] states that control points are domain-specific and are specifically difficult to identify. The approach within the paper will start with the basic supply chain and build outwards from that point. The used approach is structured around the method decribed for identifying actors. As described, control is derived from either action (value creation) or from informational requirements (architectural decisions). The starting point of the approach is where a seller directly hands over the goods to the buyer. The next step is to further build outwards from this model towards a situation where national borders are crossed and the seller and buyer cannot directly hand over the goods.

4.4.1. Physical control points

Within this research, a physical control point is defined as "Control derived from owning or having control on physical resources used to progress the container shipping process". Using this definition a number of control points can be identified. Firstly, control points derived from transport means, such as the ownership or control over trucks and ships. Secondly, control through ownership or control on physical infrastructure such as the port terminals. These control points are physically required to progress the goods from the buyer to the seller and are less likely to shift due to huge investments on the part of the actor trying to obtain these physical components.

4.4.2. Informational control points

Many processes are required to enable the main transportation of the goods from the exporting company to the importing company. The goods travel great distances, across many borders, and are handled by multiple organisations. A standard method of communication is thus required to enable this process. This transportation process is enabled trough standards of documentation within international trade. However, within this process information has to move from the information source towards the end user of the information. To understand the control the different stakeholders can exercise on the process, this research looks into the documents that each stakeholder adds to the process.
Every document is evaluated on the following points: 1. *Who issues the document?* 2. *What is the main purpose of this document?* 3. *Who receives the document?* and 4. *Where in the supply chain is this document used?* From the example of shipping roses, Jensen and Vatrapu [24] found ten documents that were vital within the shipping process. One such document is the bill-of-lading, which acknowledges receipt of the goods by the carrier. It is issued by the carrier and is issued after loading the goods onto the vessel. Lastly, a case for a Dutch tire manufacturer is provided for the analysis. From these information flows combined with the identified activities, and the value exchanges between the different actors, the control points can be extracted.

4.5. From conceptual meta-framework to model

As described in chapter 1 one of the main requirements in understanding the transformation of the ecosystem is having a systematic approach of evaluating the ecosystem. Thus far, this chapter has researched different aspects of ecosystems and digital trade infrastructure. The next step is merging these concepts into a model that can be used to assess the ecosystem. The case will be assessed on the following different key aspects:

- **Key activities**: As described within the ecosystem theory, an important consideration is the role that each actor performs. This research considers the role to be a collection of key activities, which that actor performs for the supply chain. All activities of an actor will be listed. Those activities that are performed in succession are simplified into a single key activity. Something is considered a key activity if **A.** it directly enables the supply chain process to progress and **B.** performing this activity is a necessity for the shipping process.

- **Relevant actors**: The second aspect is identifying the actors that perform an important function within the supply chain. An actor is considered relevant when it fits within the selected supply chain scope, it performs a complementary service and is required for the main container supply chain process to function.

- **Value exchanges**: Value exchanges explain the interaction between two actors. It identifies why two actors would cooperate and what their mutual benefits are. Something is considered a value if it is either financial wealth or the desired service that is performed for the other party.

- **Key information**: Information streams describe which information is possessed by which actor and how the information flows from one actor to the different actors.
- **Control points**: The control points describe why an actor has control over certain key activities.
- **Time component**: The time component describes at which stage the ecosystem is evaluated. As described in chapter 2 the research considers the ecosystem in two distinct phases, the pre-TradeLens phase and the post-TradeLens phase.

A graphical representation of the model is given in figure 4.2. The connections between the different parts are shown. Firstly, each actor has a certain control point that allows it to perform an activity. The activity that follows forms a value and information exchange between two different actors. This happens within the confines of the ecosystem.

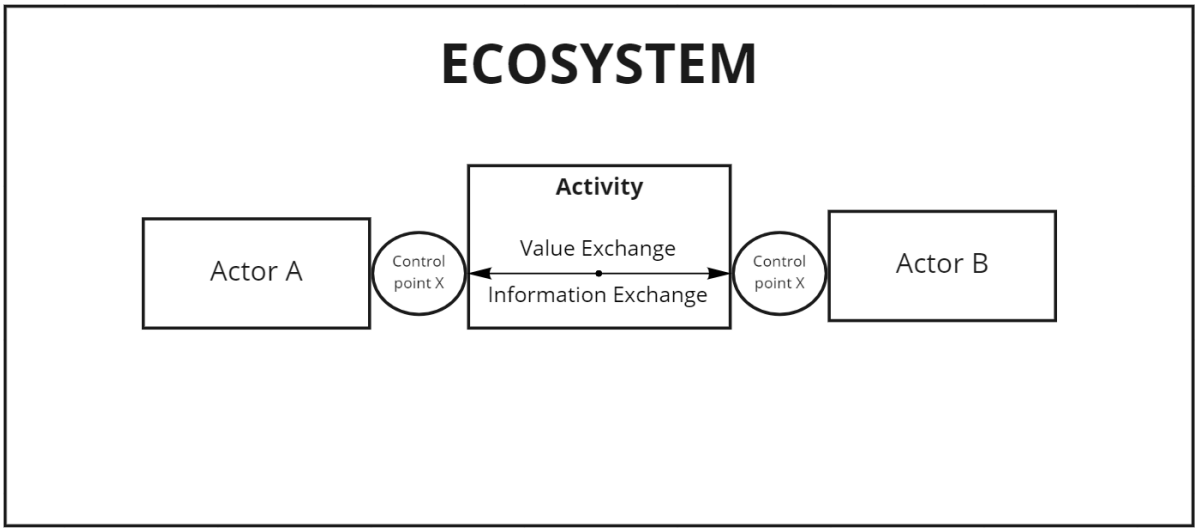


Figure 4.2: The model of the framework showing the main components of the ecosystem assessment.

5

Analysing the Shipping Ecosystem

Using the model developed in chapter 4, the ecosystem of two different supply chains will be analysed and compared. These comparisons will give insights into the mechanisms behind the development of the wider container supply chain ecosystem through digital information infrastructure. First, the different cases within the ecosystem will be introduced. Afterwards, the key activities will be identified. Following, the key actors will be presented. Lastly, the main value exchanges, the key information and control points are assessed.

5.1. Introduction of the two cases

The goal of the research is to develop a set of scenarios on how the ecosystem of container shipping can be affected. To achieve this goal two cases are used. The first case is an artificial constructed case. This case is defined as *the generic international shipping case* defined as *The Pre-TradeLens Benchmark*. The second case is that of a *Dutch Tyre Importer* defined as *The TradeLens Enhanced Import*.

5.1.1. The generic international shipping case: The Pre-TradeLens Benchmark

Container shipping comes in many variations with a different variety of services performed by each actor within the chain. However, a significant portion of shipping follows the same basic processes and includes similar actors (e.g. [CO9, NB3, NB4, OS1]). The generic case is construed to give an approximation of how an international container shipment will be processed.

To develop the case a number of assumptions must be dealt with. Some characteristics of containers create unique conditons within the shipment. For example, shipping volatile chemical goods often requires special documentation and advanced safety procedures[GV4]. To limit these exceptions, the following assumptions are made which are: **1.** The shipment governs a full container load. **2.** The shipment will be delivered directly to the warehouse of the buyer. **3.** The shipment will be shipped under the Free-on-Board (FOB) incoterm. **4.** Both the buyer and seller, do not have any expertise regarding orchestrating the shipping process and must rely on the freight forwarders for assistance.

Full container load, FCL is an important assumption as it impacts the total amount of activities within the shipping process. In the reservation process, the buyer has to make a decision whether a container itself is booked or space within a container is booked. In the former, the container is assumed to be fully loaded with a singular destination shipment. This is a full container load (FCL). However, when the order only requires a limited amount of space, the buyer might select a less then container load (LCL). For LCL containers, the goods have to be bundled in a warehouse

in the nation of export and unbundled within a warehouse in the nation of import. This adds two additional steps which might hinder effective useage of the platform [NB4]. In this case there a number of added activities that have to be performed. The main advantages of FCL are the shipment only requires one bill-of-lading, commercial invoice, and packing list and the container requires less pre-and post-processing as the different shipments do not have to be bundled and unbundled by the freight forwarder [NB4]. The main advantage of LCL is that if the shipment has a low volume, the shipping space of the container can be shared with other buyers. This allows for cost sharing of the shipment and in many cases lower individual costs for shipping. The shipment is assumed to be FCL, which simplifies the main activities through elimination of pre- and post-processes.

The second assumption deals with the added warehouse processes. A shipment can either be distributed to a third-party warehouse or directly to the buyer. The intermediate step of shipping to a warehouse can be observed within the [J1] case. In many cases when FCL is applicable, the container can be directly shipped from the port of discharge (PoD) to the buyer's warehouse through booked or owned intermodal transport [NB3]. This assumption simplifies the shipping process by eliminating the added warehousing step. However, this does imply that the buyer is able to collect the shipment within the allowed container yard time [YT, NB4]

The third assumption governs the used incoterms. Incoterms are international standardised trade agreements [GV6]. These incoterms determine when ownership and risk are transferred from the buyer to the seller. Ownership includes the necessity to arrange the logistics and risk includes insurance. FOB states that the ownership and risk of the container are moved between the exporting side to the importing side the moment the container passes the railing of the ship [CO3]. FOB is one of the most commonly used incoterm within FCL international sea shipping [NB5]. The different incoterms are shown in table 5.1 and figure 5.1.

The last assumption governs the in-house expertise of both companies. Many companies do not have the trade volumes to justify developing trade departments within the company. E.g. a company that has one shipment each quarter, will achieve a more cost-effective transport process though the use of specialised intermediaries, then developing its own transport capabilities. The added costs of the specialisation outweighs the added cost of the freight forwarder.

For purpose of comparison, the generic case will govern a shipment from China into the Netherlands. This container is shipped with the use of an ocean liner. The generic case was developed using an incremental approach. This approach started with the most simplified interaction, between the seller and buyer. The first stable situation that is covered is the interchanging of goods between a seller and a buyer. Here two clear stakeholders are identified. The next step is to add a transportation step between the two parties. Here the intermodal transport company can be identified, but also to enable this transaction a third party financial institution is necessary to provide insurance for the good and to handle the transaction. However, this is only the case in the situation of national trade. When the situation is expanded towards international trade a set of new actors are identified. Firstly, the shipping carrier to move the good from nation A towards nation B. Secondly, the port of loading (PoL) and the port of discharge (PoD). These ports offer a number of services such as tugs and pilots to enable the ship to enter the port but also enable the ship to be loaded/unloaded. Thirdly, customs agencies from both nations will check whether the goods uphold all the trading standards and regulations. Lastly, to organise the container shipping in this case freight forwarder companies are used. The specific parties are more elaborated in the following chapters. A more detailed explanation of the different actors within the network and their relationships is given in chapters 5.3 and 5.4.

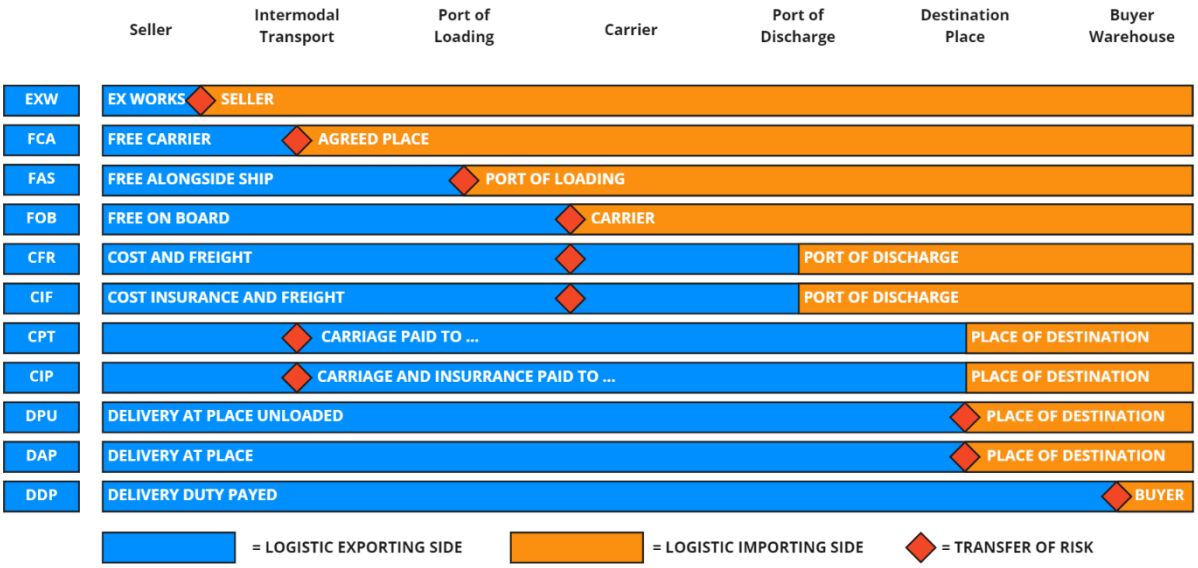


Figure 5.1: The transfer of risk and logistic obligation with the different incoterms of table 5.1. Adapted from Chamber of Commerce [GV10]

5.1.2. Dutch Tyre Importer: TradeLens Enhanced Import [VB1][VB2]

Dutch Tyre Importer (TI) is an organisation that uses TradeLens within the supply chain. One example is the use of the TradeLens platform to automate part of customs processes.

TI employs multiple sellers and uses different incoterms depending on which seller it employs at that specific time. In the researched case, TI uses the Free on Board, (FOB) incoterm. Here the seller is responsible for freight handling, the risks and the costs until the freight is on board the ship. Afterwards the responsibility shifts to the buyer, who is responsible for the remaining part of necessary arrangements, such as the import formalities, customs, unloading, and transport to the final location. The tyres are shipped within a full container. Thus only the shipment of TI will fill up the container.

The shipped goods of TI are non-perishable. This implies that a loaded container can spend a significant amount of time within a depot, without causing any issues regarding the content. In contrary, perishable goods such as flower or organic food often have a short shelf-life. These goods require a faster shipping process to provide the best quality standard to the end-user.

The following documents are uploaded within the TradeLens environment: These are the **I.** bill-of-lading, **II.** commercial invoice, and **III.** the packing list. The seller uploads the packing list and commercial invoice and the bill-of-lading is uploaded by the carrier.

5.2. Key activities

The first step in constructing the ecosystem is through identification of the key activities. An incremental identification approach is used. The starting point is identification of the key activities surrounding a simple transaction. Afterwards new elements are added, until a complete activity list is constructed. Multiple activities in succession by the sane actor, are simplified to a singular activity.

5.2.1. The Pre-TradeLens Benchmark

Generally, a transaction occurs when a buyer and seller agree to terms of the exchange of goods and services for payment. The most simplified case is where a direct transaction occurs, without any shipping. A comparable case is someone buying goods directly from a wholesaler. Here the activities identified are procurement, sales, and production/acquiring of goods. *Procurement* is the

process of the buyer selecting, contacting and agreeing on the terms, conditions, and price of good delivery [CO9]. *Sales* are the process where the seller sets a preliminary and/or commercial invoice. *Production/acquiring* the goods is the process of the seller gathering the goods for the sale.

However, the generic case also contains an international transport component. The seller, nor the buyer are able to directly execute the exchange between themselves. They require different activities to occur between them before the goods reach the warehouse of the buyer. Within the transport process, a total of three transport legs are identified [CO9]. A leg is defined as a sub-unit of the transport distance which is performed by one specific party. In the generic case these legs are identified as land transport from seller location to port of loading (PoL), sea transport from PoL to the port of discharge (PoD), and lastly, land transport from PoD to buyer warehouse. The *land transport* on both the import and export side is performed by an intermodal operator. This intermodal operator uses trucks or trains to move the goods. The *sea transport* is performed by the carrier, who employs container liners to move the goods between the ports.

To enable this process, both the goods need to be cleared by customs and the goods need to be loaded/unloaded [GV1], [GV2], [GV3] and [CO9]. *Customs clearing* is in essence the final product of a nation's customs, being able to confidently say that certain goods are legal to be shipped and that all due duties have been paid. Thus before the goods can be cleared by customs, customs has to perform a so-called *risk assessment* of the goods [GV1]. Here the container information and optionally goods are investigated and the risks of the goods containing forbidden or falsely declared goods is determined. *Collecting duties* is the process of collecting the required payment from the seller or buyer. Duties are determined by the nations of import and export. A common name for these duties are tariffs. If the goods are cleared by customs then these can be *loaded/unloaded* by the terminal operators in the port. Here specialised cranes are employed in moving the goods between the vessel and the port.

As discussed, customs agency need to perform the risk assessment and the different parties require information to perform their tasks. For calculating the correct duties, customs require the information from the commercial invoice. The *commercial invoice is generated* by the seller and states the official price the goods have been sold for. Secondly, the importing customs nations require proof that the container has been loaded. This is contained within the carrier-issued Bill-of-Lading (BoL). *Generating the Bill-of-Lading* is performed by the carrier [CO9]. This is proof the container has been loaded by the carrier.

A missing set of activities is that of arranging other actors to perform them. As most activities are not triggered by themselves, an actor has to trigger them. As described in the introduction of chapter 5.1.1, the shipment is assumed to be shipped under the incoterm FOB, thus both the seller as well as the buyer have to arrange the transport. This activity can be described as *arranging logistics* on both the importing side as well as the exporting side. To arrange the logistics, both parties employ their own freight forwarder, who is tasked with orchestrating the logistics. This orchestration contains the *booking of land transport*, *booking sea transport*, *lodging customs declaration*, and *Acquire insurance for the transport*. The lodging of customs is the act of gathering the information required for customs declaration, such as the HS codes. Lastly, the carrier provides slots for shipments to be booked and as such has to *book loading/unloading* with the terminal operators. Secondly, within Europe, the carrier also provides the *Entry Summary Declaration (ENS)*, which provides information on all the loaded goods on the vessel[CO2], [GO8]. The ENS data elements are used for the necessary risk assessment to address the potential safety and security issues of incoming shipments.

5.2.2. TradeLens Enhanced Import

The transport process is started when the tyre importer places a *purchase order* towards the US-based seller. Within this purchase order, the tyre importer declares which type and quantity of tyres

they want. This seller has a subcontract with a factory in China that *produces the tyres*. Secondly, the seller arranges with the freight forwarder to book the carrier slot for the shipment.
Another set of key activities are between the factory and the container depot. First, the factory has to *collect the container*. Here dependent on the shipping instructions, it will collect the empty container from the depot to fill it. Afterwards, the seller receives the loading data and *forwards the packing data* to the freight forwarder.
Within physical transportation, the same activities can be identified. However, the actors performing these activities differ. Firstly, *land transport from factory to PoL* is performed by trucks owned by the factory itself. Similar, on the importing side, the *transport from PoD to buyer warehouse* is done by trucks of the tyre importer itself. Thus the arrangements of these logistics and the transportation can be simplified into the same activity. The *sea transport from PoL to PoD* is performed by the carrier with the corresponding activities such as *arranging loading and unloading*. Twenty-four hours before the loading of the containers, the carrier *submits the ENS data* to Dutch customs. Customs perform the *risk analysis*. The ship moves the goods to the Dutch port of Rotterdam. Once the ship arrives at the port, the buyer *lodges an import declaration* for the Dutch customs perform a second *risk analysis* and *calculate the import duties*. If both activities are finalised, the buyer receives the *import clearance* from customs in the form of permission to discharge.

Table 5.1: The international standards of shipping, incoterms, as of 2020 [GV10]

Abbreviation	**Name**	**Description**
EXW	Ex-works	Buyer has to retrieve the goods from the seller's location
FCA	Free Carrier	Seller transports the goods to an agreed place, the buyer has to retrieve them.
FAS	Free alongside ship	The seller organizes the transport of the goods to the place alongside the carrier, the seller does not organize the clearance.
FOB	Free on board	The seller organizes the transport onto the vessel and organizes the clearance.
CFR	Cost and freight	The seller organize the transport to the port of discharge. The buyer carries the risk of this transport.
CIF	Cost insurance and freight	Similar to CFR, but the seller will also carry the risk.
CPT	Carriage paid to...	The seller organizes the clearance and organizes transport. The risk is carried by the transport company.
CIP	Carriage and insurance paid to ...	Similar as CPT, but the seller also organizes the risk of transport.
DPU	Delivery at place unloaded	The seller incurs all the costs until the goods reach an agreed location including the unloading of the goods.
DAP	Delivery at place	Similar as DPU, without the unloading.
DDP	Delivery duty paid	The seller incurs all the costs.

5.3. Ecosystem members

The second step in describing the reconfiguration is to analyse the actors within the ecosystem. An actor analysis is performed to find all the relevant actors using the methods described in chapter 4.1.4 and 4.1.5. As the key activities have identified the main processes within container shipping, the next step is identifying who performs these key activities. An actor is considered relevant if it performs one of these key activities.

Every actor is structured using the following aspects:

1. The activities the actor performs.
2. The interactions this actor has with other actors.
3. The information this actor possesses and requires.

5.3.1. The Pre-TradeLens Benchmark

Within the benchmark the following key actors can be identified:

1. **Buyer**: The buyer plays the instigating role within the ecosystem [CO6, CO9]. Without a buyer, the shipment will not occur. The buyer performs the following activities. First, it performs the *procurement* activity. This activity requires the buyer to select a supplier/seller based on the goods requirements, available network, or similar relevant factors. Afterwards, the buyer and seller agree on the shipping terms, earlier described as the incoterms. The buyer also agrees on the price of the sale using a preliminary invoice given by the seller.

   The second activity of the buyer is that of *arranging import* through a freight forwarder [CO9]. As described in the introduction in chapter 5.1.1 , in this case the buyer does not possess the specialisation nor the network to handle the complex information streams within the logistics[1]. Thus it will subcontract the freight forwarder to handle this process. In exchange for a payment, the freight forwarder will provide this service.

   Lastly, the buyer performs the *payment for goods* activity [NB4]. This process is critical in launching the physical shipping process as the seller will not ship the goods without some assurance that payment will be provided. This is often achieved through a letter of credit or a bank draft. These documents provide the seller with the assurance that the shipped goods and all relevant shipping services will be compensated.

   Looking at the interactions of the buyer, two main interactions are identified. First the interaction between the buyer and seller to successful exchange goods for payment. This also includes the interaction with the financial service providers to enable this exchange. Secondly, the interaction between the buyer and the freight forwarder on the importing side to handle all logistics under the contract of the FOB incoterms.

   The information that is required by the buyer is both the preliminary invoice as well as the commercial invoice. These documents provide the buyer with the exact quantity, quality and type of goods. Secondly, it provides the contractual base for the shipment.

2. **Seller**: Within container shipping, the seller can be the supplier or both the supplier and the producer. In many cases, the seller contacts the manufacturer and sells their goods as a wholesaler or trading company to the buyer. Within the purchasing process, the seller has the following tasks: Firstly, the seller will have to develop a quote. Secondly, the seller will settle on the incoterms and carry out their respective part. Thirdly, the seller provides documentation about the sold goods.

   The seller interacts with the buyer in the sales/procurement process, with the freight forwarder to arrange the transport, and with the financial service provider to arrange payment procedures.

   The main information the seller possesses is the commercial invoice, the packing list and the preliminary invoice. The first one details the exact goods, the incoterms the goods are sold

[1] There are examples of buyers with high volume to have the specific expertise and network to perform many of the logistical tasks. E.g. the ownership of own trucks to collect shipments from the port.

under, and the value that will be paid for the goods. The packing list details the specifications of the goods and in which container the goods are shipped. Lastly, the preliminary invoice is a document that describes the quote and a price calculation for the buyer.

3. **Freight Forwarder**: The freight forwarder (FF) performs the role of the supply chain orchestrator. Within this role, it performs a significant set of key activities. The freight forwarder is tasked with the transport arrangements. There are three legs of transport that the freight forwarder performs. These are the transport legs between the seller and the PoD, the sea transport between the two ports, and the land transport between the PoD and the buyer. The FF employs its business network of transport companies to enable the land transport and if required by the incoterm will make the booking with the sea carrier.

   A freight forwarder is contracted by the seller or the buyer. In this case both the seller as well as the buyer contract a freight forwarder. These can be the same company or two different forwarders. The freight forwarder often performs the following tasks: Offer advice on the shipping process, prepare the necessary paperwork for the process, arrange payments and organisation for all different transport processes, warehousing and export packaging, act on behalf of the seller or buyer, incurs the risk of the transport, and lastly, keeps the seller or buyer updated on the current status of the shipment.

   To perform these tasks the freight forwarder has to interact with the intermodal transport to organise the land transport. Secondly, the FF interacts with the sea carrier to organise the sea transport. Thirdly, interaction with financial services is included to arrange the insurance of the goods. Lastly, the FF interacts with customs to get permission to load and/or discharge the goods.

   The freight forwarders have a significant information position due to having a large network. They position themselves as an information intermediary and use that position to buy transport services in bulk. This part allows them to offer competitive prices towards their customers. Within the freight forwarder's role of information intermediary, the following documentation is passed between the different actors:

   - bill-of-lading
   - Commercial invoice
   - Certificate of origin statement
   - Inspection certificate

   The above documentation is also used to lodge customs declaration, which can be the import and/or the export declaration, shipper export declaration and export packing declaration.

4. **Carrier**: A carrier refers to companies that carry the shipment. This can be either by the truck, aeroplane, railway and by sea. However, within the context of this research, the carrier is referred to as the sea carrier. The first key activity of the sea carrier is that of transporting the containers over the sea between the two ports. The carrier is also tasked with performing two different information tasks. First, the carrier issues the bill-of-lading. This document acts as proof that the shipment has been loaded onto the vessel and ownership is thus transferred between the holders of this document. Secondly, the carrier performs the task of ENS reporting for customs purposes.

   The carrier interacts with three different parties. First, the carrier has close interactions with the ports and terminal operators. These are vital for loading and unloading the cargo on time. The second interaction is that with customs for the ENS reporting. Lastly, the carrier

interacts with the freight forwarder to gather vital information for the ENS reporting and to confirm the booking.

The key pieces of information are as described in the bill-of-lading and the ENS report. To issue the bill-of-lading and the ENS report the shipper requires the packing list, which is gained from the freight forwarder.

5. **Customs**: Customs perform an important governmental role. As customs are the main enforcer of national legislation regarding import and export[GV3]. As goods cannot be imported/exported without the explicit permission of customs agency, all their activity regarding clearing the goods are described as key activities. The main activities are performing risk assessment and duty collection [GV1]. Here customs check for financial[2] and non-financial risks[3].

   The main interactions customs perform is with the freight forwarder regarding the documentation of the shipment to perform the risk assessment. Secondly, through the ENS reporting it interacts with the carrier. Lastly, through on-site inspections, it interacts with the ports and terminal operator.

   The main information that is required to perform the risk assessment and thus clear the goods are the bill-of-lading supplied through the ENS reporting and the commercial invoice supplied by the freight forwarder. These two documents enable customs to issue the clearance documentation and the invitation to pay for duty collection.

6. **Intermodal Transport**: The intermodal transport performs a straightforward but vital activity. The transport of goods between either the seller and the PoL or the transport between the PoD and the buyer. Within the context of this research, the assumption is made that this transport is performed using container trucks.
   The Intermodal has a direct information interaction with its contractor the freight forwarder. All relevant information is given through this party.
   The main relevant information is the packing list and to a lesser extent the bill-of-lading from the truck. However, this bill-of-lading does not perform a key task within the container shipping process and will thus not be considered key information. The packing list is issued by the seller and supplied through the freight forwarder.

7. **Port / Terminal Operator**: The port and terminal operators facilitate the transport of the container through loading and unloading of the goods. To achieve this the port has to arrange a slot for the containers to be loaded and communicate this with the shipping carriers.

   The main interactions of the port are with the shipping carriers and the freight forwarders. The shipping carrier provides the terminal with an estimated time of arrival (ETA), whereas the terminal operators provide the shipping carrier with an available dock. At the same time, the terminal operator provides the freight forwarder with expected unloading/loading times.

   The key information the terminal operator requires is the ETA and the actual time of arrival (ATA). The former describes when the ship is expected to reach the port, whereas the latter provides the terminal operator with the actual time the ship will arrive.

[2] The financial risks are identified as: **A.** Reporting the correct value of goods, **B.** Using the correct HS code, **C.** Handing in the correct forms. Source: https://www.belastingdienst.nl/bibliotheek/handboeken/html/boeken/HDU/plaatsing_van_goederen_onder_een-controle.html

[3] The non-financials risks are for example: (Trade)-political reasons, goods from embargoed countries, veterinary regulation, et cetera. Source: https://www.belastingdienst.nl/bibliotheek/handboeken/html/boeken/HDU/plaatsing_van_goederen_onder_een-controle.html

8. **Financial Services Provider (FSP)**: There are two key activities of the financial services provider. First, facilitating ownership transfer through enabling the transfer of payment. Secondly, providing insurance for the goods. It is not required that the provider of the insurance is the same financial provider as the facilitator of the payment. In many cases, both the importing and exporting actors use different FSP. In this research, these providers have been simplified into the financial services actor.

   The main interactions the FSP performs is in regards with the ownership transfer activity. Here the FSP interacts with both the buyer as well as the seller. Through a bank draft or letter of credit, the FSP acts as an intermediary for the financial transaction. In the second activity, the FSP performs risk assessment and provides the freight forwarder with insurance for the goods during a pre-determined set of transport legs.
   The FSP issues the bank draft or the letter of credit (LoC). These documents contain the terms for the payment of the goods to occur. In the case of the LoC, the FSP requires the bill-of-lading. The moment the BoL is provided, the FSP initialises the payment. Within the second activity, the FSP requires the commercial invoice with the information regarding the value to be insured.

5.3.2. TradeLens Enhanced Import

Using the same approach as the benchmark case, the different actors are identified.

1. **Seller**: The following activities are performed by the seller. First, he initialises the production by sending a production order to the factors. Secondly, the seller will arrange part of the logistics through the use of a freight forwarder. This is performed by arranging the booking of the selected carrier by the TI and developing the commercial invoice to be sent to the TI.

   The interactions with the factory are to initialise the production and coordinate the transport. The former requires the seller to send a production order to the factory and to receive the production plan. The seller coordinates the transportation by forwarding the carrier booking from the freight forwarder to the factory. The interaction with the buyer is to forward the bill-of-lading to the TI, to issue the commercial invoice, and to handle the payment. The interactions with the freight forwarder is for handling the carrier process.

2. **Factory in China**: There are multiple Chinese manufacturers who make the tyres. After receiving a production order from the seller, the Chinese factory will start to produce the tyres and send a production plan to the seller. The factory will arrange the collection of a container from the depot using the factory-owned trucks. The factory will use the same trucks to arrange the transport of the loaded container to the PoL. Lastly, lodging the export declaration to the China customs are done by the factory.

   The factory has close interactions with the seller. They share data regarding the production order, the production plan and the packing lists. These provide the seller with the ability to generate the commercial invoice. The second set of interactions are with the Chinese customs with lodging the export declarations.

   Key documentation provided by the factory is that of the packing list. This explains exactly what is loaded onto the trucks. The production plan describes when the tyres will be finished and are ready to be transported. Secondly, the factory provides the Chinese customs with the export declaration for their risk assessment.

3. **Forwarder**: The forwarder is contracted by the US seller. The main tasks are to arrange the transport and loading from the factory in china to the port in Qingdao. In this activity, the forwarder enables the loading of the goods, through a booking with the carrier. The trucks

are from the factory itself. The export formalities are performed by the forwarding company. Also, the forwarder provides the carrier the export fee, document service fee, and Chinese terminal handling fee.

The main interactions are with the seller to provide the booking confirmation and performing as an information intermediary between the carrier and the seller.

The key information it requires within this case is the bill-of-lading given by the carrier, the packing list given by the seller. The forwarder provides customs with the customs declaration using the packing list provided by the seller.

4. **China customs**: China customs receives the export declaration and after approving allows the tyres to leave the country. Before approval can occur, customs need to perform a risk analysis.

   The main interactions of customs are with the freight forwarder. The FF provides customs with the necessary information. This information is mainly based on the packing list.

5. **Depot**: The depot supplies the empty containers to the factory. These containers are picked up by the factory.

6. **Carrier**: The carrier performs three key activities. It transports the goods between the two ports. This includes communication with the two ports to arrange the loading and unloading of the goods. The second activity is issuing the bill-of-lading. The documentation that the goods have been loaded. Thirdly, lodging the ENS report. This is a formal EU customs process where the bill-of-lading is provided with EU customs.

   The carrier interacts with the freight forwarder in receiving the booking and sending the booking confirmation and the bill-of-lading. Secondly, it interacts with EU customs through the ENS reporting.

   The main piece of information the carrier provides are thus the bill-of-lading and the ENS report. The former acknowledges the transfer of ownership between the seller and the TI. It also describes information about the goods that have been loaded onto the vessel. The second piece of information is the ENS report. This is mainly information from the bill-of-lading.

7. **Belgian Customs**: Belgian customs perform a first risk analysis using the ENS report, which contains data about the shipment that has been loaded onto the vessel. This data is received directly from the carrier.

8. **Tyre Importer NL**: The TI provides the purchase order to the us-based seller. The purchase order provides selection of the quantity and specifications of the tyres. Secondly, the TI provides payment towards the seller based on the commercial invoice. The third key activity performed is that of transporting the container from the PoD to the warehouse. This is done with trucks owned by the company. The remaining key activity provided by the TI is that of paying the import duties. After receiving the invitation to pay, the TI provides the payment for customs duties.

   There are two main interactions the TI performs within the system. First, regarding the purchasing process, in this research defined as procurement, the TI has direct contact with the US-based seller. The seller provides the confirmation of the order and the commercial invoice. Secondly, the interaction with Dutch customs. The TI directly lodges the import declaration with customs agency and pays the duties. In return, the TI receives permission to discharge. The TI has shipping contracts with a carrier, this carrier will be used to ship the goods.

The following key information is required by the TI to perform customs lodging. First, they require a trusted commercial invoice. This implies that the invoice has not been falsified. Through the use of TradeLens, the TI directly extracts the original commercial invoice from the platform through the use of APIs. Afterwards this commercial invoice is automatically lodged to customs for the import declaration. This method allows the TI to upload trusted source data.

9. **Dutch Customs**: Dutch customs perform the activity of risk analysis and container clearance. Risk analysis is performed based on the data within the commercial invoice. Following risk analysis, customs clear the goods to be discharged. Thus the goods are allowed to be unloaded from the vessel. Secondly, customs send an invitation to pay to the import declarant, in this case, the TI provides the payment.

   customs only interactions are with the TI. The TI supplies Dutch customs with the required information to perform the risk analysis.

   Required for perform the risk analysis and developing the invitation to pay, is the original commercial invoice. Important for the Dutch customs in this part is the financial risk, as described in chapter 5.3.1. Customs require trustworthy data to negate the risks sufficiently. This can either be gathered through a intermediary, such as a freight forwarder or through software that directly sends the source data. In the case of the TI, a software solution is used to lodge the data from the commercial invoice to customs.

5.4. Value exchanges

Using the found interactions defined in chapters 5.3.2 and 5.3.1. The value transfers can be identified for the two cases. These value transfers will visualise how different actors work together. For both cases, a table of the identified interactions are provided and the defined value transfers between them. To visualise the value transfers a modified e^3-control model will be used. This modeling approach main has been succesfully demonstrated in examples such as the beer living labs project[13]. The modeling approach has been discussed as being successful in solving complex inter organisational issues [11, 16]. As a supply chain is a complex inter organisation ecosystem, this model is good fit to visualise and build the value exchanges between the different actors. A legend is provided in figure 5.2. Verification of the models is performed by a step-by-step walktrough. Here it is checked that the model does not contain a loop and that every branching path ends with a boundary element.

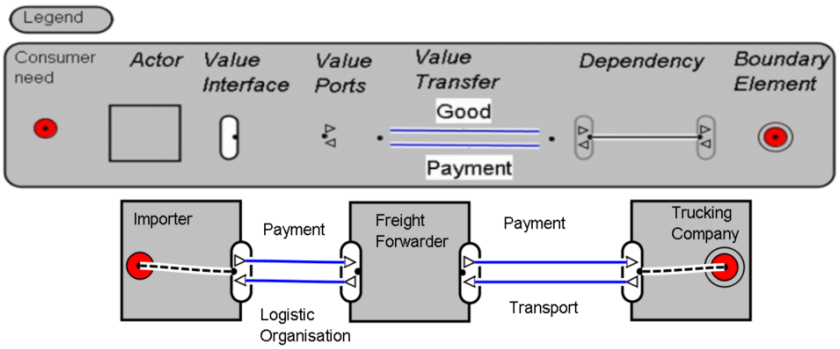
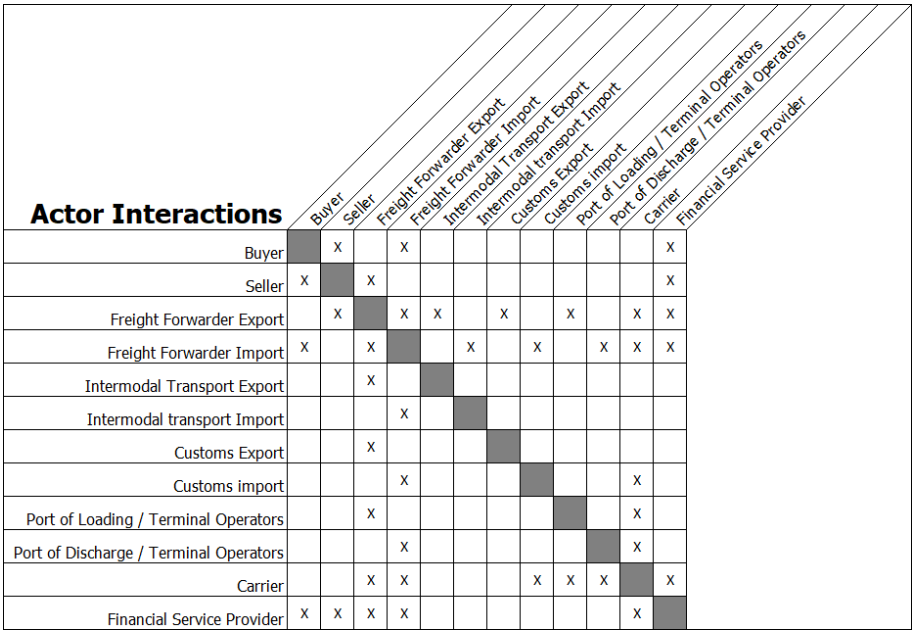


Figure 5.2: Legend for the e^3-control model, adapted from Frö ler et al. [13]

5.4.1. Pre-TradeLens Benchmark

The identified value transfers for the benchmark case are given in figure 5.4 and the matrix in figure 5.3.



Actor Interactions	Buyer	Seller	Freight Forwarder Export	Freight Forwarder Import	Intermodal Transport Export	Intermodal transport Import	Customs Export	Customs import	Port of Loading / Terminal Operators	Port of Discharge / Terminal Operators	Carrier	Financial Service Provider
Buyer		x		x								x
Seller	x		x									x
Freight Forwarder Export		x		x	x		x		x		x	x
Freight Forwarder Import	x		x			x		x		x	x	x
Intermodal Transport Export			x									
Intermodal transport Import				x								
Customs Export			x									
Customs import				x							x	
Port of Loading / Terminal Operators			x								x	
Port of Discharge / Terminal Operators				x							x	
Carrier			x	x				x	x	x		x
Financial Service Provider	x	x	x	x							x	

Figure 5.3: The identified interactions between the different actors for the benchmark case.

The main value exchanges are:

1. **Buyer**

   (a) **Seller**: *Procurement/Sales*: The buyer exchanges payment for the specified goods.

   (b) **Freight Forwarder Import**: *Arrange Logistics*: The buyer exchanges payment for logistics assistance from the freight forwarder. The freight forwarder will handle the physical transport from the port of loading to the buyer and the insurance on behalf of the buyer.

   (c) **Financial service provider**: *Prepare payment*: The buyer pays a fee in exchange for the bank drafting a letter of credit for the seller.

2. **Seller**

   (a) **Freight Forwarder Export**: *Arrange Logistics*: The seller exchanges payment and the shipment information for logistics assistance from the freight forwarder. The freight forwarder will handle the physical transport of the goods between the seller and the port of loading and the insurance on behalf of the seller. The freight forwarder will forward relevant documentation to the seller.

   (b) **Financial service provider**: *Initialise payment*: The seller send the bill-of-lading to the financial service provider in exchange for initialising the transaction between the accounts of the buyer and the seller.

3. **Freight Forwarder Export**

   (a) **Freight Forwarder Import**: *Exchange information*: The importing freight forwarder will give the exporting freight forwarder information regarding which carrier will ship the goods. The exporting freight forwarder will receive the ability to book the carrier.

   (b) **Intermodal Transport Export**: *Arrange Land transport*: The freight forwarder subcontracts the intermodal transport company to transfer the goods between the seller and the port of loading. The transport company receives a payment for this service.

(c) **Customs Export**: *Lodge Export Declaration*: The freight forwarder supplies customs with the information for the export customs to perform a risk analysis. The information that the freight forwarder supplies is the commercial invoice and the packing list. If applicable the freight forwarder will provide the payment on export duties. In return the freight forwarder receives permission to load the goods on the carrier.

(d) **Port of Loading/Terminal Operators**: *Exchange information*: The freight forwarder receives information from the terminal operator on the time slots the ship arrives and when the goods are to be loaded. In return, the forwarder arranges that the goods are delivered within the correct time window and that the terminal handling fees are paid.

(e) **Carrier**: *Arrange sea transport*: The freight forwarder will provide the carrier with a booking and a payment to transport the goods from the port of loading to the port of discharge. The carrier provides the physical transportation using its vessels and the official acknowledgement of receiving the goods through a bill-of-lading.

(f) **Financial service provider**: *Arrange insurance*: The Freight forwader will receive insurance on the goods in exchange for information on the goods in the form of the commercial invoice and a fee for the insurance.

4. **Freight Forwarder Import**

(a) **Intermodal Transport Import**: *Arrange Land transport*: The freight forwarder subcontracts the intermodal transport company to transfer the goods between the port of discharge and the buyer's warehouse. The transport company receives a payment for this service.

(b) **Customs Import**: *Lodge Import Declaration*: The freight forwarder supplies customs with the bill-of-lading, the commercial invoice, and the import duties. The documentation is necessary to perform the risk analysis. In return, customs give permission to discharge the goods.

(c) **Port of Discharge/Terminal Operators**: *Exchange information*: The freight forwarder receives information from the terminal operator on the time slots the ship arrives and when the goods to be discharged. In return, the forwarder arranges that the goods are collected within the correct time window and that the terminal handling fees are paid.

(d) **Carrier**: *Exchange information*: The freight forwarder will exchange information with the carrier regarding epected time of arrival. The carrier will collect the payment for shipping from the freight forwarder.

(e) **Financial service provider**: *Arrange insurance*: The Freight forwader will receive insurance on the goods in exchange for information on the goods in the form of the commercial invoice and a fee for the insurance.

5. **Carrier**

(a) **Customs Import**: *Lodge ENS*: The importing customs will receive the ENS report from the carrier regarding the cargo on board of the vessel. In exchange customs allow the vessel to enter its destination port.

(b) **Port of Loading/Terminal Operators**: *Arrange loading*: The carrier will supply the terminal operator with an expected time of arrival and the actual time or arrival. In exchange, the carrier will receive terminal handling of the vessel with a minimum amount of delay.

(c) **Port of Discharge/Terminal Operators**: *Arrange unloading*: The carrier will supply the terminal operator with an expected time of arrival and the actual time or arrival.

In exchange, the carrier will receive terminal handling of the vessel with a minimum amount of delay.

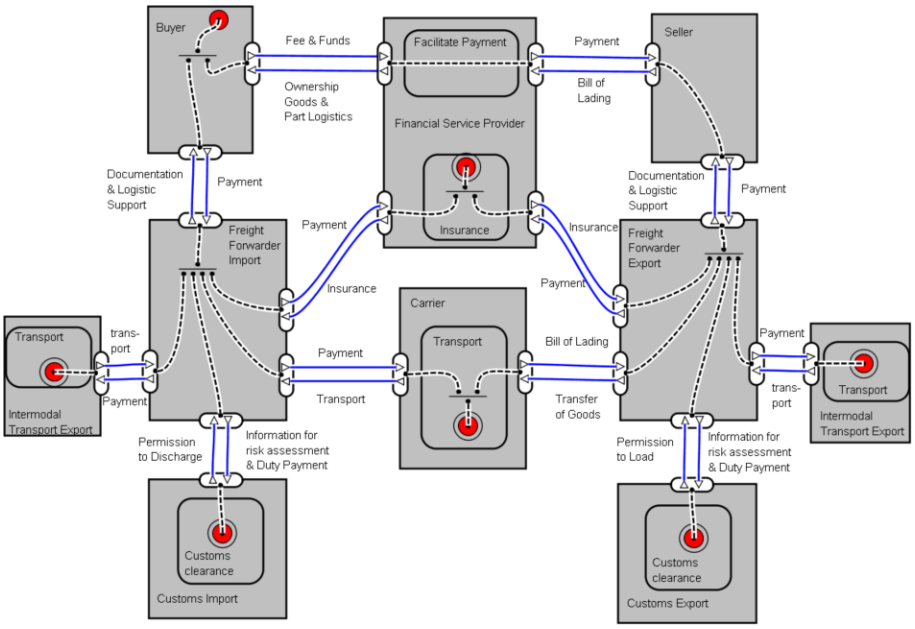


Figure 5.4: The e^3-control model of the benchmark case.

5.4.2. TradeLens Enhanced Import

The identified value transfers for the blockchain-enabled import case are given in figure 5.6 and the matrix in figure 5.5. The explanation is provided in the following list.

Actor Interactions	Seller	Factory in China	Freight Forwarder Export	China Customs	Depot	Carrier	Belgian Customs	Tyre Importer NL	Dutch Customs
Seller		X	X					X	
Factory in China	X		X		X				
Freight Forwarder Export	X	X		X					
China Customs			X						
Depot		X							
Carrier			X				X		
Belgian Customs						X			
Tyre Importer NL	X								X
Dutch Customs							X		

Figure 5.5: The identified interactions between the different actors for the Tyre Importer case.

1. **Seller**

   (a) **Factory in China**: *Production of goods*: The seller provides the factory with a production plan, the shipping instructions and payment. In return the factory transports the

goods to the port of loading and provides goods.

(b) **Freight Forwarder Export**: *Arrange Logistics*: The seller provides the freight forwarder with a payment, the commercial invoice, and the selected carriers. In return the freight forwarder will arrange a booking with the carrier and lodges the export declaration.

(c) **Tyre Importer**: *Production/Sales*: The Tyre importer will provide payment, a purchase order and a list of approved carriers to the seller. In return the buyer receives the bill-of-lading, the commercial invoice and the ownership of the goods.

2. **Factory in China**

   (a) **Freight Forwarder Export**: *Exchange information*: The factory will supply the freight forwarder with the packing list. In exchange the factory fulfils his obligation towards the seller.

   (b) **Depot**: *Collect container*: In exchange for payment the factory collect an empty container from the depot.

3. **Freight Forwarder Export**

   (a) **China Customs**: *Lodge Export*: In exchange for permission to load the goods, the forwarder supplies customs with information regarding the shipment, such as the packing list and the commercial invoice.

   (b) **Carrier**: *Book Carrier*: The freight forwarder books a slot with the carrier and gains a loading date. In exchange the carrier gets a payment through the Tyre importer.

4. **Carrier - Belgian Customs**: *Lodge ENS*: The carrier lodges the bill-of-lading within the ENS report for the Belgian customs. The Belgian customs then send a permission to discharge to the carrier.

5. **Tyre Importer - Dutch Customs**: *Lodge Import Declaration*: The Dutch tyre importer lodges the original commercial invoice and provides payments for the duties using the invitation to pay provided by customs. In return the Dutch customs provide the tyre importer with a permission to discharge the goods from the port.

5.5. Key information

A majority of the processes have informational requirements to be performed. For example, the risk assessment performed by customs requires the packing list and the commercial invoice. This section will describe which documents are used within the shipping process and the information these documents contain.

5.5.1. Pre-TradeLens Benchmark

The following documents have been identified as performing a key function within the benchmark.

1. **Commercial invoice e.g.[J2, J3, VB1, CO5, CO6]**: The commercial invoice is the document with most of the details of the transactions. Firstly, it contains the identity of both the seller and buyer of the goods. Secondly, it explains which incoterms are applied to the goods. Thirdly, it describes the quantity, the specifications and price of the goods. Fourthly, it provides payment plan details and which currency is used. Lastly, it provides the final destination of the shipment. In some cases, the Commercial invoice includes the HS Code.

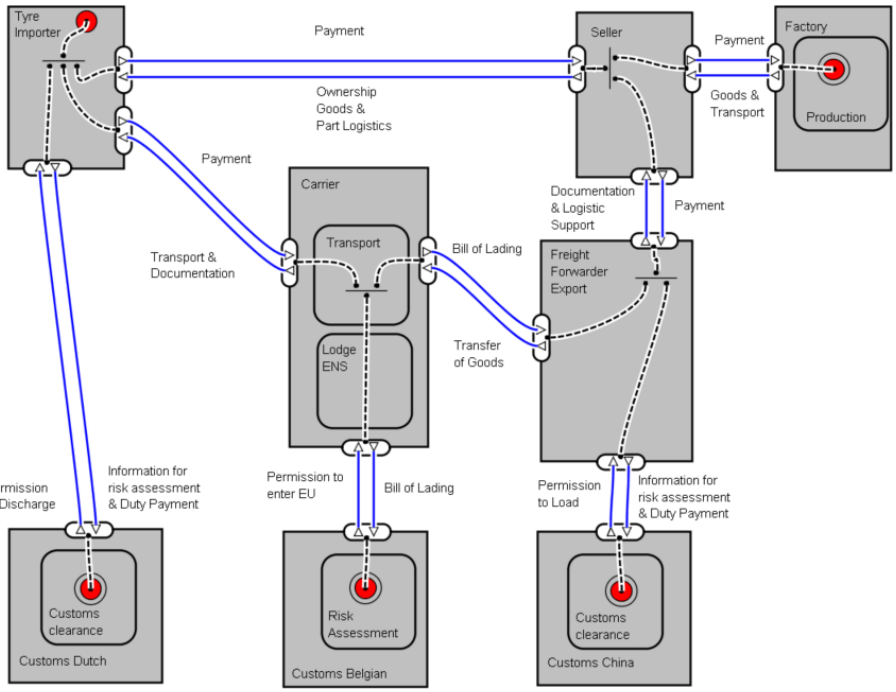


Figure 5.6: The e^3-control model of the TradeLens enhanced case.

The harmonised system classification (HS)[4] is a trade standardisation code. This code is developed to standardise the required tariffs for the different goods.

2. **Packing List e.g.[J2, CO5, CO6]**: The packing list provides an insight into the packing of the goods. Firstly, it provides the quantity of the goods and a description of the goods. Secondly, it often provides the weight of the shipment. Thirdly, it describes the amount of packages. In some cases it might also be accommodated with special handling instructions in the case of fragile or otherwise special care goods.

3. **Certificates Origin e.g.[J2, CO5, CO6]**: The certificate of origin provides the importing country with the reassurance of where the goods come from. Often they are given by a chamber of commerce. In most cases, when there is no international trade agreement between countries, an origin certificate is required.

4. **Shipper's Letter Instruction e.g.[CO6, TL1, CO8]**: The shipper's letter of instruction is a document that contains all the required information to move the goods. It provides the following information. Firstly, the identity of the buyer and seller. Secondly, the port of loading and the port of discharge and the specifics of the goods. Thirdly, a declaration regarding hazardous goods. Fourthly, the insurance and other relevant financial information. Fifthly, declaration of who is allowed to act on behalf of the buyer or seller.

5. **Bill-of-Lading e.g.[J1, J2, VB1, CO5, CO6]**: This documents is issued by the carrier and proves that the goods have been loaded onto the ship. It states the port of loading and the port of discharge. Secondly, it gives a short description of the loaded goods, such as a number of packages, which container, the weight and volume of the goods, and which seal the package has been sealed with. This document provides two functions: Firstly, it provides

[4]The HS code is a standardised code used for identifying goods for international trading. Most goods have their own HS code such as HS:4011.1000.00 = Passenger car tyres

evidence that the goods have been loaded. Secondly, it contains the used incoterm and thus the applied contractual obligations.

6. **Bank Draft/Letter of Credit e.g.[CO5, CO6]**: The Bank Draft and the Letter of Credit are both financial documents that handle the financial side of the goods transaction.

   The bank draft is drawn by the exporter and instructs the importer to pay a certain value at the time of the draft or a specified time in the future. When the draft is to be paid upon receiving it is called a sight draft. Whereas when a specified time in the future is determined, it is called a time draft. The banks act as an intermediary for handling the payment and processing documents.

   The letter of credit is a document that determines that payment will be received when the exporter presents the shipping document to the bank. E.g. the bill-of-lading from the carrier. This document provides assurance to the the exporter that payment will be received and to the importer that payment will only happen after the goods have been shipped. The bank acts as an intermediary in exchanging the payment for proof of shipping. A letter of credit is often the more expensive option of the two.

7. **Import/Export Declaration e.g.[J1, J2, VB1, CO5]** : The import/export declaration is a formal paper that gives details of the goods that are being imported or exported[GV9]. Depending on customs region of entry, the formal procedures can differ. Generally, the import declaration contains the main relevant information regarding the shipment for customs agencies. Such as price, certifications, type of goods, et cetera. Based on the import declaration, customs duties are calculated. In most cases the use of a freight forwarder or customs broker is used to perform the custom formalities.

8. **Case Specific Certificates [J1, J2, CO6]**: There are two distinctions of specific documents which might be required within the shipping process. Firstly, the certification documents. Secondly, the dangerous shipping documents.

   Certain consumer goods require certificates to prove the good is of a certain quality of origin. One such example is that of UTZ cacao. Here the product wants to claim that it is of sustainable origin. This certificate can be used as prove for this origin.

   Secondly, some goods carry inherent risks when moving and mitigation measures must be taken. The dangerous goods form or dangerous goods declaration gives the carrier sufficient information regarding the shipment to take those measures. Without this form, the goods are not allowed to be shipped.

5.5.2. TradeLens Enhanced Import

Within the Tyre Importer case, five documents are identified as performing a key function. These are the Commercial Invoice, the Packing List, the bill-of-lading, the Permission to Discharge and the Invitation to Pay. The first three have been covered in the last chapter. Thus the two remaining documents are the permission to discharge and the invitation to pay.

- Permission to Discharge: This document issued by Dutch customs is a formal declaration that the goods are allowed to be discharged from the port. This document is given after the risk assessment has been performed and the invitation to pay has been sent to the tyre importer. This document contains the addressee, the consignor, information regarding the shipment, information regarding customs office, different reference numbers, and information regarding the country of origin.

- Invitation to Pay: This document is a formal request towards the tyre importer to provide payment for the import duties. It contains information regarding the import declaration, the description of the goods and their value.

5.6. Control points

After identifying the actors, the activities, the value exchanges, and the key documentation/information, the next step is to identify the ability of certain actors to perform an activity. This is done through the following approach. The key activity describes a necessary action to perform. These activities will be listed. For every activity, the required resources will be described to perform the activity. These required resources explain what an actor needs to possess to perform a certain activity and thus explain how an actor can exercise control over the process. These can be either physical or informational. Physical resources are objects such as trucks, ships, funds, and goods. Informational resources are objects such as a business network, information regarding goods, licenses, et cetera.

- **Procurement**: The actor performing procurement requires two resources. First, it requires funds, as without funds the actor is not able to pay for the shipment and thus is not able to pay the bank draft or issue a letter of credit. The second resource is the actor who can supply the desired goods. The procurement process produces together with the sales process a commercial invoice and initialises the shipping process.
  The following control points are identified: Owns funds, ability to select supplier, has information on the goods.

- **Sales**: This activity requires an actor who agrees to a transaction, access to goods required for said transaction and information about the goods such as price. The sales activity produces a commercial invoice detailing a wide range of specifications on the transaction. This includes information such as the identity of the seller, the identity of the buyer, the selected carrier, the items, et cetera.
  The following control points are identified: Issues with the commercial invoice, issues packing list, owns the goods.

- **Production/acquiring**: To perform this activity the actor requires a factory or similar production facility or business contacts that have these facilities available. This activity produces information regarding the goods. This is information regarding the production costs, the packing of the goods, the goods specifications[5]. The production/acquisition process produces the goods required for shipping.
  The following control points are identified: Owns the goods, owns the production facility.

- **Land Transport**: To perform this activity the actor requires a location to load the shipment, a location to unload the shipment, and a means of transporting the shipment. This activity produces information regarding where and when the shipment has been loaded and where it shall be unloaded.
  The following control points are identified: Owns transport means, has the ability to select intermodal operator.

- **Sea Transport**: This activity requires a port of loading, a port of discharge, a means to move the shipment between the two ports, a booking for a shipment, and contacts with the different terminal operators.
  The following control points are identified: Owns the vessel, has terminal operator network.

[5] Goods specification can be a wide range of different conditions such as weight, quantity, material, size, brand, et cetera.

- **Loading/Unloading**: This activity requires the actor to have specialised infrastructure[6] to enable the ship to enter the port, a ship that request entrances, a shipment that needs to be loaded or unload, clearance from customs to load or discharge the goods, and the expected and actual time of arrival of the ship.
  The following control points are identified: Has specialised infrastructure, Has physical port.

- **Customs Clearing**: This activity requires a shipment that needs to go through customs, trustworthy information regarding that shipment such as the monetary value and specifications, a performed risk assessment, and the legislative power to clear goods. The activity produces custom clearance for loading/discharging the goods.
  The following control points are identified: Legal ability to issue customs clearance[7], ability to perform risk analysis.

- **Risk Assessment**: This activity requires a shipment that needs assessment, the trustworthy information on the shipment such as the bill-of-lading and the commercial invoice, the legislative power to perform the activity.
  The following control points are identified: Legal ability to perform a risk analysis.

- **Collecting Duties**: This activity requires information on the consignee or the buyer, the shipment, the tariffs for the shipment, the legislative power to collect duties, and a performed risk assessment and custom clearance. The activity produces an invitation to pay which is a formal request for duty payment.
  The following control points are identified: Legal ability to issues invitation to pay.

- **Issue Commercial Invoice**: The actor issuing the commercial invoice requires information on the goods, the order, the buyer, the seller, the agreed to shipping terms[8], and the agreed to payment method.
  The following control points are identified: Has specification of goods, Issues commercial invoice.

- **Issue Bill-of-Lading**: The actor issuing the Bill-of-Lading requires the packing list, a shipment, and clearance from customs to export the goods. This activity produces the bill-of-lading which acts as a formal document stating the transfer of the goods between different transport operators.
  The following control points are identified: Has the vessel.

- **Arrange Import/Export Logistics**: The actor performing this activity requires a shipment that needs to be transported, information regarding the shipment, and the ability to contract a range of different required subcontractors or be able to perform all different logistic activities itself.
  The following control points are identified: Has a sufficient network, has capabilities to gather and share logistic information.

- **Book Land Transport**: This activity requires a shipment, a packing list, a date for shipping, and contacts with an intermodal operator which can perform a leg of the shipment. It produces a booking confirmation.
  The following control points are identified: Has contacts with the intermodal operator.

[6] Specialised infrastructure is defined as the different machinery and services only a port can provide, such as pilots, towage, fuel bunkering, container cranes, terminals, et cetera.
[7] In this instance, the legal ability is defined as the legal framework which allows a certain actor to be the sole party to perform this activity. In the case of container shipping, this entails the legal framework of customs organisation.
[8] These are often described as incoterms, see table 5.1

- **Lodge Customs Declaration**: To perform this activity, the actor requires a trustworthy commercial invoice, the bill-of-lading/packing list, buyer/seller permission to lodge customs declaration.
  The following control points are identified: Has access to trusted data.

- **Acquire Insurance**: This activity requires information regarding the shipping contracts, the value of the goods.
  The following control points are identified: Has specifications of goods.

- **Lodge Entry Summary Declaration**: This activity requires a bill-of-lading of the shipment and the shipment to be in transit. It produces the Entry Summary Declaration, ENS report.
  The following control points are identified: Has ability to issue Bill-of-Lading.

- **Initialise payment**: This activity requires a letter of credit and a bill-of-lading. It produces the payment from the buyer to the seller.
  The following control points are identified: Has license to issue a letter of credit, ability to verify the buyer has funds.

5.6.1. Configuration of Control Points within the two cases

The control points identified are presented in table 5.2. In both cases, the buyer is able to control most of the process as the holder of the funds. Whereas the seller/factory has control over the goods and all relating information streams. The main differences are that of the lodging of the import declaration and the acting as a data intermediary. In the tyre importer case, it is observed that the freight forwarder in the importing side does not have the same control points as within the generic case. The buyer has its own infrastructure regarding intermodal transport and has the capability to lodge the import declaration. Figure 5.7 shows the differences between the two different control point cases. In figure 5.7 the yellow checked boxes show the differences between the two control points configurations. An yellow marked box with an X shows the difference between the two situations and thus indicates a shift of an control point.

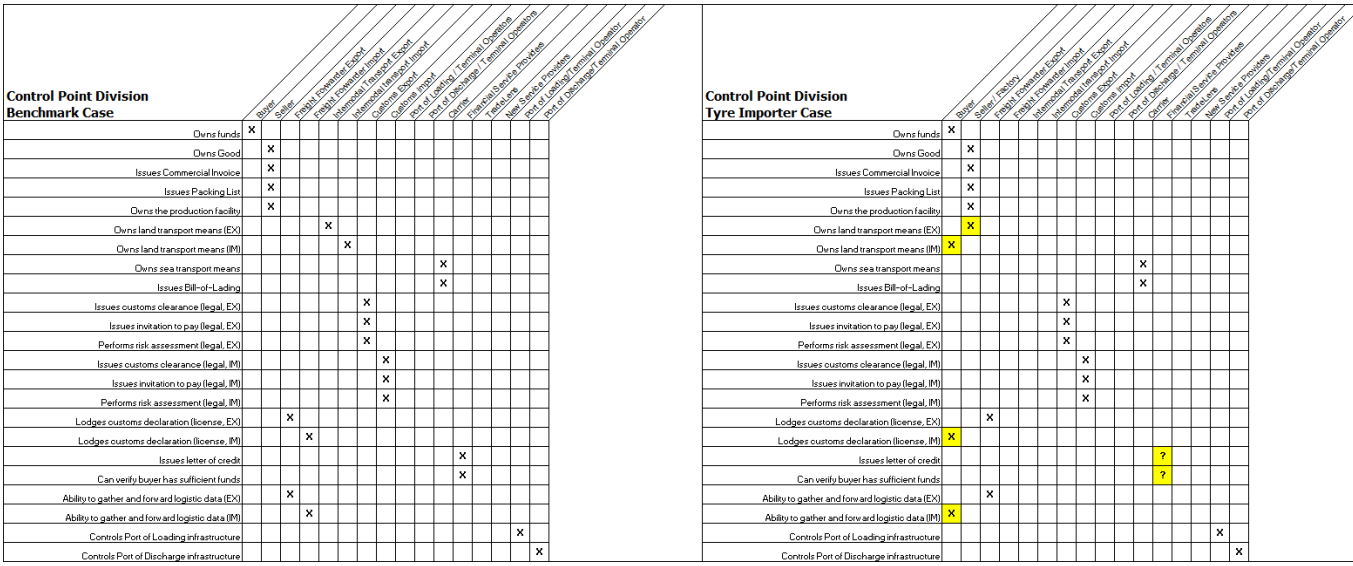


Figure 5.7: The configuration of control points between the benchmark case and the tyre importer case

Table 5.2: The configuration of the control points within the two cases

Control point	Benchmark case	Tyre Importer Case
Owns funds	Buyer	Tyre Importer
Owns Good	Seller	Factory in China
Issues Commercial Invoice	Seller	Seller
Issues Packing List	Seller	Factory in China
Owns the production facility	Seller	Factory in China
Owns land transport means	Intermodal Transport export, Intermodal transport Import	Factory in China, Tyre importer
Owns sea transport means	Carrier	Carrier
Issues Bill-of-Lading	Carrier	Carrier
Issues customs clearance (legal)	Import customs, export customs	Import customs, export customs
Issues invitation to pay (legal)	Import customs, export customs	Import customs
Performs risk assessment (legal)	Import customs, export customs	Import customs, export customs
Lodges customs declaration	Freight forwarder export, Freight forwarder import	Freight forwarder export, tyre importer
Issues letter of credit	Financial service provider	Not mentioned
Can verify buyer has sufficient funds	Financial service provider	Not mentioned
Acts as information intermediary	Freight forwarder export, Freight forwarder import	Freight forwarder export, buyer

5.7. Comparison between the Benchmark and the Tyre Importer cases

In this chapter the benchmark case and the tyre importer case will be discussed. First, the main observed differences between the two cases are discussed. These will be discussed along the lines of the developed assessment model. Afterwards, for these differences, the influences of TradeLens will be evaluated.

5.7.1. Main Differences

This chapter will describe the main differences between the two cases.

- **Key Activities**: The first main difference is within the land transport. The arranging of the land transport is not identified as a separate task within the TI case as both the factory as well as the TI have trucks available to perform this activity. Secondly, a number of activities are not mentioned within the case. However, for the following activities, it is presumed that they do occur. These are insurance arrangements and arranging the letter of credit/bank draft. Thirdly, lodging import declaration is not performed by the freight forwarder, but by the buyer.

- **Relevant Actors**: The financial service providers are not mentioned within the case, but are presumed to be performing similar functions as within the benchmark case. The main missing actor is the freight forwarder on the importing side. All functionalities it performs are done by the buyer in the case of the TI. Thirdly, the intermodal operators are missing on both sides. However, both the factory as well as the buyer have their own land transport capabilities. Fourthly, the container depot performs a function within the TI-case. For the benchmark case, the depot has been considered outside of the scope for the ecosystem.

- **Information Flow**: Within the benchmark case, the main information tasks are performed by the freight forwarders. Whereas in the TradeLens case, the buyer performs the information

flow tasks on the importing side. This is a critical distinction as it enables the buyer to arrange pick up of the goods at the terminal and to lodge customs declaration. In efficiently arranging the pick up the buyer requires the actual time of arrival and release by the port of the shipments. These events are currently lodged within the TradeLens platform. With regard to the lodging of customs declaration. The required information is the original commercial invoice. Using this information the buyer is able to lodge the actual value of the goods using both the monetary value and the aforementioned HS-codes.

5.7.2. Effects of TradeLens on the supply chain

As shown in chapter 3.4.1 TradeLens enables the sharing of data in a structured, auditable, and secure way. The following aspects have been identified as being influenced through the implementation of TradeLens.

- **Efficiency**: One of the main effects of the TradeLens platform is the near-instant availability of documents through the API-enabled blockchain platform. In the case of the tyre importer, it is observed that this availability of information in combination with the trusted data through the immutability of the platform, and the specific software package the tyre importer was able to significantly increase the efficiency of its import declaration process. Other similar processes such as lodging export customs and initialising the payment through the letter of credit are both processes that could experience an increasing inefficiency.

- **Reconfiguration control points**: A different effect of the TradeLens platform is the ability of actors to capture control points of other actors within their supply chain. The key process in this reconfiguration is the development of new capabilities. Firstly, the activity of arranging land transport could be done by the buyer/seller if the ETA and ATA is known. This information gives the buyer/seller the ability to just in time gather or drop off the container [NK]. This could increase the operational effectiveness of this piece of the supply chain. One such example would be to gather the container as soon as possible. This could enable the company to decrease the required warehouse stock. Lastly, a reconfiguration that was observed is the buyer having the capability to lodge the customs declaration. In this case the digital platform was used to extract the required data using the API structure. Since the data is immutable and auditable, the buyer will have significant confidence in the trustworthiness of the supplied data. The platform allows the buyer to have a more secure method of lodging customs data. In the case that fraud is detected, the buyer will have a paper trail to show who performed the fraud and when this fraud happened. Allowing them to pursue legal actions against this trader.

  In the TI-case it was observed that the buyer was able to perform these functions, however this does not imply that TradeLens caused this development. What can be derived is that the usage of the digital platform enhanced these activities and improved upon its efficiency.

5.7.3. Barriers and Stimulating factors

A part of determining whether an actor gains from this infrastructure opportunity is understanding the factors that hinder an actor in developing the capabilities and factors that stimulate the actor to develop these capabilities. Within the barriers and stimulating factors, the following factors have been identified:

- **Shipping volume**: The buyer is observed as an actor which is able to capture the control points of the freight forwarder. However, the likeliness is largely dependent on the number of containers the buyer requires to have shipped. If the volume is not sufficient to compensate

the economic investment for the required digital innovation, then it will be less likely for the buyer to invest [YT].

- **Container type**: FCL containers have the benefit that each FCL container only has one BoL. However, an LCL container carries multiple shipments. These shipments require additional steps within the process as the shipment has to be bundled within the container and unbundled [CO11, YT]. These steps take place at a separate warehouse. For the buyer to be able to exploit the digital platform functionalities, he has to have opportunities to improve the process efficiency. In contrast to the FCL-case the buyer is not able to directly collect the shipment at the docks, so it cannot use the information to collect the goods more effective. However, for the lodging of customs declaration, the buyer will remain able to perform this activity. To conclude, the container type imposes some limitations on the type of activities the buyer can perform.

- **Standardisation**: An important factor in developing software is the variation in the input. Developing software that only has to process a singular type of data will be lower in costs then complex applications which have to handle multiple different input files. Standardisation is important in decreasing this variation and making the software less expensive and more trustworthy. A lower degree of standardisation within documents such as commercial invoices, bills-of-lading, and packing lists is identified as an issue for digital platforms [YT, NK]. Standardisation will make a standard market solution viable. This standard market solution enables certain actors to develop the required capabilities to perform some of the information activities.

- **Network effects**: Network effects can either be a stimulating factor or a barrier. Firstly, a growing usage of the network will motivate more and different actors to start sharing and gathering data with the platform. A higher degree of actors make the investments into automating different information tasks more cost-effective. However, a lower degree of participation, might result in actors choosing a different solution if the perceived network benefits are stronger in other cases. A high degree of participation makes it worthwhile to invest into the new infrastructure [YT]. Secondly, network effects could be a major stimulating factor as more users might result in the development of value-added service through new service providers. These parties will only enter if a perceived market opportunity exists.

  A lack of alternatives could be a stimulating factor for the development of digital platform. For this type of platform it is likely that as the platform grows, it will less interesting to choose for an alternative [YT]. In this case there is a significant first mover advantage. If there is an alternative for the singular platform, it is expected that a federated landscape will be the future [YT] Here the platforms are compatible and share data. The data sharing will be to their own advantage [YT].

- **Past Investments**: The past investment barrier will hinder actors to join the network as they might be less willing to write off past investments in other infrastructure projects [NK]. These are on a case-by-case basis, but could hinder different organisations to approve a new infrastructure and thus block innovation for themselves. This might result in averse network effects. E.g. a governmental customs agency had recently invested into a new internal electronic infrastructure. Because of these investments, they were not willing to adopt the digital platform [NK].

- **Regulatory Framework**: This factor describes how regulations enable or block further development of the digital infrastructure. Limits imposed on data-sharing or specific informational

requirements might affect how new value-added services are developed within the digital infrastructure. Within this regulatory framework these could be the use of licenses to perform certain key activities. For example, to import plants and vegetables, the importer requires to be registered [GV7, GV8].

5.8. Future scenarios of the supply chain ecosystem

In this chapter, the different possible scenarios are presented. For every scenario the control point configuration, the shift in activities, and how TradeLens enables this shift will be discussed. Important to note is that for every scenario the same effects are assumed for both the exporting as well as the importing side. Additionally, it is not likely that only one scenario will become reality. Different supply chain solutions will work for different industry domains. It is likely that certain domains will keep using the services of certain actors, whereas other might try to adopt as many activities as possible. Currently, their are many different configuration for the supply chain, such as companies having their own importing capabilities, whereas other use third party logistic providers, or other different supply chain configurations. The different configurations presented in the following chapters are all scenarios that are possible to become reality.

5.8.1. Freight Forwarders increase efficiency through TradeLens [YT]

The first scenario is described as the status quo scenario. Within this scenario there is no control point shift. The stable conditions are the same as before the implementation of TradeLens. The freight forwarder keeps performing the traditional forwarding tasks as information orchestrator. Within this role, the freight forwarder provides customers with transport of the goods and lodges customs declaration. It is assumed that freight forwarders use the better data sharing approach to enable an increase in efficiency and cost effectiveness. These gains are partly transferred to its customers and are able to stay competitive within the market through lower prices.

5.8.2. Buyer and Seller develop more capabilities [YT, NK]

The second possible scenario is the disintermediation of the freight forwarders through the development of capabilties by the sellers and buyers within the supply chain, see figure 5.8. Here it is observed that the control points of ability to lodge custom declaration and the ability to gather and forward data are moved to the buyer and seller. The buyer will make a booking with a carrier, the intermodal transport company, arrange insurance and lodges its import declarations. Whereas the buyer performs the booking with the intermodal transport company on the exporting side, lodges the export declaration, and arranges the financial obligations.

TradeLens has enabled this shift through enabling the buyer and seller to directly gather the data from the platform and share it with relevant partners within the shipping process. Since data is gathered at the source and is auditable, it can be safely used for risk assessment by customs agency and does not require an information intermediary as long as the buyer uses the correct software application. This enables both the buyer and the seller to directly lodge the declaration without the need of a customs broker or freight forwarder. Secondly, the buyer and seller can use the data from the TradeLens platform to directly book with intermodal operators and carriers. As they have the necessary information to perform the tasks available, they do not require the data gathering capabilities of the freight forwarder. Hence, all relevant tasks of the freight forwarder are taken over by the buyer and seller.

5.8.3. Carrier performs bigger role [NK]

The third identified scenario is that of the carrier using their information position to vertically integrate different actors within the supply chain. Here the main control points of the freight forwarders and intermodal operators are moved to the carrier. see figure 5.9. It is similar to the

Control Point Division Scenario: Buyer develops capabilities	Buyer	Seller/ Producer	Freight Forwarder Export	Freight Forwarder Import	Intermodal Transport Export	Intermodal Transport Import	Customs Export	Customs Import	Port of Loading / Terminal Operator	Port of Discharge / Terminal Operator	Carrier	Financial Service Providers	TradeLens	New Service Providers	Port of Loading/Terminal Operator	Port of Discharge/Terminal Operator
Owns funds	X															
Owns Good		X														
Issues Commercial Invoice		X														
Issues Packing List		X														
Owns the production facility		X														
Owns land transport means (EX)					X											
Owns land transport means (IM)						X										
Owns sea transport means										X						
Issues Bill-of-Lading										X						
Issues customs clearance (legal, EX)							X									
Issues invitation to pay (legal, EX)							X									
Performs risk assessment (legal, EX)							X									
Issues customs clearance (legal, IM)								X								
Issues invitation to pay (legal, IM)								X								
Performs risk assessment (legal, IM)								X								
Lodges customs declaration (license, EX)		X														
Lodges customs declaration (license, IM)	X															
Issues letter of credit											X					
Can verify buyer has sufficient funds											X					
Ability to gather and forward logistic data (EX)		X														
Ability to gather and forward logistic data (IM)	X															
Controls Port of Loading infrastructure														X		
Controls Port of Discharge infrastructure															X	

Figure 5.8: The configuration of control points when the buyer develops more capabilities.

disintermediation of the freight forwarder, however the main difference is that the carriers expand their logistic operation to not only performing the traditional freight forwarding tasks, but also performing intermodal transport to a certain extent. The carrier is able to take these control points due to their physical control points. As the carrier owns the vessel, they attain high confidence in remaining within the supply chain ecosystem, whereas the role of the freight forwarder becomes more threatened due to the loss of their exclusive information position. This gives the carrier an opportunity to perform more services towards the buyer and seller by including lodging customs and arranging intermodal transport. Additionally the carrier currently holds exclusive right to manage the TradeLens platform. This position could be used to enable further vertical integration of supply chain services. However, on multiple occasions the carriers has stated that they work on a governance model using all the different ecosystem actors [TL1].

5.8.4. Expansion of services Freight Forwarder [YT]

The last ecosystem reconfiguration to be discussed is that of the expansion of services by the freight forwarder, see figure 5.10. In this case the freight forwarder tries to gain a physical control point through expansion of services. Through operating as a third-party-logistics provider, the freight forwarder starts to manage the warehouse and stock of the buyer/seller. Within this role the freight forwarder can keep performing their core business as a logistic orchestrator without the high threat of disintermediation through other actors. Additionally, as customs require more and more

Control Point Division Scenario: Carriers incorporate more activities	Buyer	Seller / Producer	Freight Forwarder Export	Freight Forwarder Import	Intermodal Transport Export	Intermodal Transport Import	Customs Export	Customs Import	Port of Loading / Terminal Operators	Port of Discharge / Terminal Operators	Carrier	Financial Service Providers	TradeLens	New Service Providers	Port of Loading Terminal Operator	Port of Discharge Terminal Operator
Owns funds	X															
Owns Good		X														
Issues Commercial Invoice		X														
Issues Packing List		X														
Owns the production facility		X														
Owns land transport means (EX)										X						
Owns land transport means (IM)										X						
Owns sea transport means										X						
Issues Bill-of-Lading										X						
Issues customs clearance (legal, EX)							X									
Issues invitation to pay (legal, EX)							X									
Performs risk assessment (legal, EX)							X									
Issues customs clearance (legal, IM)								X								
Issues invitation to pay (legal, IM)								X								
Performs risk assessment (legal, IM)								X								
Lodges customs declaration (license, EX)										X						
Lodges customs declaration (license, IM)										X						
Issues letter of credit											X					
Can verify buyer has sufficient funds											X					
Ability to gather and forward logistic data (EX)										X						
Ability to gather and forward logistic data (IM)										X						
Controls Port of Loading infrastructure															X	
Controls Port of Discharge infrastructure																X

Figure 5.9: The configuration of control points when the carrier develops more capabilities.

capacity to perform the risk analysis. The freight forwarder/customs broker might become licensed to perform the risk analysis for customs agency. This will relieve customs agency of the pressure of growing trade volumes, while at the same time protecting the role of the freight forwarder as key actor within the process.

Control Point Division Scenario: Freight Forwarder expands capabilities	Buyer	Seller / Producer	Freight Forwarder Export	Freight Forwarder Import	Intermodal Transport Export	Intermodal transport Import	Customs Export	Customs import	Port of Loading / Terminal Operators	Port of Discharge / Terminal Operators	Carrier	Financial Service Providers	Traded Lens	New Service Providers	Port of Loading/Terminal Operator	Port of Discharge/Terminal Operator
Owns / Manage funds			X													
Owns / Manage Good		X														
Issues Commercial Invoice		X														
Issues Packing List		X														
Owns the production facility	X															
Owns land transport means (EX)				X												
Owns land transport means (IM)					X											
Owns sea transport means										X						
Issues Bill-of-Lading										X						
Issues customs clearance (legal, EX)						X										
Issues invitation to pay (legal, EX)						X										
Performs risk assessment (legal, EX)			X			X										
Issues customs clearance (legal, IM)							X									
Issues invitation to pay (legal, IM)							X									
Performs risk assessment (legal, IM)		X					X									
Lodges customs declaration (license, EX)			X													
Lodges customs declaration (license, IM)		X														
Issues letter of credit											X					
Can verify buyer has sufficient funds											X					
Ability to gather and forward logistic data (EX)			X													
Ability to gather and forward logistic data (IM)		X												X		
Controls Port of Loading infrastructure															X	
Controls Port of Discharge infrastructure																X

Figure 5.10: The configuration of control points when the Freight Forwarder develops more capabilities.

6

Discussion

This chapter will discuss the findings, the employed method and the contributions. This is achieved by splitting this chapter in five parts. First, the main findings will be discussed in chapter 6.1. Afterwards, in chapters 6.2 and 6.3 the managerial and scientific contributions will be discussed. Following this, in chapter 6.4 the used approach will be discussed. Lastly, in chapter 6.5 a number of suggestions for future research will be made.

6.1. Findings of the research

This research aims to answer the research question posed in chapter 1: *What are possible supply chain configurations that come with a digital information infrastructure?*. Six sub-questions are asked to answer the different aspects of this main research question. For every sub-question the findings, the chosen method and the limitations of the research will be discussed.

6.1.1. Sub-question 1: History of digital platforms and TradeLens

The first sub-question asked was: *What is the history behind the administrative burden within supply chain shipping and TradeLens?* To answer this the research started with investigating the history behind the TradeLens infrastructure and the wider container shipping developments. This was done through a desk study which mainly focussed on using historical perspective for the main developments and research into digital infrastructure for the main concepts behind digital infrastructure. This showed that the digital infrastructure developed slowly over time as it went from purely a paper-based information infrastructure, to a siloed infrastructure, where every actor had its own digital non-interconnected infrastructure, to the current modular and API enabled structure. Secondly, this development initially did not solve many of the administrative burdens the supply chain actors experienced. Due to the lack of standardisation of key documents, electronic data sharing still required a significant amount of manual labour. These findings were expected, as many news articles within trade magazines and governmental research projects describe these burdens and the potential of services such as TradeLens. The history can thus be summarised of the platform and wider digitisation can be summarised as a constant effort to increase efficiency to handle ever-growing container volume and security demands.

6.1.2. Sub-question 2: Description of the ecosystem

The second sub-question asked was: *How can the ecosystem of the container supply chain be described and which ecosystem concepts are important to consider?* The literature review on

ecosystem theory showed that the supply chain can be considered a service ecosystem. The main value creation is intangible, as the ecosystem itself does not produce a good. Here the main aspects to describe the ecosystem were that the value creation is performed to co-production of multiple service offerings and the exchange of these services. Important in analysing a service ecosystem is the use of value networks. This value network is later employed using the e3-control modelling approach in chapter 5.4. Here the different value exchanges are shown.

6.1.3. Sub-question 3: Defining the model

The third sub-question stated was: *How can control, actors, diffusion and other relevant barriers and stimulating factors be described within the ecosystem?* The research proposes a meta-framework consisting of five key concepts to be of importance. These were concepts identified from ecosystem theory, stakeholder theory, diffusion theory, barriers and stimulating factors and control points. The ecosystem theory describes how different actors are interdependent and influence each other within the container shipping ecosystem. It identified criteria for an actor within the ecosystem to be of relevance. One such aspect evaluated the different actors through assessing whether the service was generic in nature or complementary to services of other actors.

Stakeholder theory describes how to evaluate the motivations, incentives, and possible issues for different stakeholders. The main findings were that stakeholder theory can be used to set the unit of analysis. Within the research, this was the organisation. Secondly, it was used to identify the barriers and stimulating factors through evaluating how different actors might react to the developments and thus improve or decline their position within the ecosystem. However, a significant amount of overlap exists between the ecosystem theory and the stakeholder theory. Both use the concept of actor or stakeholder and both argue from the point of incentives and relations to other actors. Of these two concepts, the ecosystem theory was most useful in defining the important aspects within the model.

Diffusion theory describes how a typical innovation acts develop over time. As an innovation aims at achieving mass-market, it goes through a number of phases. Such as development, adaption, and mass-market stabilisation. The TradeLens case was found to currently be in the adaption phase. Here a market-ready version is being adapted by different actors within the market as it grows further. This theoretical concept was used to add a time dimension to the case. Secondly, the theory was used to assist in developing the different scenarios as it shows the different ways the innovation might progress from the current point of development.

Control point theory describes how different actors can exercise control on specific progress. It was found that that this concept can explain how the network can be reconfigured. First through assessing the control point configuration of both the benchmark as well as the tyre importer case, a network configuration of control points can be developed. Through moving control points between actors different scenarios can be developed. One finding was that control points are generated through having access to a set of resources. These resources can both be physical (e.g. trucks, ships, terminals) but also informational (e.g.ability to issue certain documentation, license to perform activities, governmental mandate).

Barriers and stimulating factors describe different factors which can inhibit or accelerate a certain process. This concept was found to be useful to describe why certain scenarios are more or less likely to occur and to develop managerial advice on how to negate or handle certain scenarios. Within this research, barriers have been identified but did not perform a significant role in the development of the scenarios. These were mostly identified using control point theory and the interviews.

These concepts have shown to have sufficient overlap to develop a model for analysis. There exists a large overlap between the ecosystem theory and the stakeholder/actor theory.

6.1.4. Sub-question 4: Developing the benchmark model

The next research sub-question was: *What is the configuration of a generic container supply chain ecosystem?* This research used a cross-analysis of academic articles, interviews, and public sources to develop a generic model of container shipping. The main finding was the current role of the freight forwarder within the ecosystem. The freight forwarder performs the role of network orchestrator and plays for many firms a key function in enabling shipments to pass physically as well as legally from the seller to the buyer. It arranges transport of both sea and land and it performs customs lodging to enable the goods to enter or leave legally. However, that role is also largely dependent on the information position the freight forwarder currently has. The freight forwarder gathers data from the seller, carrier, port/terminal operator, customs and intermodal transport and arranges the information to be formatted and send to the correct parties.

6.1.5. Sub-question 5: Assessing the two cases

Following this, the sub research question was: *Which elements are transformed through the introduction of the TradeLens platform?* The research performed a case analysis of a Dutch tyre importer and used the same approach to structuring the information as with the generic case. When evaluating the configuration of the network, the research found that a number of actors were missing or not described within the case. Most notably, the freight forwarder was not present on the exporting side of the supply chain. It was observed that the main activities performed by the freight forwarder, were performed by the tyre importer itself. When investigating the role of TradeLens on this difference, the main findings were that TradeLens enabled a more effective way of sharing data with the Dutch customs through automated data sharing through APIs. Secondly, it was found that there was no need for intermodal operators as the company had its own trucking division. The company already performed the freight forwarder activities before the implementation of the platform, however, they became less expensive to perform due to automation. The main finding when comparing the benchmark case with the tyre importer case was that the capabilities required to perform the role of the orchestrator of information have become more available to the tyre importer. This case analysis showed that the main reconfiguration is to be expected around the activities the freight forwarder performs. To conclude the elements affected through the TradeLens platform are that of data sharing, the activities of the freight forwarder, and redistribution of control points.

6.1.6. Sub-question 6: Developing the possible scenario's

The last research sub-question was: *Which future scenarios can be derived for the TradeLens platform?* To finalise the research and answer the main question, the research performed an analysis of barriers and stimulating factors and developed a set of scenarios using control point redistribution. It found a set of five different scenarios likely. Every scenario governed the redistribution of the freight forwarder control points. One exception, it was also found that freight forwarder could expand their service through acting as a third-party logistics provider and retain their core business. Secondly, the carrier could provide a bigger logistic role through performing activities similar to freight forwarders.

6.1.7. Main research question

To conclude, the main research question restated was: *What are possible supply chain configurations that come with a digital information infrastructure?* The answer to this research question is a set of multiple different configurations where different actors perform the core information orchestration function. These can be either the current actors or different actors who vertically integrate these new activities. These findings show that large scale reconfiguration is not likely, due to the existence of many physical control points. These control points are less likely to shift. This was initially a surprising finding. Initially, it was expected that a system that still relied on a significant amount of paper-based communication, would be deeply impacted through digital innovation infrastructure. However, from the developed scenarios, it is more likely that the freight forwarder will develop their services, as fewer assumptions and developments are required for this scenario to become possible. One should note that these scenarios are not likely to be comprehensive. As stated within the research, the scenarios will probably be a combination of the different scenarios. Currently, multiple different configurations of the container supply chain can already be observed. It is likely that innovation will not make one such scenario dominant. Additionally, the developed scenarios are given from either the analysis or through interviews with the different experts. Potentially, this method could leave some scenarios unexplored. However, as both of the experts are closely researching the developments within the container supply chain, it is expected that these scenarios are most likely.

6.1.8. Validation and generalisation of the research

The findings presented in the previous chapter must be valid and generalisable to a degree to be of any scientific, societal and managerial contribution. Firstly, the validity and secondly, the generalisability of the research will be discussed

To validate the research, two points need to be addressed. First, is the developed benchmark a valid representation of real container shipping cases? Secondly, are the found scenarios plausible developments for the container supply chain.
To validate the former a model representation showing the main actors and activities were discussed during both interviews with supply chain experts. During these interviews, the question was asked whether the models were missing key activities and actors. After these interviews missing actors and activities were added.
To validate the latter the scenarios were developed and discussed with the experts. During the interviews, the experts were asked how the activities of a certain actor could develop. These were cross-referenced with the developed scenarios. Two limitations of this validation approach is the number of interviews and the source of the interviewees. Two experts were consulted to validate the findings. As this number is on the low side, this will impact the validity of the validation method negatively. Both interviewees were supplied through the supervisors. This creates sampling issues, as the interviewees are not picked at random from a sample of ICT experts. This second point also impacts the validity of this approach negatively.

6.2. Managerial Recommendations

The managerial recommendations are structured using the following approach. First, two general recommendations on how to use the findings will be presented. Afterwards, organisation specific recommendations will be discussed during the second part.

6.2.1. General recommendations

The managerial contribution is twofold. Firstly, **as a tool for practitioners to increase their understanding of a business ecosystem.**

The provided framework offers practitioners a deeper understanding of the exact workings of a business ecosystem. It supports decision making regarding future innovation for both businesses as well as policymakers. It helps to develop a long-lasting complementary relationship with other businesses. It explains how different competitors, suppliers, customers and other actors develop and aim a business network.

Secondly, **as a tool for practitioners in extracting domain-specific control points.** From the business perspective, practitioners can use the insight gathered from control point extraction to assist in decision making regarding future strategy. The control points will describe why a business can enact control on a certain business process. These insights can be valuable in understanding the value position of the company. Secondly, understanding the configuration of control points of other actors within the ecosystem allows the practitioner to evaluate business opportunities for control point capturing and innovation. From the policy-maker view, control point extraction help to uncover where legislation could help or hinder further innovation within a specific domain. Licenses and legal frameworks provide an important provider for control points.

6.2.2. Organisation specific recommendations

The research developed a set of general findings which are usable for management in many different settings. As the research also investigated specific actors, it is possible to develop organisation specific recommendations. For the investigated actors the research recommends the following:

1. **Freight Forwarders**: This research found that the current position of freight forwarders within the value chain is threatened to a certain extent. As different actors are enabled to develop the capabilities that are traditionally held by the freight forwarder. The advised strategy for the freight forwarder would be the following:

    - *Leverage digital infrastructure to enable automation*: As the digital infrastructure will allow more efficient information processes it can be used to lower the operating costs of the service. As the costs lower, the price for the service can be decreased as well. This reduction will make it less likely for a client to start developing their own capabilities.

      However, the practitioner should be aware of the challenges that accompany digital infrastructure as described in chapter 3.3. There are four areas of challenges within the implementation phase of digital infrastructure. Firstly, collaboration on data sharing is required within the wider supply chain. This requires a willingness from all the actors to share their data with the other actors who require them. This does imply a loss of control over information to a certain extent. Also, the organisation of the practitioner should have the required knowledge to develop the systems. Without the knowledge, the platform might not be used to its full potential and even hinder the growth of the organisation. A lack of flexibility or organisational agility could also hinder the implementation of the platform. Company processes must be adaptable for full exploitation of the platform. Lastly, the organisation requires an ability and willingness to integrate both internal and external processes. To solve this challenge, the practitioner should focus on integrating their own structure with the wider digital platform structure.
    - *Expand value offering*: Digital infrastructure might change the main business model of the freight forwarder if left unchallenged. An important strategy in coping with this challenge is diversification of the value offering. There are two main methods of developing the value offer. First, develop a risk analysis system in co-operation with customs. The main objective here is to attain the risk assessment control point of customs and

enable the freight forwarder to become a customs service provider. Secondly, the freight forwarder could expand the value offering into warehouse management of the buyer or seller. Through offering more services to the client, will reduce the required effort on the client-side and enable the freight forwarder to stay the information orchestrator.

2. **Buyer/Seller**: Companies that often require international container shipments are enabled to develop capabilities for information organisation. This research showed the important role of information management within the supply chain to enable the container to progress. Traditionally the information management task was given to the freight forwarder as the gathering of information was limited due to many different actors and incompatible methods of documentation. However, digital infrastructure enables this information flow to become better structured and allow the client to perform the information tasks. The following recommendations are made for the buyer/seller.

    - *Automate customs declaration*: Using the data pipeline concept, where information is captured at the source. Develop software applications that use the digital platform to directly lodge the information gained from the commercial invoice and the packing list to customs. This allows for automated customs lodging.
    - *Lobby/Allow standardisation*: An important identified barrier in the applications of TradeLens is the extent to which documentation is standardised. As standardisation increases, it becomes less effortful to develop value-added services for the platform. Through lobbying and allowing standardisation of documentation to take place, it will allow developing more cost-effective services or new value-added services such as direct booking of container slots.

3. **Carriers**: The carrier has a unique position as being the centre of the supply chain. The carrier has the opportunity to expand its share within the chain and vertically integrate some of its partners. The following strategy is recommended for the carrier to perform.

    - *Integrate intermodal transport and lodging customs declarations*: The carrier can use the information position to increase the effectiveness of the overall supply chain. As the platform enables licensed users to more efficiently lodge customs declarations, it will be a significant opportunity for the carrier to integrate these control points of the freight forwarder. Additionally, the carrier could start with developing land, rail and inland shipping contracts or capabilities to become the central solution for clients in the container shipping transport.

4. **Customs**: Customs are faced with an increasingly global trade and increasingly higher security and import/export duty demands. Important in solving these issues is the ability to leverage data more effectively. The following two strategies will enable customs to handle these higher trade flows, while still balancing the security and financial risks. The following strategy is developed for customs to leverage the digital infrastructure or platform.

    - *Standardise trade documentation*: Currently, a high amount of variation within trade documentation reduces the cost-effectiveness of developing software solutions to automate important data collection processes. Customs have the position to place regulatory requirements on documentation. However, this should be performed within an international standard, otherwise, different nations will adopt different standards. By co-operating with the platform, an international standard for trade documentation can be developed.

- *Automate risk assessment and data collection*: Currently, a license is required to lodge customs data. This limits the number of partners who lodge the import data. The key in automation is standardising the processes at the data collection side. It is advised to develop certified software packages, which use APIs to directly collect the source documentation from the platform. These packages allow for an automated solution for data collection without requiring a license for the user. Additionally, the collected data can be integrated with risk assessment software to automate a large part of the process.

6.3. Scientific Contributions

This research has contributed to two scientific areas. Firstly, **A method to assess a supply chain ecosystem configuration within the information infrastructure domain.**

This research provided a method for analysing the effects of the framework and develop predictions for future scenarios. To achieve this, the research combined a set of five different theoretical concepts. These are business ecosystem theory, stakeholder theory, diffusion theory, control point theory, and barriers and stimulating factors.

The first theory used is that of the business ecosystem. This theory describes how different actors within a specific business landscape will interact and influence each other. In this research, that of the container supply chain ecosystem is used. This theory assisted in identifying relevant actors to take into consideration.

The second theory is that of stakeholder theory. This describes when someone can be considered a stakeholder. The theory was mainly used in identifying the different factors that could generate a barrier or stimulating factor for a specific organisation and helped in identifying the different motivations behind certain business decisions are.

The third used theory within the research is that of diffusion of innovation. This theory describes how innovation act within the time domain. As innovation mature, different effects can be observed, such as network effects or the removal of barriers. This theory was used to develop a time-axis within the research, where the ecosystem can be evaluated on different time stamps and the insights were used to develop the different possible scenarios and what has to change to make these scenarios more likely to occur.

A fourth theory is that of control points. This concept describes why certain actors have control over a process. A requirement for a stable process is that all the control points are allotted to the different actors. Control point theory is used to describe and visualise the reconfiguration of the ecosystem.

Lastly, Barriers and stimulating factors are the main concept which describes different socio-technical factors that can inhibit or support development to progress further. This research used barriers and stimulating factors to identify the different factors that will enable or block different scenarios.

Secondly, this research has shown **a systematic approach to acquiring stable control points decoupled from the actors.**

The major component of the main approach within the research was aimed at decoupling the control points from specific actors. When an actor has control over a control point, he can exercise influence on a specific process. Within the research of Rukanova et al. [41], it was shown that control points perform an important role in the reconfiguration process. To understand how the ecosystem can be reconfigured, this research developed a systematic approach to identify these control points. as within the mentioned research, it was discussed as being a challenge.

To decouple the actors from the control points, the approach first identified the key activities from each actor. These key activities such as issuing the bill of lading require specific resources to be performed. These resources were given through identified value exchanges. For example, to issue the bill of lading, the carrier requires the goods, clearance from customs, the vessel and the

packing list. As two of these resources are not provided by the actor who performs the activity, but through a value exchange from the other actors. It can be argued that it requires the remaining resource of owning the vessel is a stable control point within this activity. An example is provided in figure 6.1. This resulted in a systematic approach to identify these control points.

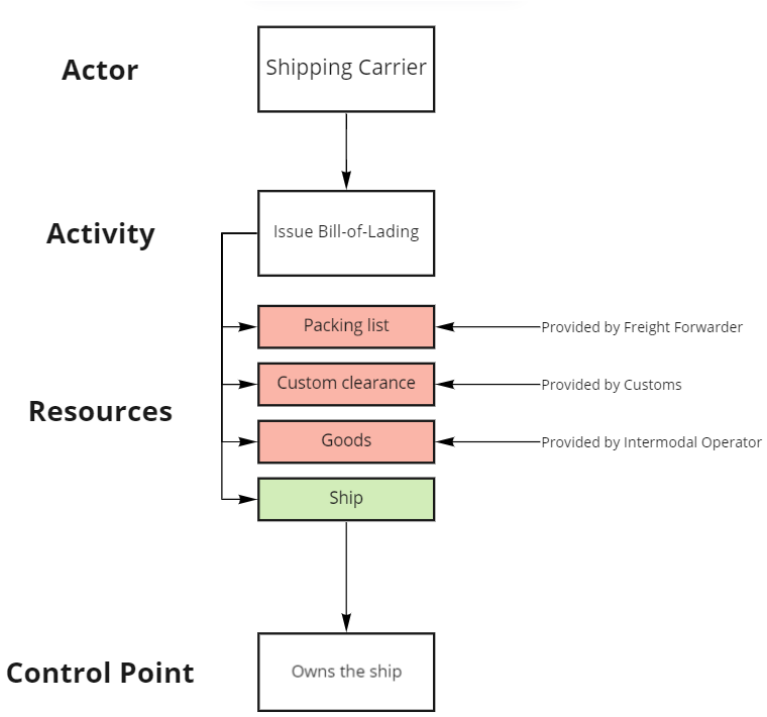


Figure 6.1: A schematic overview of how control points have been extracted for the carrier within the container shipping ecosystem.

6.4. Research Approach

This research had a number of issues that could lower the validity of the claims made. These are the selection of concepts, the development of the model and the development of the generic model.

First, the selection of the concepts was mainly done through the use of combined insights of researchers on two distinct domains and a selective literature review. The limitation of such an approach is that many different concepts, which might have been more suited in identifying the development have not been considered. The research does not offer a method to mend this issue. However, the usage of the different concepts is explained to large extent and the application is accounted for. As described in chapter 6.3, a systematic approach to identifying control points was lacking. Thus this research has developed an approach that did not yet exist. The exclusion of possible better concepts is thus not seen as an issue for the usability of the model.

The second issue is that of the development of the model. As can be seen in the final model is that a number of concepts are derived from the developed meta-framework. One could argue that the selection of the different parts is arbitrary in nature. However, the different concepts were selected based on two distinct aspects. First, the overlap between the concepts. As one aspect of the model will be used to aid the investigation in the other aspect, it is important that a specific amount of overlap is available. Secondly, recurring elements in literature. The research started with an actor-based view on the supply chain. This was mainly chosen due to the meta-framework developed during the initial phase of the research. During the research as more insights were derived, it was seen that the activities were a more stable factor and generate more insights into the supply chain. This resulted in the actor-based view gradually move towards an activity

based-view. Here the different aspects were defined as: "Who performs the activity?", "What is required to do the activity?". This approach is better suited to identifying stable control points within the supply chain.

The third issue is the development of the benchmark model. The research used a cross-referencing approach to generate the model. The main limitations of this approach are that the design decisions of the researcher could carry significant bias, as the researcher is inclined to show the results he wants to find. A better approach was to not develop a benchmark model but gather insights from real-life case studies. However, within the time span of the research, this was not feasible. To solve the issue of bias, the researcher provided a clear list of design decisions and assumptions at the beginning of the development of the model. Secondly, the researcher gathered a significant amount of sources and cross-referenced many for a clear and concise image.

6.5. Recommendations for future research

Apply method to different supply chain cases.
The method has only been applied to two cases. For the method to be more generally applicable, more different supply chain cases should be tested with the model for better comparisons. Secondly, other domains, which have important information flows, can be used to test the model. When considering the different cases it is advised to perform the same activity for cases such as bulk shipping (e.g. Oil, minerals) regulation heavy shipping (e.g. livestock, food, certified products).

Include a wider ecosystem scope.
Ecosystem theory is built upon the assumption that a range of different actors all works together for a certain ecosystem goal. This research used the foundation of this premise but did put some actors outside of the scope. To further the claims of this research, it would be advised to research the role of suppliers, different government branches (excluding customs), and the different societal organisations with regards to the supply chain. Their effect is currently unknown within this research.

Apply the method to the Amazon case.
During the research, the Amazon logistic solution has been observed. Amazon is a seller-based logistic system, where the seller holds nearly all of the control points within the supply chain. This is in contrast to the researched case, where most of the control points were distributed evenly between actors. Application of this method to the Amazon logistic case might show different control points which were not observed or remove some of the control points considered within this research.

Develop the role of resources within the control point theory
The last step in identifying the control points was performed using value exchanges and resources. The value exchange provides both actors with the desired resource. These resources are required to perform other activities. However, the exact usage and definition of resources themselves have not been sufficiently discussed. This research recommendation would be to further these definitions. What is a control point resource? When is a control point resource locked? When is a control point resource unlocked? Which resources give the owner a control point? These questions will enable further control point theory.

Remove barriers and stimulating factors from the research
This research mainly uses two interviews to identify the main barriers and stimulating factors. However, due to the small sample, these factors might not be correct or important factors are lacking. Furthermore, the role of these factors was limited in developing the scenarios. Suggested future research is to perform this research within a different or similar domain without using the barriers and stimulating factors.

Develop model without using stakeholder theory
Identified within this research was the overlap between ecosystem theory and stakeholder theory. Both have similar concepts, whereas the ecosystem theory investigates the wider network, stakeholder theory investigates the individual in context to the developments. In this research, the role of stakeholder theory was limited due to the focus on the ecosystem. Suggested future research could be into developing the model exclusively using the concepts from diffusion, ecosystem and control point theory.

7

Conclusion

This research investigated possible scenarios for the TradeLens platform to affect the supply chain ecosystem. Four possible scenarios have been identified as likely for the supply chain ecosystem due to the digital information infrastructure TradeLens. Firstly, a scenario where the ecosystem remains similar, but freight forwarders leverage the the digital platform to develop their services. Here the control on the supply chain stays similar but overall becomes more efficient. Secondly, one where value-added services are developed for buyers and seller of goods to leverage the digital platform and disintermediate the freight forwarder. Here the buyer/seller develops in-house capabilities using the API-enabled structure of digital to perform the customs declaration. Thirdly, a scenario where the carrier vertically integrates the activities of other actors within its own organisation. Using its unique position as a key player within the supply chain, the carrier could become a one-stop-shop solution to the buyer and seller, by offering additional services such as arranging intermodal transport and customs declarations. The fourth scenario is an expansion of the role of the freight forwarder. To emphasise the added value of the forwarder, it could develop warehouse capabilities and/or support customs through risk assessment. In the former, the forwarder starts to manage the warehouse of the buyer/seller next to its original tasks. In the latter, the forwarder develops capabilities of performing risk assessment for customs agencies and thus become an essential intermediate in lowering customs costs.

Key in findings these scenarios were the five meta-framework concepts. These are stakeholder theory, ecosystem theory, diffusion theory, control points, and the barriers and stimulating factors. Stakeholder theory governs the actors of a system and describes the incentives, stake and position of the actor. Ecosystem theory describes how different actors within a business domain interdependently influence each other and co-operate to a certain ecosystem goal. Diffusion theory explains how innovation diffuses over time and describes the different phases an innovation progresses through. Control points theory explain why a certain actor can exercise control on a certain process additionally it generates insight into the possible configuration of the network after destabilisation of the network due to innovation. Lastly, barriers and stimulating factors govern the factors that enable or block a certain development to progress further. These five concepts were used to develop an ecosystem assessment method. The main findings of this method were that the freight forwarder performs a vital orchestrating role within the current supply chain ecosystem. It acts as a data intermediary between the client, in most cases the buyer or the seller, and the other actors such as the carrier, terminal operator and customs. In a case of a Dutch Tyre Importer, it is observed that the freight forwarder can be disintermediated and that TradeLens did aid in greatly reducing the costs for such a disintermediating solution. However, currently, a license is still required to perform one of the key activities of the freight forwarder which is custom brokerage.

For TradeLens to enable disintermediation, value-added services have to be developed which allow data sharing from the source through the TradeLens platform towards the customs agencies.

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A

Consulted Data Sources

Table A.1: The complete list of sources used throughout the research. 1 out of 3.

Source Code	Source Type	Description / Title	Reference
CO01	Commercial website	Cargosmart, alternative to TradeLens	https://www.cargosmart.com/en-us/
CO02	Commercial website	What is Entry Summary Declaration	https://www.xeneta.com/blog/what-is-ens-and-why-is-there-an-ens-charge
CO03	Commercial website	What is Freight on Board (FOB)	https://corporatefinanceinstitute.com/resources/knowledge/other/freight-on-board-fob/
CO04	Commercial website	Terminal Handling Charges	https://www.incotermsexplained.com/terminal-handling-charges-2/
CO05	Commercial website	Shipping software supplier: Essential documentation for shipping	https://www.easyship.com/blog/common-international-shipping-documents
CO06	Commercial website	Online freight broker	https://www.freightos.com/
CO07	Commercial website	Online Freight Forwarder	https://www.icontainers.com/
CO08	Commercial website	Shipping software supplier: Essential documentation for shipping	https://www.shippingsolutions.com/blog/documents-required-for-international-shipping
CO09	Commercial webste	Container buy/lease platform: The shipping process	https://container-xchange.com/blog/container-logistics-tour/
CO10	Commercial Website	Freight Forwarder: Shipping Process	https://www.asianausa.com/ocean-shipping-process-overview/
CO11	Commercial Website	Advantages and Disadvantages of LCL shipping	https://www.duprelogistics.com/the-advantages-and-disadvantages-of-lcl/
CO12	Commercial Website	Example of a shippers letter of instruction by Flexport	https://assets.ctfassets.net/92fo1e671z6m/4pa1r5ir5opr07cElT8neC/a9ea58b577277c700db66ec92d7322f6/SLI_v.12192019.pdf

Table A.2: The complete list of sources used throughout the research. 2 out of 3.

Source Code	Source Type	Description / Title	Reference
FF1	Academic paper	The Role of Exporter and Freight Forwarder in the United Kingdom	Davies [5]
FF2	Academic paper	Comparative Perspectives of International Freight Forwarder Services in China	Lu and Dinwoodie [27]
FF3	Academic paper	Profiling International Freight Forwaders: an Update	Murphy and Daley [33]
GV01	Government Website	Government Website: 12.00.00 Plaatsing van goederen onder een douaneregeling	https://www.belastingdienst.nl/bibliotheek/handboeken/html/boeken/HDU/plaatsing_van_goederen_onder_een-controle.html
GV02	Government Website	European Commission on customs declarations	https://ec.europa.eu/taxation_customs/business/customs-procedures/general-overview/customs-declaration_en
GV03	Government Website	European Commission on the role of customs	https://ec.europa.eu/taxation_customs/business/customs-controls/general_en/
GV04	Government Website	International Maritime Organisation	https://www.imo.org
GV05	Government Website	Quick Info: Entry of Goods and Temporary Storage	https://ec.europa.eu/taxation_customs/sites/default/files/02_taxud_ucc_entry_of_goods_and_temporary_storage_quick_info_en.pdf
GV06	Government Website	Customs security: european Commission	https://ec.europa.eu/taxation_customs/general-information-customs/customs-security/security_en
GV07	Government Website	Guidelines regarding importing products from a non-EU country to the Netherlands	https://business.gov.nl/running-your-business/international-business/import/importing-products-from-a-non-eu-country/
GV08	Government Website	Dutch regulations regarding importation of plants	https://www.belastingdienst.nl/wps/wcm/connect/bldcontenten/belastingdienst/customs/safety_health_economy_and_environment/health/plants_flowers_fruit_and_vegetables/
GV09	Government Website	EC customs declaration guidelines	https://ec.europa.eu/taxation_customs/business/customs-procedures/general-overview/customs-declaration_en
GV10	Government Website	Chamber of Commerce: Incoterms 2020, everything tto know	https://www.kvk.nl/advies-en-informatie/internationaal-ondernemen/incoterms-2020-alles-wat-je-moet-weten/

Table A.3: The complete list of sources used throughout the research. 3 out of 3

Source Code	Source Type	Description / Title	Reference
J1	Academic paper	Academic paper describing the avocado trade	Jensen et al. [22]
J2	Academic paper	Academic paper describing the rose trade from Kenya	Jensen and Vatrapu [24]
J3	Academic paper	PHD paper on trade	Jensen [21]
J4	Academic paper	Academic paper describing how TradeLens creates value	Jensen et al. [23]
NB1	News or Blogs	Shipping logistic blog and website	https://www.morethanshipping.com/
NB2	News or Blogs	Marine news blogs	https://www.marineinsight.com/
NB3	News or Blogs	Ocean Freight: Step by step explanation	https://www.ecomcrew.com/all-about-freight/
NB4	News or Blogs	The most common used incoterms	https://blog.globartis.com/here-are-the-5-most-commonly-used-incoterms/
NK	Interview Expert	Interview with TradeLens expert from IBM	
TL1	Commercial website: TradeLens	TradeLens main website	https://blog.globartis.com/here-are-the-5-most-commonly-used-incoterms/
TL2	Commercial presentation TradeLens	Company presentation on the TradeLens platform	
VB1	Teaching Case	TU Delft teaching case describing the used case	Rukanova and Tan [45]
VB2	Academic paper	Academic paper on the used case	Rukanova et al. [46]
YT	Interview Researcher	Interview with TU Delft Digital Trade Infrastructure researcher	

B

Interview Protocol

The interview protocol for the TradeLens case study participants
Project: TU Master Thesis Management of Technology: "The Ecosystem of TradeLens, A research into evolving roles, functions and relationships after introduction of digital information infrastructure"

Date: *Date of interview*
Time: *Time of interview*
Location: Zoom video conference
Interviewee: *Name of interviewee*
Interviewer: B.J. (Jan) Hoek

The interview is expected to take around 1 hour to 1.5 hours of time.

1. Introduction *This part of the interview will take around 10 minutes*
The following questions will be asked:

- How long have you been involved with the TradeLens platform?
- What was your role within this development?
- What is your current role towards the platform?
- How long have you been involved with the researched cases? *Provide cases*
- What other relevant experience do you have regarding digital information infrastructure

2. Existing actors and activities analysis
This part of the interview will take approximately 20 minutes.
The interviewee will be presented with the schematic in figure B.1. The interviewee will be asked to answer the following questions regarding the schematic.

- Are these all actors with significant influence within the supply chain? Do you see any missing actors? *(Objective: Identify all relevant ecosystem actors)*
- Which actor is considered to be the most vital within the shipping process? Why? *(Objective: Find the key player within the ecosystem.)*

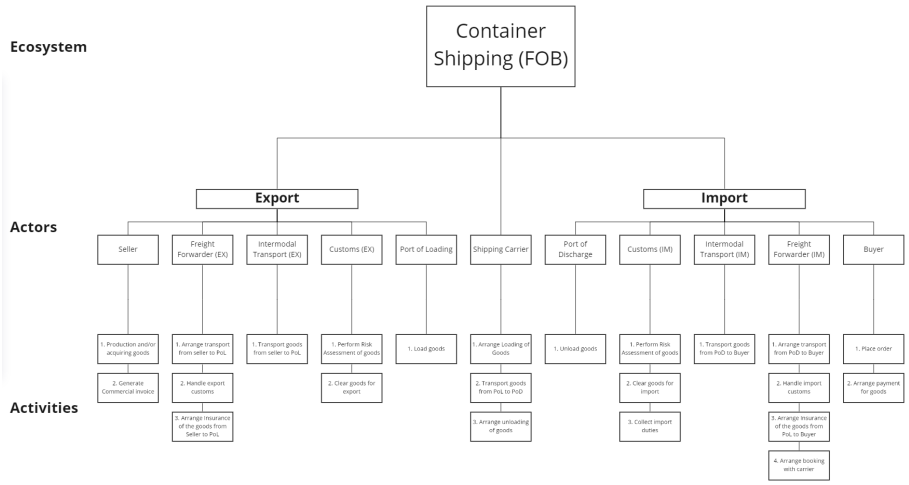

Figure B.1: A tree diagram of the ecosystem, actors and main activities.

- *(After showing the activities per actor)* Are these the core activities of this actor? Would you add or change any activities? *(Objective: Generate a comprehensive list of key activities)*

3. Transformation of ecosystem analysis

This part of the interview will take approximately 40 minutes.

The earlier discussed key activities and actors will be presented to the interviewee. The interviewee will be asked to show how key activities of the different actors transfer to other actors. For every transfer the following information will be asked.

- What is the key activity that is transferred? *(Objective: Identify activity transfer)*
- Does the essence of the key activity develop when done by the different actor? *(Objective: Identify change of the activity)*
- How did TradeLens enabled the different actor to do this key activity? *(Objective: Identify factors of activities that enabled transfer)*

The second part of the transformation is identifying important factors in transformation. The interviewee will be asked which factors block or stimulate activity transfers. This is done through the following procedure:

- *(After showing an unchanged key activity)* Why is this key activity unaffected? *(Objective: Identify blocking factors*
- Could a different actor integrate this key activity, and why (not)? *(Objective: Identify more blocking factors*
- Would it be desirable for a different actor to integrate this activity? *Objective: Identify stimulating factors*

4. Future development of ecosystem

This part of the interview will take approximately 20 minutes

The interviewee will be asked to give its view on further development. Here the following questions will be asked:

- Which further transformation do you expect to happen? *(Objective: Identify important developments*

- Which conditions are required for this development to take place? *(Objective: Identify blocking factors)*
- Why is it likely that this development will take place? *(Objective: Identify stimulating factors?)*

5. Closure

The interviewee will be thanked and the interview will be completed.