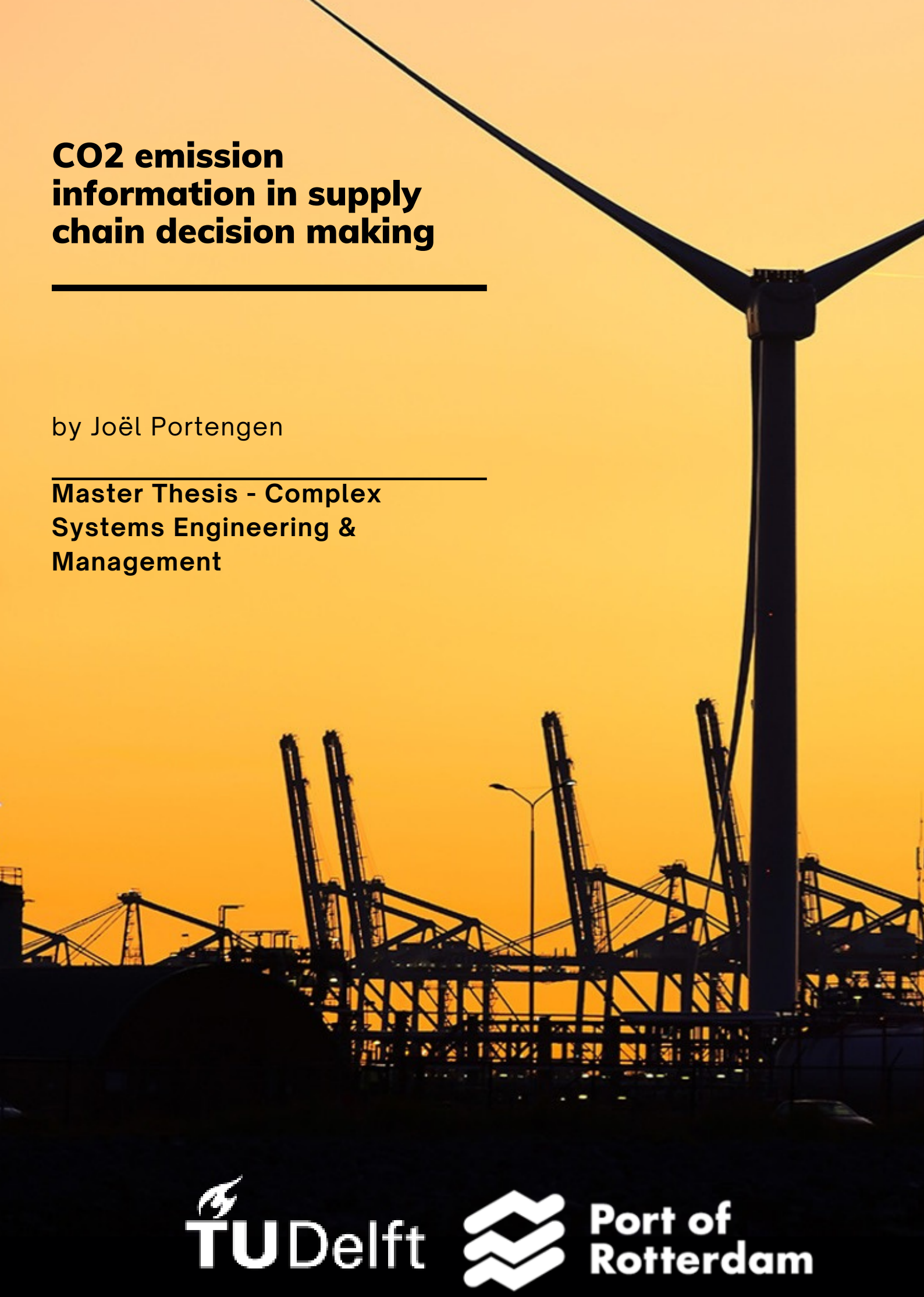
CO2 emission information in supply chain decision making

by Joël Portengen

Master Thesis - Complex Systems Engineering & Management



CO_2 EMISSION INFORMATION IN SUPPLY CHAIN DECISION MAKING

An exploratory study of the opportunities for CO_2 emission information in decision making processes of port hinterland activities of cargo owners

A thesis submitted to the Delft University of Technology in partial fulfillment of the requirements for the degree of

Master of Science in Complex Systems Engineering and Management

by

Joel Portengen

4581008

To be defended in public on November 29 2023

Graduation committee

Chairperson	Prof.dr.ir. Lorant Tavasszy	Transport & logistics
First Supervisor	Dr. Ron van Duin	Transport & Logistics
Second Supervisor	Prof.dr. Yao-Hua Tan	ICT
Advisory Supervisor	Dr. Boriana Rukanova	ICT
First External Supervisor	Daniel Bollard	Port of Rotterdam

The work in this thesis was made in the:

Faculty of Technology, Policy, and Management
Delft University of Technology

As a graduate intern at:

Port and supply chain performance
Port of Rotterdam

Supervisors:	Prof.dr.ir. Lorant Tavasszy	Faculty of Technology, Policy, and Management
	Dr. Boriana Rukanova	Faculty of Technology, Policy, and Management
	Dr. Ron van Duin	Faculty of Technology, Policy, and Management
	Prof.dr. Yao-Hua Tan	Faculty of Technology, Policy, and Management
	Daniel Bollard	Port of Rotterdam

PREFACE

Met trots presenteer ik u het afsluitende werk van mijn studie in Delft. Inmiddels 9 maanden verder, inclusief een aantal vakanties en een operatie ben ik blij hier te kunnen schrijven dat het af is. Ik sluit met dit onderzoek een periode af die ik nooit had willen missen. Zoveel dingen geleerd, nieuwe vrienden gemaakt en bovenal lol gehad dat ik het bijna jammer ga vinden dat het klaar is. Zonder de begeleiding van in het bijzonder Daniel Bollard van het havenbedrijf Rotterdam, was het ook (nog lang) niet klaar geweest. Zoals het eerste belletje om de eventuele stage te bespreken binnen een halfuur klaar was, vlogen alle meetings voorbij. Veel gelachen en productief als het moest, heb je me steeds weer een stapje in de goede richting geholpen, zonder jou en 'ons' team Port & Supply Chain Performance was het niet gelukt.

Daarnaast wil ik graag Ron van Duin bedanken dat je vanaf minuut 1 betrokken bent geweest bij mijn thesis. Het opzetten van een onderzoek en vinden van onderwerpen en methodes was met jouw ervaring in veilige handen. Ook Lori Tavasszy wil ik in het bijzonder bedanken voor het vertrouwen in bepaalde keuzes die ik maakte en het meedenken in de richting die ik op wilde. Boriana, I very much liked to have you on my graduation committee even though you tried to convince me you weren't eligible as supervisor. Your positive attitude and creative thinking helped me through a few impasses during the thesis, and confirmed why I wanted you on board in the first place.

Ook zou ik graag alle mensen die ik heb geinterviewd willen bedanken voor jullie bijdrage aan mijn onderzoek. De inkijk in jullie wereld heeft mij veel geleerd en heeft er zeker voor gezorgd dat hier nu een mooi onderzoek ligt.

Voordat u doorleest in dit document, kan ik het niet laten om ook mijn vriendin, familie en vrienden uit Westland, HvGL en loodjes te benoemen. Jullie aandacht voor iets wat niet per se gehoord moest worden maar wel lekker was om te vertellen, kan niet onbenoemd blijven. Ook waren jullie aanwezig bij alle onvergetelijke momenten van de afgelopen jaren en als het aan mij ligt, houden we dat erin.

Dan nu de introductie van mijn onderzoek naar de waarde van CO_2 emissie in logistieke besluitvorming, vanuit het perspectief van een havenbedrijf beschrijft. Waar theorie samenkomt met de praktijk en CO_2 informatie in een wetenschappelijk jasje inspanning vraagt van de lading-eigenaar. Hiermee sluit ik mijn dankwoord af en laat ik u beginnen met lezen.

Joël Portengen
Delft, November 2023

SAMENVATTING

De wereldwijde transportsector stootte ongeveer 23% van alle CO_2-emissies uit, en dit zal verdubbelen tegen 2050 als er geen mitigatiemaatregelen worden genomen. Scope 3-emissies worden beschouwd als de moeilijkst te meten en aan te pakken, maar omvatten meer dan de helft van alle emissies. Een relatief klein en transparant deel van het goederenvervoer is de haven-achterlandomgeving van het containervervoer. Een eigenaar van lading die wordt geïmporteerd of geëxporteerd, is verantwoordelijk voor zijn goederenstroom en heeft beslissingsbevoegdheid over de (gedelegeerde) logistieke activiteiten in hun haven-achterlandomgeving, echter omdat vervoer niet tot de kerntaken van die ladingeigenaren behoort, wordt dat gezien als hun scope 3 emissies. Om mitigatie van emissies in het containervervoer te initiëren, wordt in deze scriptie onderzocht wat ladingeigenaren momenteel denken van hun Scope 3 emissies en wat zij beschouwen als kansen om deze te verminderen in hun supply chains.

Theoretische kennis van CO_2-emissie als besluitvormingscriterium in besluitvormingsprocessen is ruimschoots beschikbaar in de literatuur. Echter, dit is minder gebruikelijk in de praktijk. Scope 3-emissie rapportageverplichtingen, die in januari 2024 beginnen, krijgen momenteel alle aandacht in de scheepvaartsector. Emissie-informatiediensten worden ontwikkeld om aan de wetgeving te voldoen, maar er ontbreekt perspectief over hoe verder te gaan met het actief verminderen van emissies ten opzichte van puur rapporteren. Er wordt een discrepantie gevonden tussen de literatuur waar emissies al zijn opgenomen als besluitvormingscriterium in besluitvorming en de praktijk waar het verzamelen en rapporteren van emissie-informatie alle aandacht krijgt. Deze scriptie beoogt een deel van die discrepantie op te vullen door de volgende belangrijkste onderzoeksvraag te beantwoorden:
Hoe kan informatie over CO_2-emissies in een havenomgeving bijdragen aan het verduurzamen van logistieke processen van lading eigenaren?

Vier belangrijke theorieën vormen een conceptueel raamwerk in deze thesis. De eerste is supply chain performance en deze wordt gebruikt als uitgangspunt van dit onderzoek, waarbij de prestaties van een supply chain worden gemeten aan de hand van bedrijfsspecifieke besluitvormingscriteria. Vervolgens worden theorieën over besluitvorming en informatiesystemen geraadpleegd om het raamwerk aan te vullen met theorie over de decarbonisatie van logistiek. De theorieën worden gecombineerd tot een gevisualiseerd conceptueel kader dat de rest van het onderzoek ondersteunt.

Een meervoudige casestudie is geschikt om een 'hoe' of 'waarom' onderzoeksvraag te onderzoeken. De selectie van de cases is gebaseerd op het doel van het onderzoek en beïnvloedt de interpretatie van de resultaten. Het verkennen van de mogelijkheden van de twijfelachtige KPI in besluitvormingsprocessen vereist een diverse casusselectiebenadering. In de casusselectie wordt er gevarieerd op product- en marktsegment, om het effect van emissie-informatie op verschillende besluitvormingsprocessen te omvatten.

Semi-gestructureerde interviews worden gehouden met logistieke besluitvormers van vier bedrijven, waarbij hun input het theoretische conceptuele kader valideerde en uitbreidde. Uiteindelijk worden interviews gehouden met experts in CO_2 tools, om verbeteringen te ontdekken voor emissie-informatiediensten. Alle interviews, zowel in de casestudy als in de expertronde, worden samengevat, gevalideerd door

de geïnterviewde en achteraf gecodeerd om onderwerpen van interesse te categoriseren.

1) Gebrek aan beschikbaarheid van gegevens, 2) datakwaliteit, 3) verantwoordelijkheid en 4) intrinsieke motivatie zorgen ervoor dat een motor producent, een materiaal gereedschap distributeur, en kledingbedrijf terughoudend zijn om informatie over CO2-emissies op te halen. Als er al voorspelde emissiereducties zijn gekoppeld aan alternatieve logistieke activiteiten, worden deze alleen gezien als een mooie bijkomstigheid van efficiëntieverhogingen. Alle bedrijven erkennen dat wettelijke druk hun prioriteit voor Scope 3-emissies kan verhogen. Consumenten en aandeelhouders worden ook geïdentificeerd als potentieel invloedrijk voor logistieke besluitvormers, maar alleen door de drankbrouwer (Zowel consument als aandeelhouders), kledingbedrijf (alleen consumenten) en automobielbedrijf (alleen aandeelhouders). Vergelijkingsfuncties over meerdere jaren, afspraken over verantwoordelijkheid en minder gedetailleerde emissiedoelen in de vroege fasen zijn veel voorkomende reacties van de experts die de kwaliteit en perceptie van informatie over kooldioxide-emissies kunnen verbeteren. Havenautoriteiten kunnen een faciliterende adviserende rol hebben voor hun klanten door informatie en wettelijke uitleg te verstrekken, technologische impasses te doorbreken door initiatieven te stimuleren en te lobbyen voor 'effectieve' wetgeving.

Technologische ontwikkeling van (duurzame) logistieke activiteiten kan en moet het aantal duurzame opties voor logistieke besluitvormers vergroten. Drukfactoren zoals wetgeving, consumenten- en aandeelhoudersvoorkeuren zijn nodig om inspanningen van lading-eigenaren te genereren om CO2-emissies daadwerkelijk te prioriteren in hun besluitvormingsafwegingen en dus daadwerkelijk duurzame opties te selecteren. Datakwaliteit kan worden verbeterd wanneer er meer gegevensbronnen beschikbaar komen als gevolg van verantwoordelijkheidsovereenkomsten tussen lading-eigenaren en transportbedrijven. Emissie-informatietools zijn waardevol bij het samenvoegen van meerdere gegevensbronnen, naar op maat gemaakte inzichten in logistieke Scope 3-emissies. Ze moeten minimaal bevatten: 1) functies voor vergelijking van vervoerswijzen, 2) erkende emissiefactors zoals Kg CO2/tonkm en 3) frequente updates van de emissie-prestatie. Havenautoriteiten kunnen helpen door te lobbyen voor aanvullende effectieve wetgeving, advies te geven aan bedrijven die hun haven gebruiken over hoe ze aan de wetgeving kunnen voldoen en samenwerking tussen deze bedrijven te faciliteren.

EXECUTIVE SUMMARY

The global transport sector emitted approximately 23% of all carbon dioxide emissions and this will be doubled by 2050 if no mitigation is applied. Scope 3 emissions are perceived as most difficult to measure and tackle , yet they comprise of more than half of all emissions. A relatively small, but transparent part of freight transport is the port-hinterland environment of container transport. An owner of cargo that is imported or exported is responsible for the freight flow and has decision making power over the (delegated) logistical activities in their port-hinterland environment. To initiate mitigation in emissions of container freight transport, it is explored in this research what cargo owners currently think of their scope 3 carbon emissions, and what they perceive as opportunities for mitigating them in their supply chains.

Where theoretical foundations of carbon emission key performance indicators in (multi-objective) decision making processes are widely available in the available literature, this is less common in practice. Scope 3 emission reporting obligations, which start in January 2024 , are currently receiving all attention in the shipping sector. Emission information services are developed to comply with the legislation, but lack of perspective on how to proceed to mitigation of emissions instead of purely reporting. A discrepancy is found between the literature where emissions are already included as key performance indicator in decision making and practice where gathering and reporting emission information receive all attention. This thesis aims to fulfill a part of that discrepancy by answering the following main research question:
How can carbon emission information in a port environment contribute to making logistics processes of cargo owners more sustainable?

Supply chain performance theory is used as a starting point of this research, where the performance of a supply chain is measured by customized key performance indicators. Decision making and information systems theory are then consulted to design a conceptual framework for supply chain decision making. Decarbonization of logistics are the last concept from the available literature and introduce carbon emission key performance indicators to supply chain decision making. The theories are combined into a conceptual framework that structures the rest of the thesis.

A multiple case study is appropriate to research a how or why research question. Selection of the cases in the multiple case study is based on the purpose of the research and affects the interpretation the results. Exploring the opportunities of a questionable KPI in decision making processes, requires a multiple case study with a diverse case selection approach. Product and market segment are differentiated on in the case selection, which comprehends the effect of emission information on various decision making processes in port-hinterland supply chains. Semi-structured interviews are conducted with logistical decision makers of four companies and their input validated and extended the theoretically constructed conceptual framework. Expert interviews are then ultimately conducted to discover improvements for emission information services and a broad stakeholder perspective including port authorities. All interviews, in either the case study or the expert round, are summarized, validated by the interviewee and coded afterwards to categorize subjects of interest. Representational power of the quotations is dependent on the quotes per category.

1) Lack of data availability, 2) data quality, 3) responsibility and 4) intrinsic motivation are causing an automotive company, appliance distributor and clothing company to be reluctant to retrieve carbon emission information. If there are any projected emission reductions paired with alternative selection of logistical activities such as mode choices, they are only perceived as nice side catch of efficiency increases by the same 3 cases. All cases acknowledge that legislative pressure can increase their priority for scope 3 emissions. Consumers and shareholders are also identified as potentially impactful for logistical decision makers but only by the beverage brewer (both), clothing company (only consumers) and automotive company (only shareholders). Comparison functions over multiple years, agreements on responsibility and less-detailed emission goals in early phases are unanimous responses from the experts that can improve the quality and perception on carbon emission information tools. 2 experts stated that port authorities can have a facilitating advisory role for their clients in providing information and legislative explanations, break technological impasses by stimulating initiatives and lobby for 'effective' legislation.

Technological development can and should increase the number of sustainable options for logistical decision makers. Pressure factors such as legislation, consumer and shareholder preferences are required to generate effort from cargo owners to start prioritizing carbon emissions in their decision making considerations to actually select the sustainable options. Data quality can be improved, when more data sources become available as a result of responsibility agreements between cargo owners and transportation companies. Emission information tools are valuable in bringing together multiple data sources, towards customized scope 3 emission insights. They minimally have to contain: Mode comparison functions, renowned emission standards and frequent updates. Port authorities can assist by lobbying for additional effective legislation, advise port using companies how to comply with the legislation and facilitate collaboration among these companies.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACRONYMS

CBAM Carbon border adjustment mechanism
CKPI CO_2 emission Key Performance Indicator
CSRD Corporate Sustainability Reporting Directive
ETS Emission Trading System
DM Decision Making
HESP Harbour Emission Service Platform
KPI Key Performance Indicator
SCDM Supply Chain Decision Making
SCP Supply Chain Participant

1 INTRODUCTION

1.1 MOTIVATION FOR CO_2 EMISSION INFORMATION

Global container transport faces its biggest challenge ever in becoming carbon neutral. The transport sector emitted 23% of global emissions in 2015 and without intervention this percentage will double by 2050 considering the rising volumes of shipped freight [SFC, 2019]. The shipping sector comprises of a lot of polluting processes of which the emissions are perceived as adverse effects. A distinction should be made between these processes in order to tackle them effectively. The Kyoto agreement of United Nations [1997] distinguished three types of emissions with a category for production, energy consumption and transportation as respectively scope 1,2 and 3 emissions. Scope 3 emissions are composed of 15 sub-categories [Royo, 2020; SFC, 2019] and are difficult to comprehend, yet compose of more than half of all CO_2 emissions. Upcoming European legislation focuses on (larger) companies to obligate them to report scope 3 emissions as a first step towards reducing these emissions [European Comission, 2023]. This among other factors, awakens interest at companies with logistical activities to start thinking about emissions in their decision making process.

All logistical activities of a company that are used for moving a product from origin to destination produce scope 3 emissions. A supply chain is based on the production of a product in a region that is not the same as the market it is sold in. The owner and thus seller of the product organises a series of activities that allows their products to move from production to their warehouses in the area in which there is demand for the products. This ranges from the first miles per truck, to the terminal handling, long haul maritime transport and ultimately the transport of a container from the port of call to the final destination. A cargo owner has a responsibility over all activities in the supply chain, since they acquire every activity to begin with. However, being responsible for an activity does not necessarily mean that one has decisive power, or even has knowledge of what happens in the chain. If a section of a supply chain is selected for further analysis based on decisive power and information, it is assumed that the logistical activities between the port of call and the inland warehouse of the region of destination are best suited. Other logistical activities in for example the ocean transport, terminal handling or first-mile transport in countries of origin are expected to be less transparent for cargo owners. Port-hinterland environments are within the scope of this research, the other parts of supply chains are not.

CO_2 emission calculation tools (Appendix B) have been developed in order to fulfill the requirements of cargo owners to comply with the new regulation and to provide insights in their port-hinterland emissions. Historical data and emission standards are required to determine the emissions. Since scope 3 emissions are not restricted by company boundaries, it is often beneficial to retrieve data from other supply chain participants (SCP's), also for planning and efficiency gains [Li et al., 2005; Lotfi et al., 2013]. However, information sharing remains a hurdle in the shipping industry. There is a lot of literature available about supply chains that aim to cope with the communication barriers and information sharing between companies in supply chains [Alazzawi, 2021; Ye and Wang, 2013; Manuj and Sahin, 2011; Maylor

and Turner, 2017]. Bilateral communication via emails or calls remains the standard and the bill of lading [Koller, 1935] is still often a physical document that is handed over to the upstream supply chain actor [Wunderlich and Saive, 2020]. There is a lot of territory to gain by logistical service providers in terms of information use and efficiency improvements. A port authority can adopt a role in this stakeholder network to facilitate an information sharing service to overcome some initial barriers. The port of Rotterdam aims to stimulate companies to gain emission insights by providing a dashboard or API that allowed parties to share their data with the port in exchange for insights, without compromising their position [Havenbedrijf Rotterdam, 2022; Routescanner, 2023]. Clients of the port are satisfied in their need for emission insights, which allows for an increase in sustainability which is in line with the mission of the port [Port of Rotterdam, 2023].

Reporting was the initial purpose of these tools, with a subsequent goal of prioritizing options based on the CO_2 emission insights. Scientific relations between CO_2 emissions and decision making are proved in the available literature, while empirical evidence of logistical options to be prioritized based on emissions remain absent. An example where logistical scope 3 emissions are absent is with battery passports [German Federal Ministry for Economic Affairs and Climate Action, 2023]. The heavy regulated battery production and import has pioneered with visibility infrastructures [Rukanova et al., 2018], but is lacking of the difficult scope 3 emissions of logistics in between manufacturing facilities all over the world. The increase in attention of the industry and a lack of perspective on the use of scope 3 emission information in supply chain decision making (SCDM), introduces objective of this research. Improvement of CO_2 emission information is a sub-objective, since better information will stimulate its use and thus sustainable supply chains.

1.2 PROBLEM STATEMENT AND RELEVANCE

There is an urgent need to stop global warming and CO_2 emissions among others should be phased out rapidly. Supply chains consist of a number of sequential movement processes that all account for a share of the total scope 3 emissions. The existence of CO_2 emissions is now starting to take form in the shipping sector by means of CO_2 emission information tools that use mathematical frameworks to determine the emissions per activity or in total. Gaining insight in CO_2 emissions of port hinterland activities is not as relevant for society, as actually using the information to reduce the scope 3 emissions of logistics and thus products. Exploring factors that might affect the logistical decision makers is valuable for speeding up the reduction of emissions.

1.2.1 Societal and scientific relevance

Tackling emissions by the root, would increase the chance of success. Decision makers of cargo owners, controll their supply chain actitivities or at least the other parties who controll the actitivies. Invoking on them to become more sustainable by assessing the role of CO_2 emissions in their decision making process, contributes to the societal desire to become more sustainable. From a scientific point of view, there is a substantial amount of literature that includes emissions as decision making criteria. However, the recent trend of reporting legislation from the EU [European Comission, 2023] uncovers a lack of practical applications and knowledge. Empirically validating a theoretically based conceptual framework will add to the available knowledge and invite further research applications when opportunities of CKPI's are explored. Looking at emissions in decision making within a bigger con-

text also contributes to the number of modelling studies with a limited and scoped down environment.

1.3 RESEARCH OBJECTIVE AND MAIN RESEARCH QUESTION

The objective of this research is to evaluate whether CO_2 information has the potential to influence cargo owners to make their supply chains in a port environment more sustainable. The research question that corresponds with this objective is:

How can CO_2 emission information in a port environment contribute to making logistics processes of cargo owners more sustainable?

1.4 COSEM SUITABILITY

Decision making in complex systems has been a major focus in the master program of Complex Systems Engineering and Management (CoSEM). Port-hinterland supply chains can be seen as a highly complex system due to its high interconnection between a lot of stakeholders with different sizes, owners, assets and partner organisations. The analysis of supply chain efficiency and the application of a framework that shows the influence of CO_2 information on that efficiency requires a systems engineer with knowledge of SCDM which is taught at the CoSEM progam. The comprehensive view of implementing a CO_2 measurement tool into an existing network of terminals, carriers, shippers, operators, municipality and port authorities can be the added value of a CoSEM graduated engineer. Combining the institutional part of policy with the data driven technical part of the tool within the complex stakeholder network makes this thesis suitable for a CoSEM graduate.

1.5 OUTLINE OF THE THESIS

After having introduced the subject of the thesis, along with the problem situation and main research question, there is a need for a method to produce results that are able to answer the research question. Chapter 2 will provide this method and substantiate methodological decisions. The scientific foundation is presented in Chapter 3 which substantiates a conceptual framework. This framework will shape the multiple case studies of which the results will be presented in Chapter 4 & Chapter 5. The status and opportunities of CO_2 emission information in supply chains are explored in the case studies. These results are then used as input for the semi-structured interviews with experts on emission information tools to find results to improve the tools, which is presented in Chapter 6. Chapter 7 will then interpret the results and discuss its outcome, limitations are also included in this chapter. The thesis will be ended with a concluding chapter in Chapter 8 which will answer the main research question. This chapter will also provide societal and scientific contributions of this research and do some recommendations for further research.

2 RESEARCH APPROACH

This chapter will contain a method that allows the research question from Section 1.3 to be answered. The exploratory character of the applications of CO_2 information requires initial literature study to build a theory-based conceptual framework (Section 2.1), a multiple case study (Section 2.2) and an expert interview round to understand the opportunities for CO_2 information tools (Section 2.3). Interviews with the case study respondents, as well as port authority strategists and tool developers will be conducted as method to collect data (Section 2.4). After the method is explained, there is a clear narrative of the research that is substantiated by the sub questions to divide the research into understandable parts (Section 2.5). The order of the sub questions and approaches will follow logical steps and will form a coherent research that can answer the main research question. This narrative and method combination is visualized in the research design in the last section of this chapter (Section 2.6).

2.1 THEORETICAL CONCEPTUAL FRAMEWORK

Multiple theoretical concepts touch upon the addition of CO_2 information in logistical decision making. Information systems, supply chains, complex decision making processes, governmental or market driven pressure, stakeholder management but also CO_2 emission measurement and sustainable transportation have affinity with this problem statement and research objective. Not every aspect of these concepts is of relevance and for the sake of scope it is desired to demarcate the concepts to a level that it explains enough of the phenomena, but doesn't give an overload of knowledge and information. This framework will contain a multi-level approach towards SCDM with a focus on the role of information. From a narrow perspective of a cargo owner in a supply chain to high (abstraction) level external pressure from the market, policy or shareholders. The relation between the layers, the purpose of the framework and the use of the framework is described in Chapter 3.

2.2 CASE STUDY

As Yin [1984] presented in his renowned book on case study research, it is generally the preferred strategy to perform a case study when a "how" or "why" question is posed. Real life context and a contemporary phenomenon were also characteristics of a case study research. Yin [1984] also poses the influence of a researcher on the behavioural events in question. If that is the case, experiments are the best strategy and if there are questions with who, what, where and how much/many there is a need for a survey or archival analysis strategy. The how question combined with the modern character of the CO_2 measurement tools and the non-existing influence of the researcher on the behavioural events, concludes that a case study is desirable for answering the main research question from Section 1.3.

Case studies can be conducted with a distinction of three approaches, according to Stake [1995]:

- Intrinsic case study
- Instrumental case study
- Collective or multiple case studies

An intrinsic case study is based on the uniqueness of the case and not because it is representative of other cases. Instrumental case studies are allowed to be typical as it is of more importance that the researcher gets to investigate a phenomenon than the particular case [Crowe et al., 2011]. Then there is the collective or multiple case study, and the advantage of that is allowing comparisons to be made across several cases. Qualitative techniques such as interviews, focus groups and observations are common for data collection in case studies [Crowe et al., 2011]. Multiple sources of data collection will add validity to the interpretation of that data [Stake, 1995].

A multiple case study is the most used among researchers and students because it allows for an increased generalisability as the findings will be either confirmed or rejected by the other cases in the multiple case study. A cross case analysis will present this.

Case selection

The multiple case study approach knows an even further level of detail, since the type of research questions determine the type of cases that are to be selected as well. Seawright and Gerring [2008] identify seven types of case selection:

- Typical
- Diverse
- Extreme
- Deviant
- Influential
- Most similar
- Most different

Every type of case selection has a different purpose in case study research. The use is either exploratory or confirmatory, their value changes differently for larger N's and the representativeness is different for every case selection. Without elaborating every type of case selection, it can be determined what type of case selection is required by glancing over the problem statement in Section 1.2 and the objective of this research in Section 1.3. The effect of CO_2 emission information on SCDM is yet unknown and an exploratory research question can best be answered with a multiple case study with a diverse case selection. Seawright and Gerring [2008] describe this type of case selection as: "At least two cases have to be selected and these cases are likely to be representative in the minimal sense of representing the full population". This can be interpreted as any conclusion that is drawn from a diversely selected multiple case study analysis will have some merit in the population but this relation or group will not be comprehensive.

The diverse companies consist of a globally active beverage company, an appliances and tool distributor, a high end fashion company and an automotive company. They all have global supply chains and logistical decision makers, which are the interviewees in the case study.

2.3 EXPERT INTERVIEWS

When the effect of current CO_2 emission information services on the decision making of cargo owners has been explored, it provides grounds for iterating the designs of CO_2 emission information tools. Exploring opportunities to develop CO_2 emission information based on the cargo owner perspectives can very well be done by interviewing experts in the field of CO_2 emission information tools. The findings to answer sub questions 1 and 2 are input for this expert session and the perceptions of the experts will lead to identified opportunities for CO_2 emission information.

2.4 DATA COLLECTION

The sources of data collection are vital for answering the main research question and for providing results through the design and case study methodology. The methods that are used to collect data in this research are literature study, data exploration and semi-structured interviews with experts in the field of SCDM, CO_2 information and case study subjects.

Literature study

A study of the available literature found through Scopus and Google Scholar will be performed as desk research. Snowballing will be conducted as well as a scan of Connectedpapers.com to find articles with common grounds. This will be the input for the literature study that is conducted for constructing the framework on (CO_2) information use in supply chains.

Used search terms on Scopus and Google Scholar are:

1. TITLE-ABS-KEY (”Decision making” AND ”supply chain” AND container AND emission*)
2. TITLE-ABS-KEY (emission AND kpi* AND ”decision making”)
3. TITLE-ABS-KEY (”scope 3 emissions” AND calculation)
4. TITLE-ABS-KEY (decarbonizing AND logistics)

Interviews

Semi-structured interviews have proven to be successful in providing factors that are likely to influence the effectiveness of implementing an intervention in the Crowe et al. [2011] research. Interviews are widely used as a data collection method in qualitative researches [Roulston and Choi, 2018]. Roughly three forms of interviews are used to collect this data, structured, unstructured and semi-structured interviews according to Leavy [2014]. Structured interviews often have the same structure as a questionnaire or survey, where there is no room for diversion and there has to be an answer to a question. Unstructured interviews is a story told by the interviewee with little or no interruptions by the interviewer. The role of the interviewer is to find structure in the story and contribute to the narrative of the interviewee, the more an interviewer contributes to the narrative the more the interview will become a semi-structured interview. A semi-structured interview is the most appropriate way of interviewing for data collection on a certain phenomenon [Leavy, 2014]. A guide and prepared interview form is used to structure the interview and steer it towards the interesting subjects of which a knowledge exchange is desired, this is a significant difference with an unstructured interview.

Another advantage of the semi-structured interview is that, more room is provided for following up on angles that the interviewee presents by his answers, than with a structured interview [Leavy, 2014; Kallio et al., 2016; Mason, 1996].

Semi-structured interviews are the suitable method for retrieving information on the application of the tool in the stakeholder network. The use of a CO_2 emission calculation tool is designed to change the behaviour in the market towards a bigger role for CO_2 emissions. Expert interviews are valuable for understanding the perceived importance of CO_2 emission at this moment.

After conducting the interviews it is encouraged to have the interviewee check the summary in order to validate the output. Confirming the content speaks to the ability of the interviewer to grasp the core of an interview and focus on the important topics.

Coded case study responses

The interviews of the multiple case study are analysed by coding the responses based on categories. This allows for a better understanding of perception and attitude of the cargo owners, and will add merit to findings when often discussed. Coding of text can be done by using artificial intelligence nowadays ([ATLAS.TI, 2022], but in this thesis it is important to grasp the attitude and perception of a respondent and its responses as well. The general view is that the emphasis on certain quotes is better grasped when the text is hand-coded based on recordings and summaries. This is within time and resource scope of the thesis, seeing the limited number of interviews.

Text coding is a popular analysis method for retrieving valuable results from semi-structured interviews [Deterding and Waters, 2018]. The categories to allocate the responses to are based on the conceptual framework layers from the literature chapter (Figure 3.10).

Data management

Collecting information from experts in the field by means of semi-structured interviews allows for participants to share personal information. To prevent sharing personal information by means of recordings or transcripts, it is decided by the researcher that an anonymously produced summary will contain all the valuable information from a participant and that any other personal data will be private to the researcher and destroyed after the research is completed. The summaries are included in the appendix of this thesis Appendix C.

2.5 SUB QUESTIONS AND METHODS

Decarbonisation of global logistic chains is the objective the of Paris climate agreements. To contribute to achieving this, the influence of CO_2 emission information on SCDM from the perspective of the cargo owner is researched. The main research question to reach that objective is:

RQ: How can CO_2 emission information in a port hinterland environment contribute to making logistics processes of cargo owners more sustainable?

CO_2 emission information does not yet affect logistic chains, but will start doing so with the new reporting regulation imposed by the European Committee [European Commission, 2021] that is activated on the first of January 2024 in the Netherlands

[PWC, 2023]. Companies in the logistic sector such as carriers, terminals, shippers, forwarders and operators have an increased interest in their CO_2 emission and will have attention for CO_2 reducing innovations. CO_2 emission information can be seen as an additional information stream that complements the existing information that shippers base their decisions on in current operations. The development of this conceptual framework is part of the case study as it will include insights from interviews with the case study subjects. The decision making process requires insights from the people that actually make the decisions, however a literature basis is required in order to prepare the interviews and formulate the draft framework. This will lead up to answering the following sub question:
1. How do cargo owners deal with CO_2 emission information in their supply chain decision making in a port hinterland environment?

With the different concepts and theories aligned, it can be concluded that the proposed relations are to be validated and supplemented based on empirical data. The case study is a suitable method to manage that empirical data and as earlier discussed, semi-structured with case study subjects are a method to collect the data. The framework aims to conceptualise the relation between CKPI's and other KPI's as well as the handles for cargo owners for opportunities that arise from CKPI's. The possible opportunities are identified and described in the conceptual framework, but the empirical data from the case study will elaborate on actual opportunities in the industry to become more sustainable based on CO_2 emission information.
2. How can CO_2 emission information create opportunities for logistical activities to become more sustainable?

The diverse case study participants will be subjected to interview questions that aim to retrieve some form of strategy or handling perspective in which they intend to incorporate CKPI's in their decision making. This case study is not so much focused on the sustainability policy they currently have, but more on the possibilities of CO_2 emission information for their hinterland supply chains. Within the context that a cargo owner operates, there is a range of possibilities and alternatives that improves the sustainability. This is explored by answering this research question.

The decision making process of port hinterland supply chains is now explored for sustainability aspects and the opportunities to increase the sustainability. All now in the picture of the shipping industry based on CO_2 emission information tools that provide services to identify the CO_2 emissions based on company transshipment data and internationally agreed upon standards and mathematical frameworks. A port authority naturally has a facilitating role and takes responsibility for providing such information to their customers. How their CO_2 emission information products can improve to contribute to more sustainability in the operations of their customers, is the third and last subsection of this research.
3. What can a port authority do to improve CO_2 emission information?

The empirically validated results of subsections 1 and 2 can serve as input for a explorative interviews to improve the way CO_2 information is provided to the companies. Port authorities can increase their added value by iterating their information tools to a fit-for-purpose instrument. The industry already knows a large number of services that are offered to determine a companies' CO_2 emissions. An expert session with developers of multiple CO_2 emission tools is conducted after the case studies are processed. The goal is to find opportunities to improve the tool to increase the value of the tools and ultimately increase the sustainability of supply chains.

2.6 RESEARCH DESIGN

Every section of the research has now been introduced and the methods to find answers for each sections have been substantiated, a visual flow of the research is desired. Figure 2.1 represents the flow of the research and can provide structure for the reader.

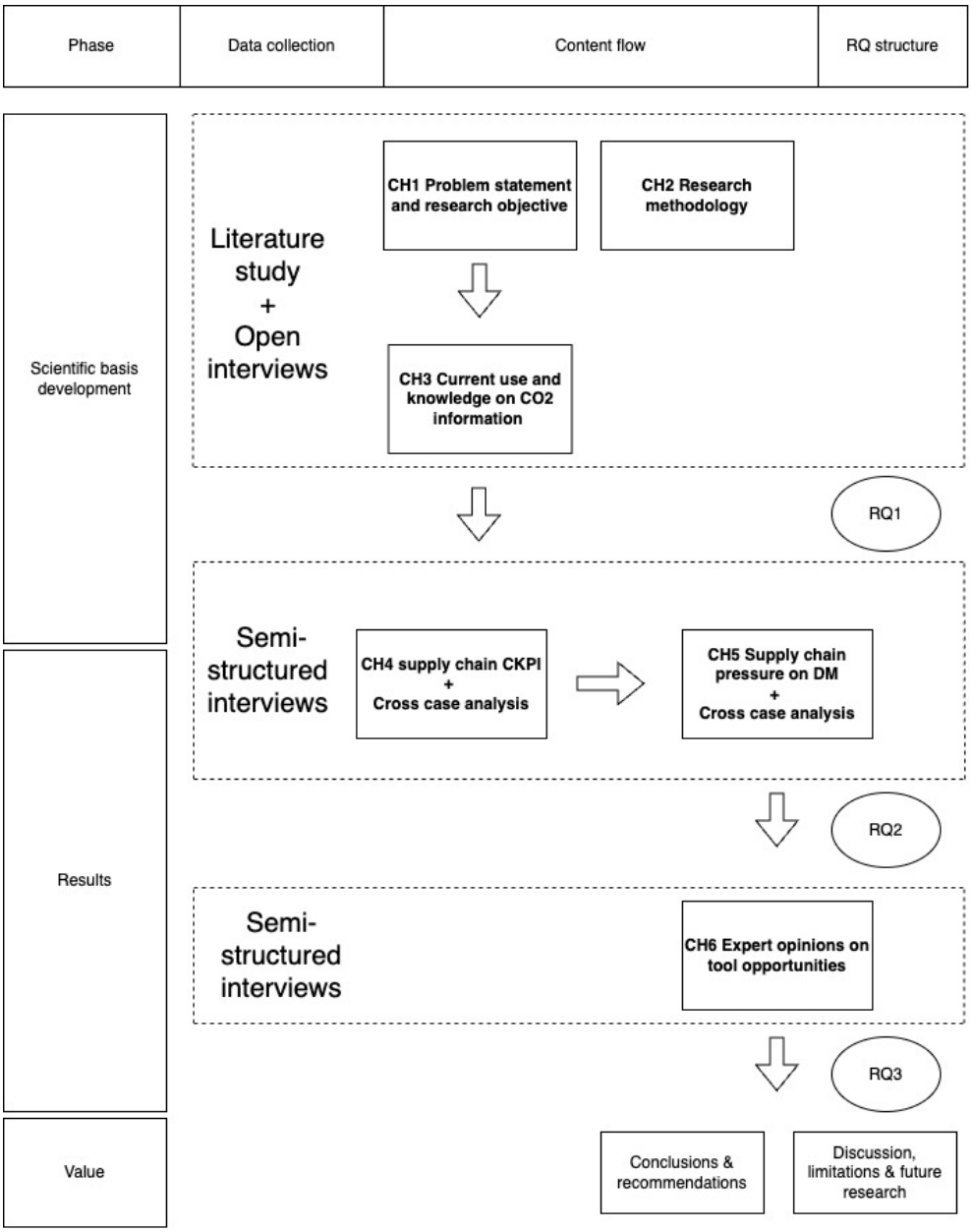


Figure 2.1: Research design of thesis

3 CO_2 EMISSION INFORMATION IN SCDM

The objective of this chapter is to provide scientific rigour to the study of SCDM and the role of CO_2 emission information (Section 3.1). Different aspects of SCDM are identified and substantiated in Section 3.2. CO_2 emission information tools are introduced, and specified in Section 3.3. A comprehensive framework for decision making is ultimately presented in Section 3.4 and concluded on in Section 3.5.

3.1 CO_2 EMISSION INFORMATION

SCDM is a complex process with a lot of variables. The outcome of the decision making process will be one or multiple decisions that will have an influence on the business operations on a short or longer term. The goal of a cargo owner (depends on the company values and) is directly related to every choice that a company makes. Whether it is an investment decision, operational decision or management decision, every decision is made based on certain performance indicators. The decision that is made will be taken with the general idea that some or all performance indicators will have a higher score after the actions follow up the decision. For every product movement between the port and the warehouse, there is a set of options from which a decision maker can choose. The decision maker is assumed to behave rational and choose the options that maximize his utility, and in other words score highest on his performance indicators. With the energy transition in motion, there is an increase of sustainable logistical innovations not all of which are an option for cargo owners, but some of which definitely are.

The conceptual environment of sustainable logistical decision making is illustrated with two (expanding) subsets in Figure 3.1. Logistical options cover the range of options that a cargo owner currently has and the sustainable logistical innovations cover the range of logistical options that improve the sustainability of the transport, but are not yet available for implementation. Some innovations are available and this is represented with the unity of the two sets. There is a subset of the logistical options that are selected in the supply chain and this is represented in the figure with a thicker black line. Now that the CO_2 emission measurement services have become available, it can be estimated how much of the selected logistical services that a company uses, corresponds with available sustainable options. Some examples of each subset are included to make the subsets less abstract. Hyperloop might be a sustainable innovation but this is not yet proven. Hydrogen sea vessels are developed and sustainable but not yet available, as opposed to electrical inland ships, who have a very limited application possibility still. Diesel trucks are not sustainable but are selected for a lot of supply chains. Shore power is available and sustainable and selected in some cases, yet not as much as desired. Same situation with one integrated planning of a port, which can prevent a lot of delays and unnecessary emissions, but also has other benefits that have no direct relation with emissions. The goal is to share as much logistical services with the subset of available sustainable options (increase the yellow canvas) and how to reach that will be part of the contributions of this thesis. This figure illustrates the role of a CO_2 emission measurement tool in achieving this goal, since the place of the selected logistical services within both subsets was not clear up until now.

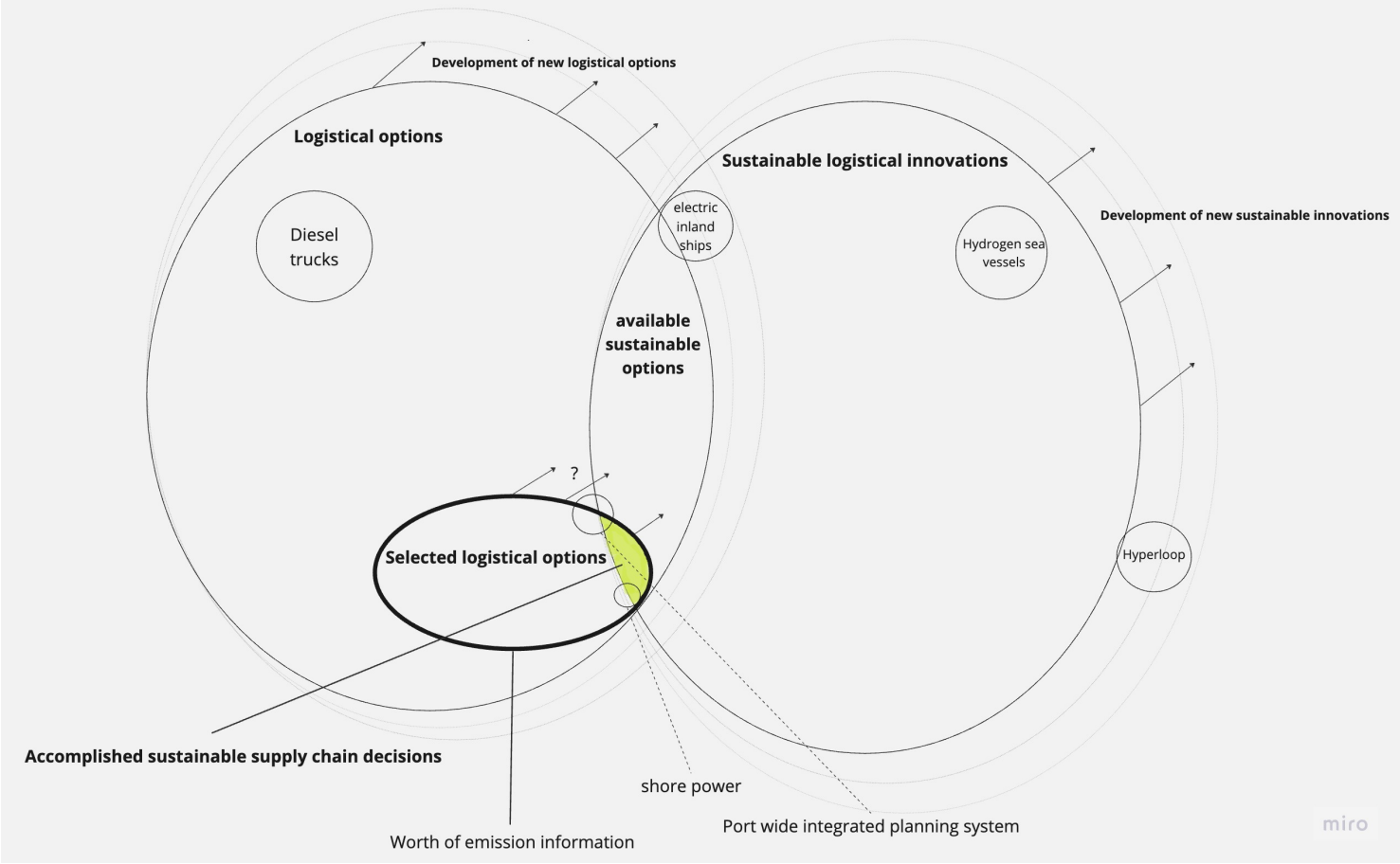


Figure 3.1: Subsets of logistical options and sustainable innovations

A significant assumption in this figure is the increase of the subsets over time. More innovations will be developed, more innovations will become actually available and more logistical options will be sustainable over time. It is assumed that the growth of the subset of logistical innovations is in the direction (thus increasingly overlapping) of the sustainable logistical innovations.

The aforementioned CO_2 emission measurement services have the ability to provide insight in the location of the selected logistical options within the subset of available logistical options. Knowing the overlap between the selected options and the sustainable options provides the starting point for a cargo owner, from which they can start improving their (environmental) performance.

The perspective of Figure 3.1 is based on the ever availability of multiple options for the execution of a cargo owners' transportation activities. Zooming in on the options for one particular activity within the supply chain from port to warehouse, requires a specific understanding of the decision making process of a cargo owner.

3.2 SUPPLY CHAIN DECISION MAKING (SCDM)

This section is intended to elaborate on the theoretical framework that is used in this thesis. The literature will be consulted to structurally expose essential concepts for understanding the relation of CKPI's and SCDM. A conceptual framework will be

the result of this section, which includes and connects multiple theoretical concepts. A representation of a physical supply chain layer forms the base, from which data is extracted, to produce KPI's that flow into a decision making process, which is subordinate to its contextual environment.

3.2.1 Physical supply chain

A global supply chain starts with the activity of extracting raw materials and transporting them to a production facility. The raw products are then prepared for processing in the production facility, where the (half)-fabricate will be stored before it is picked up by the logistics provider. This logistics provider will transport the packed (half)-fabricate to either an inland terminal to bundle the products on an inland ship or train. The destination for that logistics provider is a deep sea terminal on which the products can be transshipped on a deep sea (container) vessel, bound for another deep sea terminal in the area of the market where the products are assembled and or distributed to the customers. On that terminal it is stacked on their depot by terminal vehicles as reach-stackers and when necessary picked up and moved again. From that deep sea terminal the products are loaded on the follow-up modality, which is either a truck, a train or an inland ship. This vessel or vehicle will then either go directly to the local warehouse or go to the inland terminal where it is loaded on a truck that executes the final leg of the trip to the warehouse. The final transportation between warehouse and customer can have numerous logistic possibilities ranging from pickups at distribution centers, to home delivery or physical stores or shopping malls. Because of the great variation, this logistic activity is mostly separated from the global supply chain analyses.

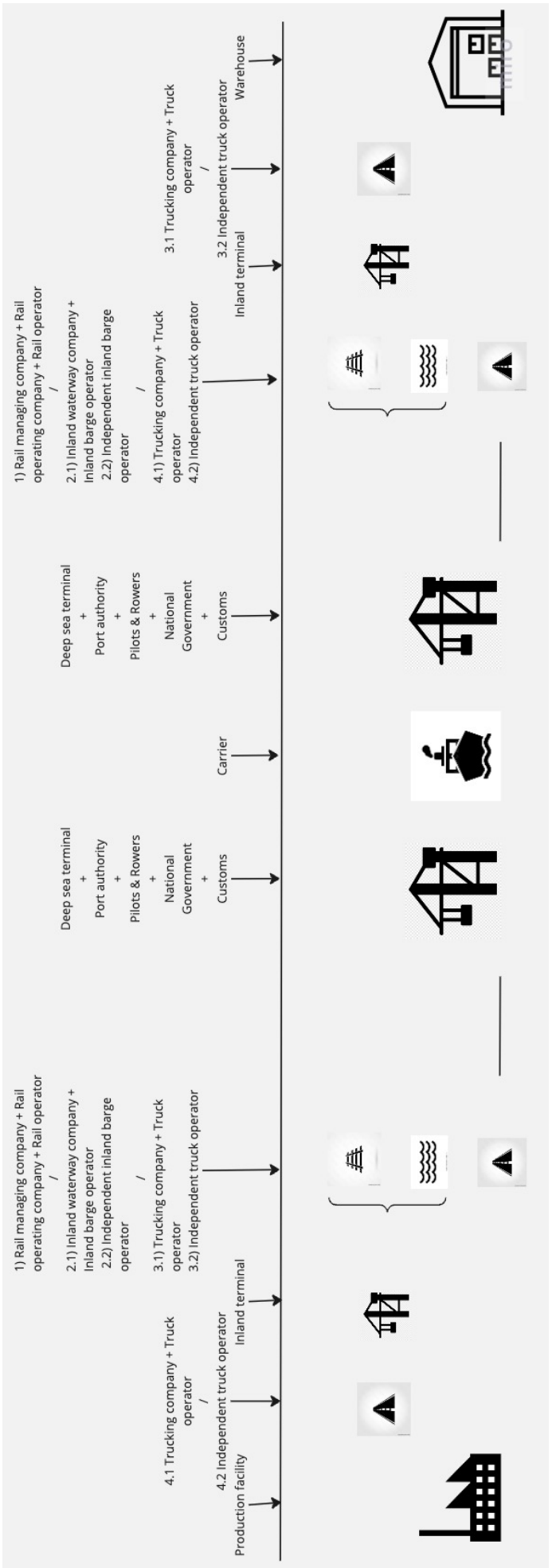


Figure 3.2: Supply chain participants

There is a large fragmentation in the service providers in global supply chains. It is common that every aforementioned activity is carried out by a different organisation. This means different decision makers and different interests, but also different decision makers. Figure 3.2 elaborates on the number of organisations that can be involved in one supply chain. Some organisations are required, others are optional and they are indicated with a number ranging from 1 to 4.2, at least one of the options is selected and at most two (in this example). The take away is that when a multi-modal transport strategy is opted, there is always an increase in the number of involved organisations. Inland barges and trains can be selected as modality if the distance from the deep sea port to the warehouse (or production facility) is big enough. These modalities become competitive with long haul trucking (which is the standard) over a longer distance, because they are more efficient per ton km[1], but they have a high transshipment cost that should be covered for [Zhang et al., 2020]. Furthermore, dependent on the expertise and strategy of the cargo owner, there are two choices for transport management in the maritime sector, carrier haulage and merchant haulage. The cargo owner makes the decision for every company in its supply chain, thus every arrow in Figure 3.2 in case of carrier haulage and hires a third party to organise the transport in case of merchant haulage. The forwarder (merchant) will then use their expertise to contact all supply chain service providers and arrange the transport from production facility to warehouse.

For the purpose of scoping considering time limitations of the thesis, it is decided by the author to focus only on the part of the supply chain between port of call and the cargo owners warehouse. The supply chain to be used in the rest of the thesis will be limited to port of call and warehouse (Figure 3.3).

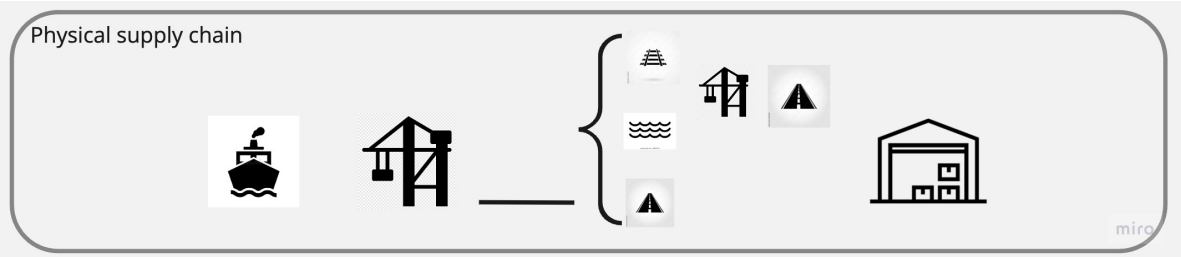


Figure 3.3: SCP's of port hinterland environment

3.2.2 Supply chain data sources

Without data it is hard to formulate customized policy with substantiated measures or properly plan valuable equipment and resources [McKinsey & Company, 2020]. A lot of organisations increase their use of data in decision making, and thus a lot of (extra) data sources are being produced. Every company uses different data sets and share different data with different companies. A very complex network of data sharing is a characteristic of supply chains nowadays [Yu et al., 2020]. In those complex networks there are some types of data with regard to its nature or content and with regard to their availability. This section identifies three types of data that are used in decision making processes of cargo owners. Figure 3.4 is the framework layer that shows these types. Public data is gathered by other organisations outside supply chains, but is made public to be accessed by everyone. The International Maritime Organisation created the Automated Identification System (AIS) [IMO, 2004], to increase global maritime safety. However, not only is the

1 Efficiency per ton km indicates the transport of one ton in weight over a distance of one kilometer.

Figure 3.4: Distinction of data types in SCDM

safety increased, it also creates a data set that can be used to track ship movements to determine travel distance or total number of trips etc. Public data also refers to industry standards such as fuel prices, trade lane specifics as distance and routes, but also fuel consumption standards or entity specifications as type of engine, size, weight and capacity. These industry standards are required to translate historical company data into KPI's that can be perceived equally by every company or organisation.

Data regarding anything that can compromise the reputation, competitive position or revenue is preferred to remain within the boundaries of company servers. This is categorized as company specific historical data. Financial records, but also transshipment data that stores the arrival time, departure time, volume, origin, destination, contents of shipments and prices are examples of possibly sensitive data. Mostly data that can embarrass the clients which thus might jeopardize future sales remains internal.

The fear of making a competitor wiser than they should be causes a reluctant attitude that doesn't encourage collaboration or data sharing. However, sharing data can also be very valuable for either party. Battery passports resemble an initiative where data sharing was successful among SCP's, after which transparency compliance to the heavy (German) legislation was possible [German Federal Ministry for Economic Affairs and Climate Action, 2023]. Coordination of loading and unloading, availability of berths or docking stations and overall status of a container along the trade-lane are examples of useful information sharing on a local level, for the benefit of efficiency [Lotfi et al., 2013]. Mansouri et al. [2015] pose the need for integrated information systems that align multiple sources such as ship data, port data, weather and economic conditions, opposed to the current manual data supply in many decision making support systems. Neutral platforms provided by port authorities (or spin offs) such as Portbase [2023], are fit to facilitate these information sharing practices because they can preserve the integrity of the data. Yu et al. [2020] concur with the aforementioned articles that sharing information in a supply chain can produce efficiency advantages, but nuance that this is not always the case.

The data becomes a product that companies can trade and exploit, but recent conceptions are that data also has to be protect from those actors that have wrong intentions. Not only is a logistical service provider conducting business by moving or storing cargo, they also have to think of a data management plan. Additional legal measures, interested parties or stakeholders and technological challenges arise with the contribution of data to supply chain management. This increases the complexity and thus complicates decision making. The additional layer in the framework aims to reflect on that complexity. It illustrates the conceptual relation going from the supply chain to the data layer.

3.2.3 Key performance indicators (KPI's)

"The general opinion is also that to a great extent, the quality of the decision making depends on the quality of the information" [Bruijn and Heuvelhof, 2017]. Information in a supply chain can have different types, but an often used type is in the shape of a KPI. This is a constantly updated value of an indicator that a company or organisations values highly and on which that company can measure their overall performance. These indicators have a lot of use for companies, and a major advantage is the ability to determine whether their decisions or policies were effective or not and whether they should make different decisions [Chae, 2009]. These performance indicators are determined by evaluating their historical data over a time period and comparing this with their own targets or with the KPI's of other players in the market. A lot of indicators can be produced with the same set of historical data, but only a few are desired by the decision makers as they can only base their decisions on some. Chae [2009] discovered in her research that the best practices of the industry favoured a small set of KPI's over a large one that might comprehend more information of the performance of the supply chain. More information can lead to a lesser quality of decision making [Manuj and Sahin, 2011]. Rezaei [2015] confirms this logic in his article on Multi-Criteria Decision Making methods. He proposes the Best-Worst-Method to cope with human flaws to compare more than 9 criteria at the same time.

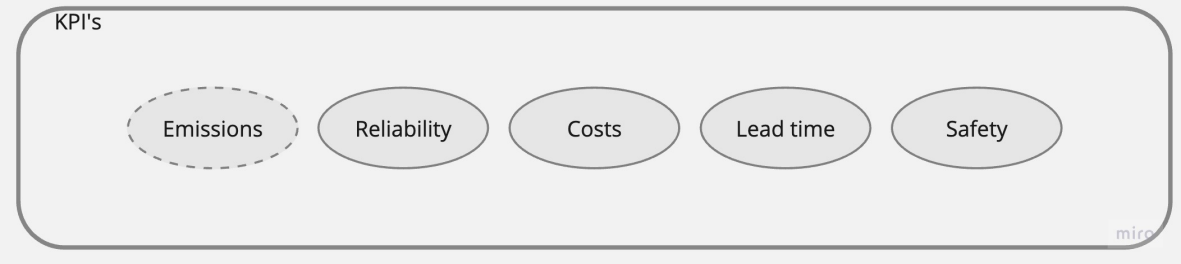


Figure 3.5: KPI layer

Figure 3.5 shows that supply chains originally have five categories in which a KPI can be grouped: Safety, reliability, time, costs and emissions (see Section C.1.1 in Appendix C for background). This is based on the preferences of a cargo owner, who have to organise their flow of products to the satisfaction of current and potential clients. The performance of a trip from origin to destination, consisting of many activities, executed by all parties can be measured by indicators that have affinity with either of these categories. The first four are traditionally decisive in supply chains, whereas the fifth has gained a lot of societal and scientific attention over the past years. Mckinnon [2018] extensively describes how logistics have to be decarbonized to tackle climate change effectively. Mamatok et al. [2019] argue emission mitigation strategies for sea port container activities and Lin [2019] specifically dive into scope 3 emission sources and mitigation strategies from the perspective of non-governmental actors. These are examples of emissions becoming the source of interest in the scientific world, but more importantly a reason to include emissions as fifth KPI performance indicator in the framework. Empirical evidence of emission mitigation strategies in decision making of cargo owners is lacking in the current literature, which is where this thesis will fill a gap in the knowledge. A doubtful relation is therefore presented as a dotted emission factor in Figure 3.5.

KPI trade-offs

Song et al. [2015] evaluate the performance of liner shipping services, based on cost, sailing speed, reliability and emissions in a multi-objective optimization model. Their conclusions were that the pareto-optimal solution was insensitive to the influence of emissions. Mansouri et al. [2015] also study multi-objective optimization models as decision making support tools. They evaluate 14 articles that all use multi-objective approaches to enhance the sustainability of maritime shipping by identifying a trade-off between costs, time, reliability and emissions. Mansouri et al. [2015] identify the need for emissions in the decision making process, and not just as an additional costs factor. Both these articles (and all articles from the review of the [Mansouri et al., 2015] article) confirm three of the four KPI categories and argue the need for emissions as additional KPI when assessing trade-offs in maritime shipping services. Safety can never be traded off for supply chain efficiency increases, so the literature does not often mentions this KPI, even though it is very often deemed first priority. The preferences of the cargo owner determine the trade-off. The balance between inventory and transportation are at the core of this preference [Viau et al., 2009].

There is an amount of products that is required to meet the customer demand and there is an amount of products that is stored as a buffer in case of disruptions in either customer demand (increase in supply) or delayed delivery (decrease in supply), this is often called 'safety stock'. The size of the safety stock is dependent on the demand, the nature of the product, the frequency of new shipments, the size of the shipments and inventory costs [Radasanu, 2016]. Inventory decisions are tactical decisions by nature as will be discussed in section 3.2.6, and these are based on company specific data (see Section 3.2.2).

Emission trade-offs

Costs are central and have a trade-off relation with every other KPI, including emissions. To increase safety there must be scheduled protocols, maintenance and checks on everything, which will be done at the expense of the lead time. Reliability and lead time also have a trade-off relation, that Prater et al. [2001] combine into one term: Agility. However, they interpret flexibility as the ability to adapt to certain disruptions or changes, whereas in this thesis reliability is a term for the occurrence of disruptions and the ability to accept and mitigate the consequences of a disruption within the remaining leg of a trip. The faster a ship sails, or the shorter the lead time, the less time there is left on the leg of a trip to cope with a disruption, thus less chance of being on time or being reliable. Emissions have an estimated trade off relation with costs. Sato et al. [2016] include the distinction into two categories, off -and insetting[2] Kim and Van Wee [2009] do not explicitly mention this distinction but do confirm that there is a trade-off relation between emissions and costs. The definition of a trade-off relation indicates an increase for either KPI at the expense of the other KPI [Silveira and Slack, 2001]. This thesis will investigate whether higher costs are accepted for less emissions.

3.2.4 Contextual factors

Any actor can only act within the boundaries of its' context. Context is not just the physical surroundings of a warehouse or store, but is also the institutional, political, economical and social environment that the company has to take into account when operating their business. External factors can influence the outcome of decision in

2 Insetting refers to company investments that support sustainable alternatives for current emission heavy parts of the company operations. Offsetting is an investment to compensate CO_2 emissions in places other than the own business operations, when there are no viable sustainable alternatives.

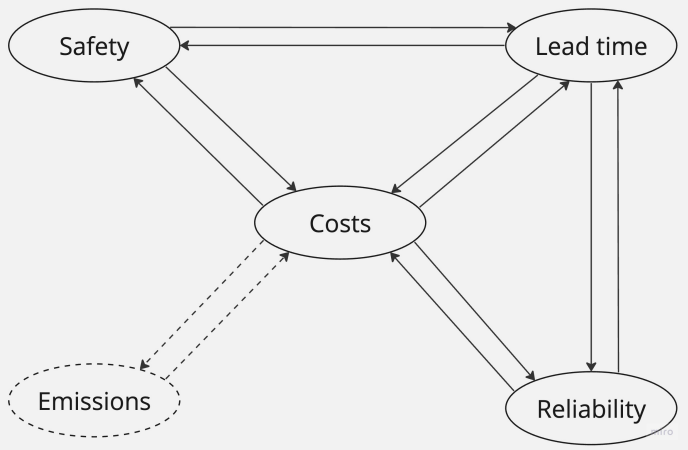


Figure 3.6: Supply chain KPI interrelation

both negative and positive ways either increasing or decreasing the posed effect of a certain decision made by the company [Wolf, 2014]. Especially decision making in complex systems such as a global production or transportation system is very dependent on its situational factors. The literature recognizes a few categories that require further elaboration, see Figure 3.7. The subsections below will do so and in the sectional conclusion there will be an interpretation of these contextual factors.

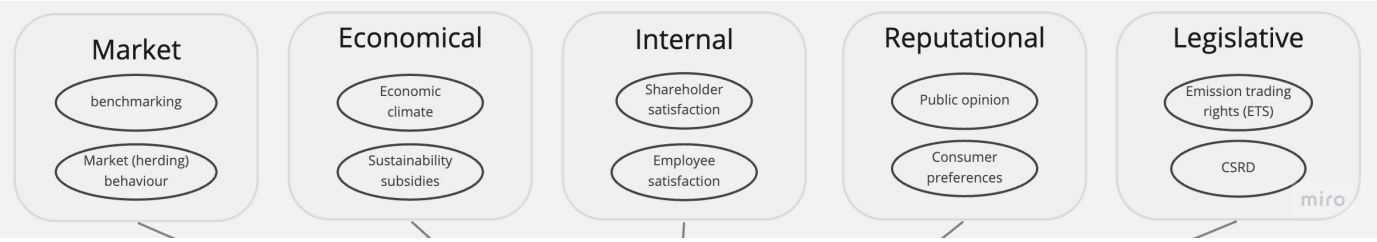


Figure 3.7: Contextual factors of influence on SCDM according to the literature

Market behaviour

The market is an organisational approach to govern supply and demand. Any company aims to add value to a product until or even after it is sold to the customer. Competition between companies is inherent to a market and is required for the balance between price and quality. A company always wants to be aware of the activities of their competitors to try and stay ahead or to learn from and try to get ahead. Benchmarking is a common principle in dealing with competitors, it is aimed at learning from a company or organisation to eventually implement in your own organisation[Anand and Grover, 2015]. Another principle that is very common in dealing with competition is herding behaviour. This is very much alike benchmarking, but with a less high over character. Herding behaviour is simply following the herd with for example new technologies or innovations and copying the competitor or at least not be the first to implement something [Scheibe and Blackhurst, 2017]. Benchmarking is aiming to eventually achieve the same as the benchmark company. The economical climate is important on a higher level and influences demand and product prices. This might affect investment decisions, which set out a trajectory of implicit decisions as well.

Internal

Employees make a company and to thrive as a company you need the best employees. Rewarding them or giving them more free days is not going to be enough in the nowadays job market. Working on projects that contribute to achieving goals that align with personal interests has become more important over the years [Aguinis and Glavas, 2019]. Employee satisfaction is therefore a situational factor that influences decision making for a company. Shareholder preferences ultimately determine the general direction of a company and usually does not interfere with day to day business. However, they can have a lot of influence on the company if they are organised [Ertimur et al., 2010].

Policy

The political climate in which a business has to operate determines the level of support that a company gains as well as the performance that they can reach [Mark and Nwaiwu, 2015]. Stability is the biggest influential factor, whereas an unstable government does not encourage investments. Also governmental investment strategies determine company performance. Some governments have a large budget for energy transitional innovations and try to promote companies to use the funds for partly financing their initiatives [RD, 2020]. The European Union has expressed their intentions to stimulate the energy transition and the reduction of emissions by setting strict targets and preferred 'stick over carrot' policies [European Parliament, 2023]. However, a more conservative government might be more reluctant to use tax payers money to innovate companies. In that sense there is less support and a company is less inclined to prioritize CO_2 emissions in their decision making process [Bell and Grinstein, 2002].

Reputation

Consumer preferences are changing constantly. Technological, societal, economical but also environmental developments influence the desires of a consumer and a major shared denominator in a large share of consumers is the increasing preference for products and services with a responsible carbon footprint [Martí et al., 2015]. The consumer preferences determine demand and by prioritizing low CO_2 emissions in the products they buy, a pressure can be built up at the cargo owners to become more sustainable to maintain sales and revenues. Part of consumer preference is the reputation that a company has in society. Being sued constantly for any reason affects the image and performance of a company [Gatzert, 2015]. Protesters that actively harass companies for the way they operate their business, also damages the reputation of a company. In recent years it has become a powerful instrument to cancel a person or company for some distasteful behaviour.

Economical

Another influential force is the status of the economy [Gaudenzi et al., 2021]. Heavy fluctuations in commodity prices can affect inventory planning and shipment quantities, which affects the tactical decision making [Schmidt and Wilhelm, 2010] as briefly mentioned and elaborately explained in section 3.2.6.

Legislation

The institutional boundaries define the action space that the stakeholders in the network have. International agreements or treaties are usually preceding national legislation in environmental issues such as tackling climate change by reducing the emission of greenhouse gasses. This is mostly due to the fact that a country cannot

tackle the climate change alone [Wilkinson et al., 2001]. Directives from international organisations as the European Union or the United Nations are then transposed into national laws which binds all people and organisations in that country to follow these laws. New legislation can be an incentive for companies to step away from their original strategy or path and expedite certain activities or processes to abide to the new laws. A good example of this is the new CO_2 emission reporting legislation from the CSRD [European Comission, 2023] which will: "Require all large companies to disclose information on what they see as the risks and opportunities arising from social and environmental issues, and on the impact of their activities on people and the environment". In practice this will mean that companies have to report their total emissions. Another important legislation change from the European Union is the ETS Directive [European Commission, 2023b] that will: "Ensure a cap and trade principle. A cap is set on the total amount of certain greenhouse gases that can be emitted by the operators covered by the system. The cap is reduced over time so that total emissions fall." This ETS system will ensure an additional fee for companies that have to buy more emission rights, which tilts the business case of an investment towards the sustainable alternative.

3.2.5 Organisational

Without support factors there is no company. The TOE framework by Baker [2012] specifically mentions the organisation to be one of the three pillars of implementing an innovation. Slack resources, intra-firm communication and linking structures between employees are examples of organisational context that Baker [2012] identifies to affect adoption and implementation decisions. Requirements that are non-debatable in the 21st century supply chains are the digital infrastructures that include communication platforms. Also physical infrastructure as an office to work in or parking places for employees and visitors are examples of standard support factors that are part of an organisation. Human resources are directly linked to the supply chain performance and implementation of supply chain management innovations Gómez-Cedeño et al. [2015]. The revenue, capital, cash flow, and other money related concerns of a company determine the status of a company. This also includes financial abilities to invest in opportunities to become more efficient, sustainable, socially responsible or simply grow. The more slack resources a company has the more likely they are to adopt or invest in innovations [Baker, 2012]. Since organisational factors are required but not the focus of this research it is included as a support layer in the framework(see Figure 3.8).

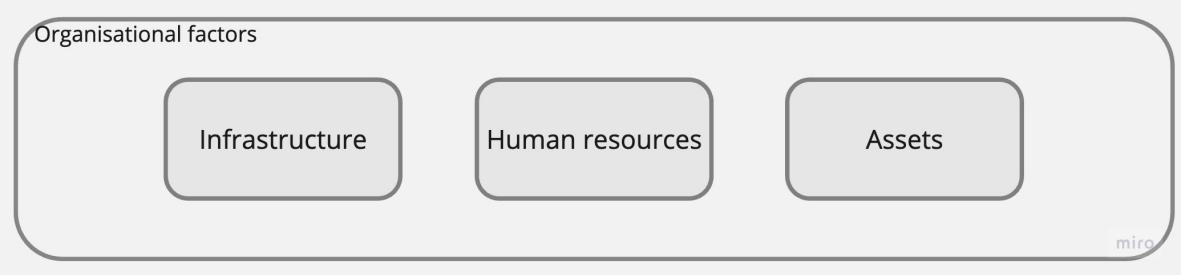


Figure 3.8: Organisational support layer

3.2.6 Decision making process

Schmidt and Wilhelm [2010] distinct three levels of decision making, these are: Strategic, tactical and operational. Operational decisions relate to scheduling and routing problems, tactical decisions are flow management policies including production levels, assembly policy inventory levels and lot sizes. The strategical decisions shape the logistical network, including locations of production, technologies and plant capacities. Tactical and operational decisions have to operate within the framework that the strategic decisions demarcated. Emissions are relevant on every level of decision making. From the location of the facilities on strategic level, to inventory levels and shipment sizes on tactical level and routing and sailing speed on an operational level (see Figure 3.9).

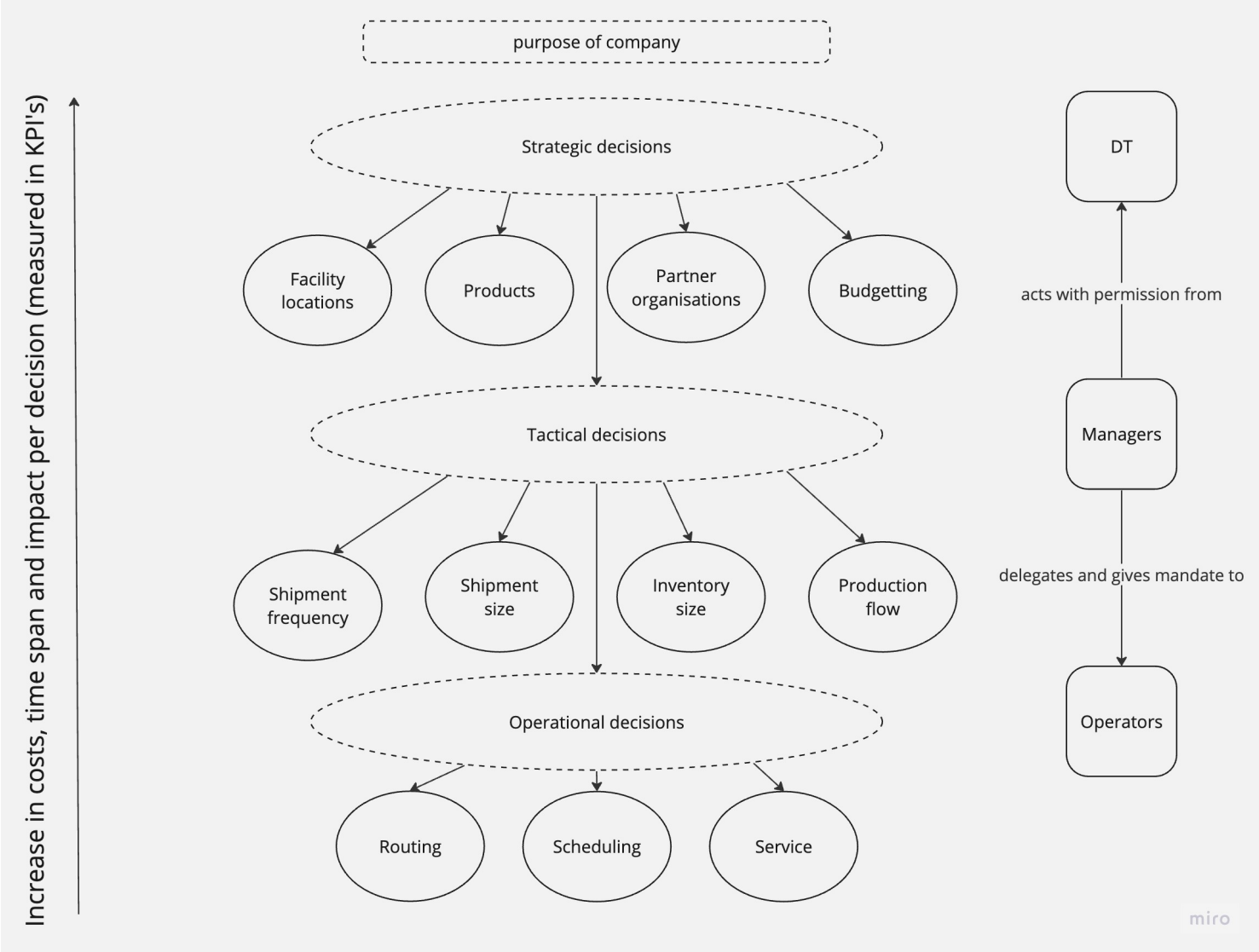


Figure 3.9: Decision making nature difference within company

The decision making in a supply chain is assumed from the perspective of a cargo owner. He is responsible for his actions and also the actions of others commissioned by the cargo owner and without their added value there would be no transport or

supply chain to begin with. The distinction of Schmidt and Wilhelm [2010] with strategic, tactical and operational types of decisions, encompass the SCDM. A cargo owner bases his decisions on his experience, relevant objective information, input from experts (or employees) and his personal opinion. When a decision maker chooses option A over option B, it is often based on a higher score on a top of the mind multi criteria analysis, where he weighs the pro's and con's of every option and then chooses the option that provides him the maximum possible utility.

3.3 CO_2 EMISSION INFORMATION TOOLS

A connection between the data layer and the KPI layer as previously described are CO_2 emission information tools. They use public and company data and emission factors to determine a company emission balance. This section focuses on the literature regarding emission information, calculation methods and available CO_2 emission information tools.

CO_2 emission information is added as as explained because of growing interest and urgency. However, emissions are not per definition a KPI, they have to be determined first. Measuring them with equipment at the source of the emitting entity is the best way to retrieve quality data. Calculating the estimated emissions is the second best way in terms of accuracy. Appropriate calculation methods can be based on information sources such as transshipment data, travel logs, fuel consumption, waiting times, load factors and volumes. Measuring emissions requires equipment with the hardware to accurately measure air quality and software that stores and communicates the measurements. Measuring versus calculating emissions both have advantages with an often mentioned trade-off between accuracy and availability of data. For scope 3 emissions, it is almost impossible to measure every emitting entity, since most entities are owned by other companies [Royo, 2020]. Schmidt et al. [2022] state that every activity that affects the balance sheet should be included in the calculation. Comprehensiveness is then also an argument for using a calculation over measurement. The chemical formulation of CO_2 is straightforward as is the fact that it is one of the gasses that enhances the greenhouse effect [European Commission, 2018]. What is not straightforward (yet) is the way that the emissions are calculated and which standards are to be used for emissions per metric of fuel or traveled distance per ton of weight per metric of fuel. Government organisations or companies do not always have the resources or skills to determine their own emissions and some companies have exploited this gap in the industry by offering their services to overcome that lack of skill and resources. CO_2 emission information services are now offered by at least 16 companies (see Appendix B), with some but not much differentiation.

The tools differentiate on the part of the market they aim to serve, and on the type of information they provide. Appendix B specifies the goal, use and calculation method of the services that are available on the market. The earlier mentioned Port of Rotterdam HESP initiative is not included since that is not available on the market. Almost all companies align their calculations with the GLEC framework of SFC [2019], offer either an API or a report (or both) and include all type of freight modalities. Every tool requires a company to deliver transshipment and or transaction data to determine the emissions.

3.3.1 Emission information in supply chains

Standards such as the scope 1,2 and 3 type of emissions have been agreed upon in the Kyoto Green House Gas (GHG) protocol [United Nations, 1997]. This differentiation in emissions separates production(1), electricity(2) and transportation(3) for every logistic process. The goal of making the distinction for scope 1,2 and 3 is to look at emissions on a wider spectrum along the value chain. Responsibility over emissions that are not directly produced by a cargo owner, but which are a consequence of the volume stream of product that they produce. Emission tools are suitable to determine scope 3 emissions of a company on specific parts of the trade lanes, such as all activities between port and hinterland warehouse. However, scope 3 emissions of a cargo owner reach far beyond that part of the supply chain [Schmidt et al., 2022; Teske and Nagrath, 2022]. The reason to limit the scope to a part of the supply chain as opposed to all scope 3 emissions of a cargo owner

is the enormous amount of possibilities and opportunities that would generate for making supply chains more sustainable. Time and resource constraints limit the supply chain to port hinterland.

The information tools can add value to the operational SCDM, since the CO_2 emission of supply chain activities will have to be decreased. The tool of Routescanner [2023] can show the distinction between two alternative options in terms of costs, lead time and emissions. However, this only concerns the options of different tradelanes, modality (inland), ports of call and logistical service providers (shipping lines & barge/rail operators). These are not the only decision making questions that a cargo owner has, but it is an existing working function of a tool already. The case study in Chapter 4 & Chapter 5 are assessing the decision making on a predefined part of the supply chain which thus concerns a small piece of the scope 3 emissions of the case study respondents. The CO_2 emission information services they are confronted with, mostly use the generic calculation method that is explained in the next sub section.

Calculation method

A data science method to retrieve CO_2 emission information from existing data sets, requires a mathematical framework and established standards for fuel consumption and emission generation [Schmidt et al., 2022]. GLEC is a mathematical framework composed by the SFC [2019]. GLEC is developed to find CO_2 emission KPI's of the scope 3 emissions. Scope 3 emissions regard every activity of a company that is not their core business but which is required for getting the product to the customer, such as long haul trucking trips to sea going container vessels and terminal stacking vehicles on a terminal to stack the containers. An important notion has to be made that the scope 3 activity of a cargo owner, such as stacking a container at a terminal, essentially categorizes as the scope 1 emission of the terminal operator, whose primary business is to operate the terminal. Every activity that requires fossil fuels to be burnt in exchange for energy, emits CO_2 . There are two ways to transfer that energy into force, one is by using a power plant that creates the energy by burning the fuel, to transfer it to a vehicle or other machine in the shape of electricity. The other is by means of an Internal Combustion Engine (ICE) that is inside a vehicle or machine. This ICE burns the fuel to generate an immediate energy that can power an engine to induce movement. By burning a fossil fuel such as coal, gas or oil there is always a production of CO_2 as byproduct of heat. Capturing the amount of CO_2 that is produced per unit of fuel that is burnt, is measured by the amount of energy in KWh it generates. However, different measurements are used in the industry, since one can measure the emissions from Well-To-Wheel (WTW), Well-To-Tank(WTT) and Tank-To-Wheel(TTW). WTW calculates the emissions based on the whole cycle of the fuel, whereas WTT and TTW differentiate the 'production' of the fuel with the use of the fuel (by an engine).

$$WTW = WTT + TTW \tag{3.1}$$

The simple summation in Equation 3.1 shows the relation between production emissions and usage emissions [SFC, 2019]. The calculation method for the WTW, WTT and TTW are all based on the Kg CO2 that is emitted per Kg Fuel. Every part of the world has different methods to retrieve the fossil fuels from the earth and have different infrastructures and thus other efficiency rates. This changes the values of the WTW and WTT emissions, thus every region has a different value in the calculations of the GLEC framework. Accuracy, (methodological) consistency, and transparency and thus reproducibility are essential for such calculations [Schmidt et al., 2022]. For a global supply chain it can be convenient to use one value for the whole chain. Global values have been presented by SFC [2019] as well. For the TTW emissions it has to be known what the Kg CO2 per kWh electricity is. The

international Energy Agency sell updated lists with this information [IEA, 2022].

Emission of supply chains are caused by the freight transport activities and these are categorised as scope 3 emissions of sold products. Not only is the CO2 factor required for determining the amount of CO2 per unit of fuel, it is also required to calculate the tonne-kilometer per activity [SFC, 2019], this unit represents one tonne of cargo moving for one kilometer. Both the weight and the distance of the activity are considered, which means the emission per activity can be determined. [Royo, 2020] agrees with this metric as A-class KPI, but identifies other KPI's and scales them in A, B or C-class based on accuracy. Teske and Nagrath [2022] recommend a standardised calculation and reporting methodology for industry specific energy intensities, since comparability and auditability are important for emission reports. Royo [2020]'s A-class KPI's would then be the best standard to adopt. Current available tools that report emission metrics with these standards are deemed to be 'good' tools.

SFC [2019] argue that their methodology is not the only ingredient for trustworthy emission information. As mentioned in Section 3.2.2, historical company data is essential for input in the calculation, because if the input of data is of poor quality, the insights and results will be of poor quality as well [Rose and Fischer, 2011]. Not all logistical companies have the knowledge and skills to perform these calculations with their own, prepared, data. The services in Appendix B fill this gap in practical knowledge. However, the requirement of transshipment data might restrict companies to acquire such services. Mansouri et al. [2015] start the last paragraph of their conclusions with: "The role of ports on enhancing the sustainability of maritime shipping needs more attention to balance the interests of the port operators and ship liners". Ports can increase their role by facilitating the informational need of their users who are for example not sufficiently digitised to supply a CO_2 emission calculation service with their transshipment data. There may be other reasons for companies to refrain from acquiring such services. A port can be a promoting and facilitating organisation that might overcome this gap. Chapter 6 will elaborate on this, by answering the third research question (**??**).

3.4 CONCEPTUAL FRAMEWORK

There are many ways in which innovations can enter a decision making process. The TOE framework that is presented by Baker [2012] is a generic conceptual framework that identifies three components that affect decision making: Technological, Organisational and Environmental. These components have an essential influence on the adoption of an innovation and this is widely confirmed by empirical applications of scholars [Baker, 2012]. Within the generic framework of Baker [2012], it is possible to formulate frameworks that specify the TOE framework for a specific sector or problem. The framework in Figure 3.10 aligns with the essential components of the TOE framework and aligns the layers as earlier described in this chapter.

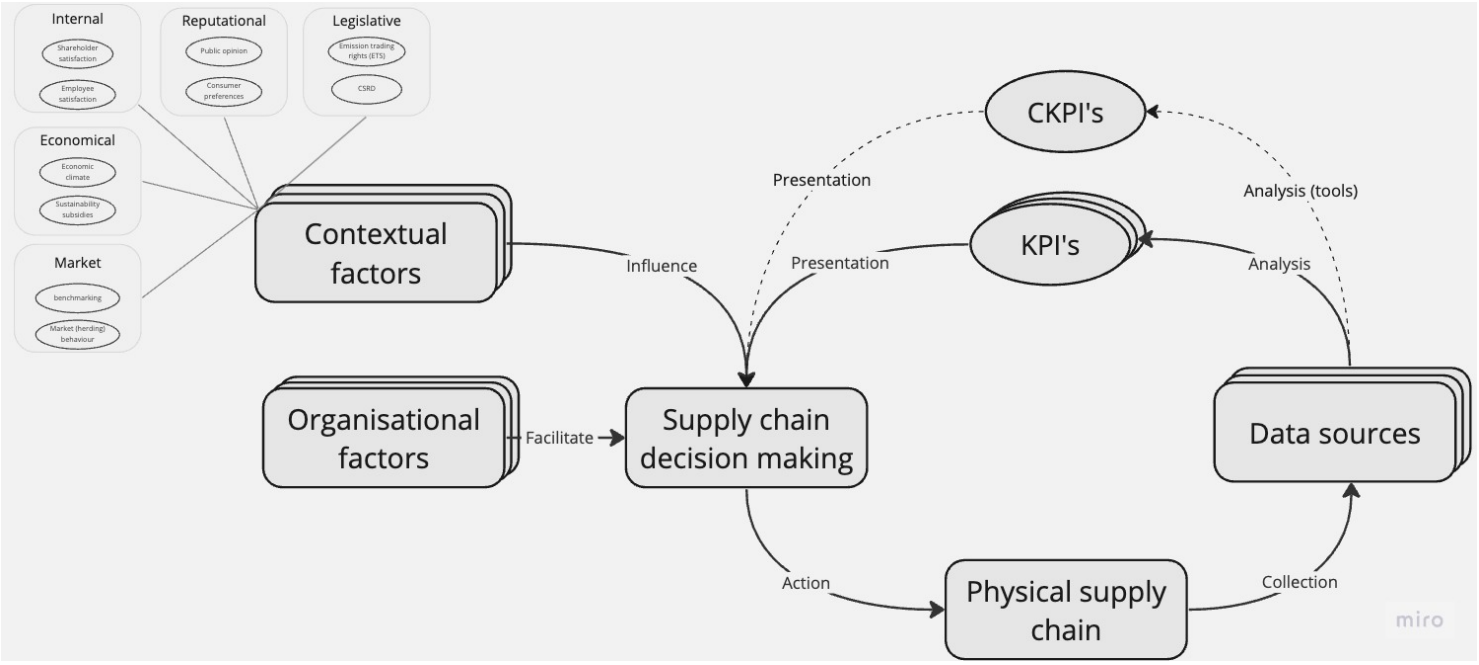


Figure 3.10: Conceptual framework of SCDM and the use of emission KPI's

To read the framework, one starts at the bottom of Figure 3.10 with the physical supply chain. Each transport entity that is used from the sea going vessel arriving in the port of call to the warehouse in the back country of destination is taken into account. Data can be extracted from these entities and collected at databases of different participants. This data is not eligible for interpretation and should first be processed. For a data set to generate value for decision making a data analysis method is required, which is different for every KPI. CKPI are relatively new as is their analysis method, Figure 3.10 therefore separates them to highlight the focus of this thesis. The contextual factors are required because they add perspective to the complexity of the decision making. Contextual factors affect the circumstances in which a decision maker has to act. Differentiated factors affect the decision making with a variety ranging from economical, internal, market and legislative factors to reputational factors. Organisational factors are required for comprehending decision making processes.

The flow of this conceptual framework is information based and ultimately leads to actions based on selected logistical activities within the SCDM process. This is a recurring process, with a short but not daily or weekly period. Facilitating organisational factors and influential contextual factors affect the decision making process.

3.5 SECTIONAL CONCLUSION

The objective of this chapter was to provide the theoretical foundation in the shape of a framework, that is to be empirically validated by the case studies. Every aspect of decision making under influence of CO_2 emission information is disclosed and formulated in the conceptual framework.

The conceptual framework sheds light on the complexities involved in supply chain decision-making. It underscores the significance of CO_2 information and its relation to other KPI's in influencing decisions across the supply chain. By understanding

this relation, cargo owners can develop strategies to make their supply chains more sustainable. However, since the use of CO_2 emission KPI's in SCDM is doubted after analysing the literature, it is also good to evaluate the potential impact of contextual factors that might affect the decision making trade-offs. These cargo owners are inclined to select the logistical option from the imaginary set of all options, that corresponds best to their company values and targets. The assumption in the decision making logic is that cargo owners have (almost) all information available before making the decision. CO_2 emission information is established, along with the calculation method that is common in the industry.

4 MULTIPLE CASE STUDY ON CKPI STATUS

The literature describes a relation between costs and CO_2 emissions, but is quite unclear on the consequences of CKPI's on decision making. The relation as is now formulated in the framework in Figure 3.10 indicates a positive influence on SCDM. With the aim to validate the structure, logic and relations of the framework, a multiple case study is conducted with four diverse selected cases. One global beverage company, an appliance and tool production company, an automotive company and a high end fashion company. Different sizes, products, supply streams and consumers speak for the diversity of the cases as prescribed by Yin [1984]. A description of each interview, additional remarks and a coded result are provided in Section 4.1. Ultimately a cross-case analysis is presented in Section 4.2. Remarks about the cross-case analysis are followed up by a sectional conclusion in Section 4.3 which will answer the following sub question:
How do cargo owners deal with CO_2 emission information in their supply chain decision making in a port hinterland environment?

4.1 CASE REPORTS ON STATUS

A variety of cargo owners is required to grasp the range of perspectives that a company will have when and if they acquire CO_2 emission information on their scope 3 emissions. An automotive company has a very differentiated supply chain with a lot of specific products from multiple manufacturers. Business to business products such as appliance-tools -and materials compose another product stream. Beverages are a homogeneous low threshold everyday product, with consistent supply chains and concerned consumers who should be attracted. The last cargo owner is specialised in clothing, which has a time dependent supply chain because of seasonal dependency and also a competitive market for the consumer. None of these supply chains can be grouped together based on shared supply chain characteristics such as schedules, countries of origin, destinations, product types or consumers. This corresponds with the intention to select a diverse set of cases based on the Yin [1984]. However, they do all use the port of Rotterdam to import or export their products between production facilities and warehouses. Contacting them for an interview for this research was thus within the possibilities of the author.

The objective of this chapter is to understand the power of CO_2 information in the supply chains of the previously mentioned supply chains, and how it relates to the KPI status quo of costs, lead times, reliability and safety. For this a deep dive in the current perception of cargo owners on SCDM is required. The interview protocol that was used to facilitate this deepdive during the interviews can be found in Section C.2.1. The framework is represented in the interview questions and are tested for validity in the decision making processes of the cargo owners. The interviews were summarized and coded by hand and Excel afterwards. Framework factors as KPI's, contextual factors and data sources are selected as coding categories. Sub categories are then based on the input from the interviews. Table 4.6 contains these subcategories as elements in the first column.

4.1.1 Case study 1: Automotive company

This company has large and fragmented supply chains with a lot of parts with a lot of origins and destinations (assembly facilities). This company is a renowned autmotive producer within the top of the market. The interview was conducted with a senior logistics manager. He is responsible for managing the European distribution of engine parts of multiple types of vehicles and engines, ranging from outboard engines for boats, motor cycles and mopeds to quads and snow mobiles. The interview was conducted in Dutch and the whole summary of the interview can be found in Section C.2.2.

Description

The company has a limited interest in more insights in the CO_2 emissions of their port-warehouse logistics at this point in time. The quality of the information is doubted, because an exact CO_2 emission calculation is still impossible. An estimation based on the back of an envelope is enough for the decision maker at this moment. The reason for this is that there is no 'golden nugget' for applying the information in their logistics activities. Whenever there is a CO_2 emission reduction of their scope 3 emissions, it is because of an efficiency increase. CO_2 emissions are never included in the SCDM process. Their partner organisation for transportation is a local and small trucking company in the Netherlands. *"Their unique selling point is their reliability, familiarity with the clients way of working and personal relation with the company"*. However, the most important reason of all, their size is small enough for the automotive company to keep control over their transportation process. When asked about changing warehouse locations to increase the chance of using other modalities as barges or trains there was reluctance: *"A truck will have to be used anyway, so that it will not increase the efficiency at all."*

CO_2 emissions have no role in the decision making process and contextual factors that might affect that relation were also not identified by the interviewee. The consumers of the automotive company are interested in enjoying their boat trip or motorcycle ride and perhaps even prefer the sound of the diesel engine over the silent sustainable alternative of electrical engines. The interviewee remains sceptical about the sustainability initiatives of other cargo owners, since they might only use it as a marketing strategy to attract more customers. This attitude is also exposed in the statement to refrain from being a front-runner and rather wait for the transportation companies to become more sustainable.

Additional remarks

Company perception of CO_2 emissions has been changing over the last year. However, considering more expensive logistical alternatives to reduce emissions is not an option yet.

Coded result

After summarizing the interview with the logistical decision maker, there is a method required to retrieve insight from the interview. Coding by subject with colours is chosen and the result is presented in Table 4.1. This interview produced 15 responses.

Table 4.1: Coded result of CKPI status of case 1

	Category	# of responses
Information	Avaiability	1
3	Data quality	1
	Desire for tool	1
Decision making	KPI trade-off	4
8	Practical	3
	Partnerships	1
Contextual factors	Market	1
4	Consumer	3
	Internal	0

4.1.2 Case study 2: Appliance-tool -and materials distributor

This appliance-tool and materials distributor is a large company with both US and European roots. 3 years ago a US and European company was taken over by a conglomerate, that is ranked top of the market. Their core business is to be the middleman between Asian production facilities of appliance-tools -and materials and to sell them to European customers, often small businesses or dealers, with a bit of margin. The interviewee was responsible for the logistics of Europe and has the authority to make decisions that affect partnerships, mode choices, even warehouse locations and all other logistical decisions. The summary of the interview can be found in Section C.2.4.

Description

At the company there is little information of the emissions between port and warehouse and at this moment it is not a priority to retrieve more information. CO_2 emission is not included in any KPI they use for their decision making. For every decision they make, costs are a driving force. *"Reducing CO_2 emissions while becoming more efficient is a nice catch."* To maintain a competitive supply chain, it is common at this company to put out transport service tenders once every two years. 17 Preconditions are included in this tender, of which none are CO_2 emission related (yet). Forwarders are invited to respond to the tender and make a chance of organising all transport activities between Asian exporter and the European warehouses. A condition in the tender is the obligation to present three types of transport, often differentiated on modality, of which the interviewee selects the best one.

The contextual factors are not experienced as pressing on their decision making on the logistics of their scope 3 emissions. The interviewee stresses: *"Our consumers have not expressed any interests in the emission information on the products they buy. The priorities of the company will remain the same until they do."* The market is not pushing the appliance company to become more sustainable either. The current attitude towards the market is to remain passive and wait for the supply side of transport to become more sustainable. Other contextual factors are not mentioned as currently effective.

Additional remarks

The interests on emissions are growing, especially of scope 1 and 2 from their Asian production facilities. EU legislation called "Carbon Border Adjustment Mechanism (CBAM)" was introduced to the interviewee and it basically covers a CO_2 tax on non-EU country produced products. The expectation of the logistical decision maker is that this will affect his choices for importing partnerships.

Coded response

After summarizing the interview with the logistical decision maker, there is a method required to retrieve insight from the interview. Coding by subject with colours is chosen and the result is presented in Table 4.2. This interview produced 10 responses.

Table 4.2: Coded result of CKPI status of case 2

	Category	# of responses
Information	Avaiability	1
3	Data quality	1
	Desire for tool	1
Decision making	KPI trade-off	3
5	Practical	1
	Partnerships	1
Contextual factors	Market	1
2	Consumer	1
	Internal	0

4.1.3 Case study 3: Global clothing company

The main holding of this company is a clothing conglomerate with multiple global brands under its branches. High end retail markets with seasonal products based on fashion trends. This company belongs to the top of the clothing companies that serve ordinary customers. The interviewee is responsible for all logistics and distribution to the Netherlands and has the authority to make decisions that affect the performance, modal split of long haul transport and warehouse locations. The interview was conducted in Dutch and the whole summary of the interview is included in Section C.2.5.

Description

There are external reports on CO_2 emission information of our scope 1 and 2 emissions, but the contents were not within the knowledge of the logistical decision maker. Scope 3 emissions were not included in these reports, and if the logistical decision maker is asked for his sustainability initiatives it comes down to using logic based on common sense. *"A dashboard that includes specific CO_2 emission KPI's is not desired for now."* They do collect data on their shipments, purchasing orders, modal split, port of loadings and approximate number of containers on a ship so there is a starting point of a dataset to start modelling trips and estimated fuel consumption and thus emissions. For the ocean part of the journey, it is customary that the carrier presents a yearly report with the emission performance compared to the previous year. This includes the use of eco-fuels on some trips in the past year. This has been a successful project on which this interviewee bases a positive review on the collaboration with its ocean carrier.

Sea trips are in general a positive note on the logistical balance. Former long haul trucks from European and North-African production facilities are replaced with short sea trips. The interviewee identified multiple levels of urgency of a shipment. *"Due to the time constraint nature of the 'high end' fashion products, it is more important that a shipment is on time for the presentation of the new collection, than a low cost, low emission transport."* However, by choosing the slowest modality as the default choice, there are multiple 'back-up' modalities to expedite a delayed shipment if need be. Reliability is the most important factor, followed by costs, lead time and emissions

respectively. Trucks are not desired, based on these priorities: They cannot be properly planned, they are expensive due to labour costs of mostly two drivers and the urgency on the distribution center to unload the truck. Efficiency is the most important driver and reducing CO_2 emissions is a nice side catch. Emissions have increased in attention over the last five years and the logistical decision maker is convinced of the responsibility that each company has to reduce their footprint.

The product characteristics are driving supply chain decisions, yet not in the direction of more sustainable logistical activities. *"Consumers are also not perceived as pushing to become more sustainable."* However, it is noticed that the consumer is becoming more demanding in the quality of their products, emissions are also becoming a part of quality. This affects the whole transportation and cargo owner market. The interviewee is aware that making the transportation industry more sustainable is about the chicken and the egg story of who starts first. They claim to take responsibility in stimulating the sustainable initiatives to scale up.

Additional remarks

Awareness within the company is growing about sustainability, but in some instances with larger decisions there is still some resistance. Selling a sustainability proposition internally requires insights in the proposed emission reduction.

Coded response

After summarizing the interview with the logistical decision maker, there is a method required to retrieve insight from the interview. Coding by subject with colours is chosen and the result is presented in Table 4.3. This interview produced 24 responses.

Table 4.3: Coded result of CKPI status of case 3

	Category	# of responses
Information	Avaiability	4
6	Data quality	1
	Desire for tool	1
Decision making	KPI trade-off	5
11	Practical	3
	Partnerships	3
Contextual factors	Market	2
7	Consumer	2
	Internal	3

4.1.4 Case study 4: global beverage brewing company

Global beer brewer with very large logistical chains of end products as well as raw products and machines. Interesting for their experience with logistical chains including perishable goods for a long time. According to their own estimation they are responsible for 0.2% of global container transport, which also indicates the scale and global ranking that this company has. The interviewee is a sustainability manager with management experience from all over the world. The whole summary is included in Section C.2.3.

Description

A company owned business comparison systems (BCS) keeps track of all data and products going in and out. Water usage, electricity consumption, productivity and

fuel consumption are examples of material usage that is kept track of in the BCS's. This information combined with IEA emission standards helps them to make their own CO_2 emission reports on a monthly basis. Their logistical activities between port and warehouse in the Netherlands are almost exclusively executed by a local transportation company between the production facility at two dutch locations at the moment but as an incentive to keep on increasing sustainability and efficiency they offer short term tenders to the logistical service providers. *"The supply market for sustainable transportation could use incentives and we are willing to accept higher cost offers for the benefit of reduced emissions"*. This corresponds with the intention to achieve the net zero targets of scope 1 & 2 emissions in 2030 and scope 3 in 2040. Other initiatives they already included in their policy are electrical inland ships and and electrical forklifts on their production sites. The ships are already in use for the legs between Port of Rotterdam and production facility and the policy of the forklifts restricts all newly purchased vehicles to have a battery and plug.

Because of internal motivation from both shareholders and employees to become more sustainable and reduce their carbon footprint, they do not experience much pressure from contextual factors at the moment. *"We believe that companies should take their responsibility to reduce emissions."* This attitude has a consequence that instead of being pushed to change, they push to change the market. Sustainability is one of the four pillars in the decision making process of the company. Free operating cash flow, operating profit and returns on net assets are the other three.

Additional remarks

The main reason that the interviewee now identifies for having CO_2 emission information is to determine the focus point. This holds for all types of decisions from strategic decisions such as closing and keeping facilities open or building warehouses next to train tracks, tactical decisions as fuel types and mode choices, or operational decisions as planning optimisation to prevent double trips.

Coded response

After summarizing the interview with the logistical decision maker, there is a method required to retrieve insight from the interview. Coding by subject with colours is chosen and the result is presented in Table 4.4. This interview produced 19 responses

Table 4.4: Coded result of CKPI status of case 4

	Category	# of responses
Information	Avaiability	3
5	Data quality	2
	Desire for tool	0
Decision making	KPI trade-off	3
11	Practical	3
	Partnerships	5
Contextual factors	Market	1
3	Consumer	1
	Internal	1

4.2 CROSS CASE ANALYSIS

The cases are analysed and compared with each other in this section. An overview of the positions of the cases on the identified factors is firstly presented. The in-

formation availability and requirements are then compared in the section after that. The decision making process comes after that. Followed by the influential contextual factors in the next section. An answer to the first research question follows in the sectional conclusion in the last section.

4.2.1 Overview of cases

Before comparing and analysing the cases it is valuable to present the key responses in one overview. The layers identified in the framework in Figure 3.10 form the categories in which the key statements are organised. Information, decision making and contextual factors all have three sub categories in Table 4.5, they compose the elements in the first column of the table.

A remark on the effect of a statement on the emission reduction of port hinterland supply chains, is included in the table by colouring a cell. A red colour indicates a negative effect towards emission reduction, a yellow cell indicates a dubious effect and a green cell indicates a positive effect towards emission reduction. The negative and positive effects are straightforward whereas the dubious effect is not. Some cells are left blank, with the intention to appoint more value to the colored cells. These blank cells contain responses that were not expressive enough to draw positive or negative effects and also do not raise doubt on the consequences for sustainable decision making.

Table 4.5: Overview of case study response on current status of CKPI's

	Case 1: Automotive company	Case 2: Appliance company	Case 3: Global clothing company	Case 4: Global beverage brewing company
Current information availability	No CO_2 emission information available	No CO_2 emission information available	No operational CKPI	Internal emission reporting system
Data quality of current tools	Questionable, not possible to determine exact information	Questionable, not aware of the existence of useful information	Hopeful, is the tool capturing all my improvements?	Sufficient for DM process
Desire for tool	Back of the envelope calculation is sufficient for now	Not interested in knowing CO_2 emissions for now	No desire for dashboard, own estimation is enough for now	No external tool required
KPI trade-off in SCDM	Efficiency driven, short lead times and cost effective transport is preferred with CO2 reduction as a side catch	Costs are leading, long lead times are preferred and CO_2 emission reduction is a side catch	Costs and reliability are leading, longer lead times are preferred and CO_2 emission reduction is a side catch	Sustainability is a major DM driver, prepared to sacrifice some cost reduction for more sustainable transport alternatives
Practical DM	Truck is inevitable. no initiatives on warehouse location or multimodality. Port-warehouse is perceived as last mile and negligible.	Barge is preferred, trucking is second best.	Trucks are undesirable. Train and if not available barge is preferred and warehouse location is based on modality priority	Only insetting, no offsetting. Zero emission ships and short distance trucks
Parnerships	Local and trusted transportation company is preferred. No initiatives on sustainability unless they initiate.	Tender for forwarder, once every two years. Forwarder provides 3 mode choices, DM chooses and forwarder executes.	Strategic partnerships with transport service providers are desired. Tender must be long enough to reap rewards of sustainability innovation investments.	Constant re-consideration on most desirable transport service provider
Market influence on DM	No frontrunning role in market. Reaction on innovations by providers combined with price attractive options.	No frontrunning role in market. Reaction on innovations by providers combined with price attractive options.	Strive for stimulating the market. Expectation of others to do so as well	Frontrunner, so the market feels the pressure of this company.
Consumer influence on DM	Consumer is generally not interested in sustainability,thus no pressure from that angle to become more sustainable.	Consumers are not interested in sustainability yet, and until they do will no interest in changing their priorities	Not a driving force for now, expectation is that it will increase in the future	The beverage is a premium product which attracts consumers with higher standards and require a level of quality. The consumer can and does affect the DM.
Internal influence on DM	Neither shareholders, nor employees or other type of internal influence now plays a role	Neither shareholders, nor employees or other type of internal influence now plays a role	Science based targets are set by management, but sometimes unknown to logistical decision maker	Net-zero targets are aimed for in all logistical decisions, company values derived from shareholders and employees are based on societal responsibility for an emission reduction.

4.2.2 Coded CKPI status

The text coded tables from the case study can be combined into a results table that sum up all responses per sub category. Out of all four case study interviews, there are 68 quotes related to the current status of the SCDM and the role of CO_2 emission information in the SCDM of the cargo owners.

Table 4.6: Combined coded result of CKPI status in SCDM

	Category	# of responses
Information	Availability	9
17	Data quality	5
	Desire for tool	3
Decision making	KPI trade-off	15
35	Practical	10
	Partnerships	10
Contextual factors	Market	5
16	Consumer	7
	Internal	4

4.2.3 Emission information availability and requirement

Table 4.6 identifies 17 responses that regard CO_2 emission information availability among all case study respondents.

Information on CO_2 emissions is not available through external emission calculation tools to the cargo owners in the case study at this moment. Only the fourth case has information on their scope 3 emissions of between port and warehouse, due to their own information systems. The lack of desire for having carbon insights is underlying in this availability as case 2 admits that they have no desire for CO_2 emission information and case 1 & 3 have sufficient insight from their own simplistic estimation. Current CO_2 emission calculation initiatives from Appendix B are not acknowledged by any of the four cases. External calculations of emissions are not demanded, own back of the envelope (case 1,2 and 3) or own extensive calculations (case 4) are opted for now. All cases mentioned data quality as impact-full on their consideration to acquire the information let alone use it. Cases 1, 2 & 3 have doubts about the quality of the information, and do not wish to get more information because of this. The 4th case has their own data analyses and therefore have the ability to do something about the quality of the data themselves.

4.2.4 Decision making process

Table 4.6 shows largest category to be decision making related quotes. There are 35 quotes among all cargo owners that describe current decision making considerations.

The decision making process of the cargo owners in the case study was evaluated based on their opinions and actions based on CO_2 emissions. KPI's and their importance for the port-warehouse SCDM is also touched upon. Emissions were critical in only the 4th case considering the overarching KPI-categories costs, lead time, reliability, safety and emissions as sufficiently covering all priorities of a cargo owner. Costs were driving in all four cases and in case 3 and 4 there was a small willingness to accept a higher costs alternative for an emission reduction. However, in case 3 there was a dominant intention to increase efficiency with emission reduction as a side catch. This view was also shared by case 1 & 2, but they were never willing

to accept higher costs for an emission reduction.

This was confirmed by the willingness to use multi-modal transport for longer haul transport legs of case 2 & 3. Warehouse locations were selected based on the availability of multi-modal transport options and the ultimate goal of both cargo owners was to reduce the costs. The longer lead times were even preferred since this would increase the reliability. Case 1 has no interest in other transportation companies and sees no other option than to use a truck. Case 4 constantly reconsiders the transportation service provider. However, they have been using the same company for their trucking legs over the past years, but this was not elaborated upon. Their operationable electrical inland ships are mentioned as an example that confirms their desire to improve (as it was previously executed by truck).

4.2.5 Contextual factors

Table 4.6 shows a total of 16 quotes that concern the existence of contextual factors in the decision making process of the cargo owners.

The perception and current attitude towards CO_2 emissions is subjected to contextual factors and as presented in Table 4.5. The market consists of both cargo owners as well as the transportation companies and other stakeholders that are defined in Appendix A. None of the cases experience any influence from the market on their decision making process regarding the sustainable nature of their selected logistical activities. Cases 1 & 2 have a tendency to wait for the market to offer more sustainable options. They have no interest in stimulating the market. Case 3 and definitely 4 feel the obligation to help sustainable innovations in the logistical sector to scale up. Consumers are not experienced as pressing by cases 1 & 2. Case 3 identifies the consumer as passive in their sustainability desire of clothing products, yet they see how that might increase in the future. Case 4 is aware of the preferences of their customers and estimate that they deem sustainability as important. This affects the decision making of case 4, since they feel a responsibility to change.

Responsibility is an often mentioned influential factor. The interviewee of case 3 has an intrinsic motivation to become more sustainable, whereas his company was reluctant to follow his decision making in some instances. Case 3 mentioned that there were sustainability targets set by their company board (based on science) to reduce emissions, the logistical decision maker was not aware of the contents of those targets. Case 4 has science based targets on emission reduction they strive for and translated it to tangible net zero targets. The shareholders push sustainability within the company, because of the social responsibility that they believe they have. The decision maker estimates that a large portion of their company employees agree with this belief. Case 1 & 2 are not influenced by shareholders, nor by employees or internal responsibility issues to make more sustainable decisions for their supply chains.

4.3 SECTIONAL CONCLUSION

The aim of this chapter was to answer the first research question:
How do cargo owners deal with CO_2 emission information in their SCDM in a port hinterland environment?

CO_2 emission information was theoretically structured in the conceptual framework in Figure 3.10. This chapter describes the experience of CO_2 emission information in the **SCDM!** process of large cargo owners. The results in this chapter validate a

part of the framework, which can be updated as presented in Figure 4.1. If there was no indication of any relation between a previously stated influential contextual factor and the current decision making process of a respondent, it is excluded from the updated framework. These factors can however, be included in a later stage if they are expected to become influential on the decision making process.

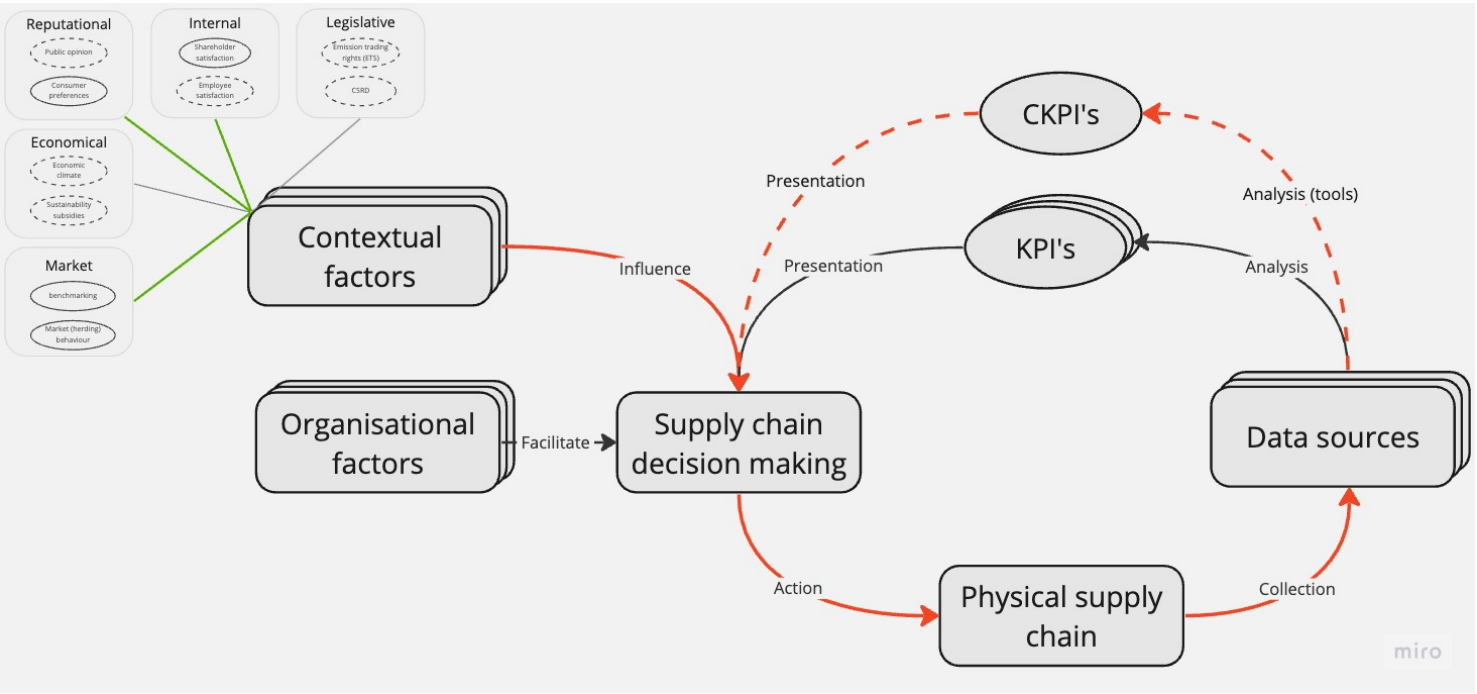


Figure 4.1: Updated conceptual framework based on current status of CKPI's

There is little demand for scope 3 emission information among cargo owners to gain insights in the emissions of their supply chains between port and warehouse. Own (back of the envelope) calculations were sufficient for now and any added value of more insight was not recognized (see Figure 4.1). Costs are leading and any initiatives on the logistical activities in the supply chains were evaluated based on their proposed efficiency increase. As indicated with yellow in Table 4.5, emission reduction is perceived as a nice side catch. This does have a somewhat positive effect on emissions since it does reduce the total, yet also restrains further emission reductions since they are not valued. Modal shift and accessible warehouse locations are considerations of the cargo owner solely based on their potential efficiency increase. The feedback arrow from decision making to the physical supply chain is red coloured to highlight the limited sustainability influence of the decision making. Strategic partnerships are traded off by short term tenders based on company preferences.

Contextual factors were mentioned as influential for sustainable decision making by the cargo owners. The degree of influence was touched upon and it was collectively concluded that none of the contextual factors were pressuring them to become more sustainable in their supply chain activities (hence the red colour of the arrow). Consumer and internal contextual factors were perceived by half the cases as potentially influential, but not pressuring in any way now. The other half did not recognize any influence for now. This division in the cases can also be seen in evaluation of the market influence. Contradictions are found as cargo owners are also part of the market and both ends of the spectrum directly affect each other. Two companies of the case study are front-runners and they push the rest of the

market to become more sustainable, while the other companies are being pushed. Other contextual factors that are included in the top layer of the original framework were not identified by any case in the case study at this point in time, they are left gray in the updated framework in Figure 4.1.

5 MULTIPLE CASE STUDY ON CKPI OPPORTUNITIES

Opportunities of using CO_2 emission information in supply chains explore how the current relation between CKPI's and SCDM, and between contextual factors and SCDM can be affected for the benefit of emission reduction. To explore these opportunities, it is vital to gather empirical data. The same case study as in Chapter 4, can be used for this, but with the addition to make the logistical decision maker think about contextual factors with future impacts on his company and performance. The description of the case study will differ from the description in Chapter 4, since it will only contain statements and perceptions on the opportunities and explorations of the future of the cargo owners. After the description per case in Section 5.1, there is a cross-case analysis in Section 5.2, which will address commonalities and contradictions between the cases. The sectional conclusion in Section 5.3 will answer the second research question:
How can CO_2 emission information create opportunities for logistical activities to become more sustainable?

5.1 CASE REPORTS ON OPPORTUNITIES

During the semi-structured interviews, it was proposed to the logistical decision makers of the cargo owners, what CO_2 emission information is and how certain tools can provide that information. The consequences for their supply chains if they had more information were explored and translated to opportunities if the cargo owner identified any. Potential influences of expected contextual factors are explored as well, followed by their expected effect on the decision making process. Since the case respondents are the same as in Chapter 4, there is no explanation of the nature of the company and decision maker.

5.1.1 Case study 1: Automotive company

Description

The data quality of CO_2 emission information is perceived as problematic, compared to exact supply chain information as import and VAT taxes. It is not expected that the information will become more exact due to the nature of the information and the lack of tangible proof of emissions. The responsibility of reporting should lay with the transportation company, since they have access to the best data sources such as travel distance, load factors and fuel consumption. The calculations based on models such as the CO_2 emission information tools are dubious since they hold a lot of assumptions and require standards that are not widely accepted yet. *"However, one valuable function of such tools would be a comparison function that will allow multiple transportation companies, routes or modalities to be compared. "*

Then again, conveying sustainability targets to a service provider can cause trouble. How can the actual emission reduction be enforced, when there are so many variables in the equation. Strategic partnerships are therefore not part of the sustainability agenda. High impact low costs transport legs are the focal point if they were to tackle their CO_2 emissions.

"Consumer preferences are impactful if the consumer decides that they value sustainability in their product considerations". It is however experienced and assumed that the consumer preferences will not change in the coming years. Technology of sustainable logistical options such as electric or hydrogen powered vehicles will eventually become available and conquer the market. Until the technology is scaled up properly, there is no effect by the market expected to affect DM towards more sustainable decisions. When the market offers more sustainable alternatives, the interviewee expects to follow. However, if the prices rise too much, it is not outside of scope to pressure the market to remain 'unsustainable'.

Additional remarks

Near shoring is a strategy that is identified for cargo owners on the longer term as a consequence of the rising attention for CO_2 emissions. Near shoring is however, not a serious strategy for the company itself, since both head quarters as well as production facilities are based in the country of origin, including its roots. The size of this department of the company is an argument for their reluctance to have already initiated sustainability in their port hinterland supply chains.

Coded response

After summarizing the interview with the logistical decision maker, there is a method required to retrieve insight from the interview. Coding by subject with colours is chosen and the result is presented in Table 5.1. This interview produced 17 responses.

Table 5.1: Coded result of CKPI opportunities of case 1

	Category	# of responses
Information	Data quality	3
7	Requirements	3
	Opportunities	1
Decision making	KPI trade-off	1
5	Reduction strategy	3
	Partnerschips	1
Contextual factors	Legislation	1
5	Consumer	0
	Internal	2
	Technological	2
	Economical	0

5.1.2 Case study 2: Appliance-tool and materials company

Description

The distribution of CO_2 emissions over a shared transport leg is a doubt for in the near future (warehouse to customer). In the port hinterland leg it is desired to see the difference between modalities on the same trade lane. This would provide more incentive to look at emissions, let alone prioritize them. However, this does not cope with the doubt of emission information, which is the data availability of the whole supply chain. The step before calculating emissions requires companies in the supply chain to gather their data. *"An opportunity for us would be a data gathering platform where every company in the chain, uploads its data including essentials to determine CO_2 emission information, and then opens up the information to the other companies in the chain."*

Even though a comparison function is preferred to be part of an emission information tool, it would not motivate them to choose more sustainable logistical alternatives if that means the costs will increase. *"Costs will remain decisive in the decision making process for now."* Scope 1 & 2 emissions are gaining interest with the European CBAM legislation and this does affect strategic partnerships with Asian production facilities. Before even becoming a viable option to buy products from, KS requires a CO_2 emission report on how much emissions were produced for producing 1 unit. Scope 3 emissions are not that far and will not receive equal attention in transportation tenders in the coming years.

EU legislation is perceived as pressuring for the decision making. *"CBAM will make us rearrange our priorities in procurement of our products."* The initial response is negative towards the policy, since it only adds more costs to importing products: *"reducing emissions is not rewarding"*. Scope 3 emissions are not affected by legislation anytime soon according to the interviewee. The consumer preferences are also not expected to change soon, thus the decision making will not change either. The interviewee identifies a potential limitation of this effect, since consumer behaviour can switch easily based on the status of the economy. *"High inflation will drive consumers to their instinctive cost reducing behaviour as opposed to their responsible, sustainable more expensive alternatives in a booming economy"*. A potential impactfull factor is shareholder pressure. The main holding, with the majority of the shares, holds a high regard for sustainability and has reported that they will apply pressure over time if they are not satisfied with the performance.

Additional remarks

Near-shoring of production is a consequence for cargo owners, following the CBAM legislation effects. The interviewee acknowledged the enforcing effects of possible scope 3 emission taxes on this near shoring strategy.

Coded response

After summarizing the interview with the logistical decision maker, there is a method required to retrieve insight from the interview. Coding by subject with colours is chosen and the result is presented in Table 5.2. This interview produced 14 responses.

Table 5.2: Coded result of CKPI opportunities of case 2

	Category	# of responses
Information	Data quality	2
5	Requirements	1
	Opportunities	2
Decision making	KPI trade-off	1
2	Reduction strategy	0
	Partnerschips	1
Contextual factors	Legislation	4
7	Consumer	0
	Internal	2
	Technological	0
	Economical	1

5.1.3 Case study 3: Global clothing company

Description

"How quantifiable are CO_2 emissions and how will the logistical decision maker know for sure that the effects of their investments are reliable?" A question that the decision maker asked when confronted with the possibility to receive CO_2 emission insights from any tool (see Appendix B). A tool is not required to determine the CO_2 emission performance, and if they were to attract an external company to produce a CO_2 emission report, it is expected that the performance is sufficient. More (frequent) insight would increase the speed of decision making as well as the evaluation power of previous decisions.

The transportation companies have the ability to gain access to valuable data such as their fuel consumption and other sources that are required for determining CO_2 emission information. Responsibility over emissions is a big gap in the practical knowledge of logistics at this moment. The interviewee agrees that cargo owners share in this responsibility, and point out that getting a bad reputation as a consequence of lagging behind in sustainability performance is very undesirable. Technologically driven initiatives such as methanol and electric powered vessels are pushing to scale up and develop, which is followed closely. Becoming a front runner in sustainable production and transportation in the clothing industry can have advantages, with respect to customer preferences. However, customer preferences might seem to tilt towards sustainable alternatives in a booming economy, but will be dominated by low cost products in economical crises. *"Legislation on scope 3 emissions will be encouraged, because it will have a positive effect on emission reduction."*

Additional remarks

Actionable opportunities on decision making or logistical activities are not mentioned by the interviewee. Neither is the influence of contextual factors on the trade-off of the KPI's.

Coded response

After summarizing the interview with the logistical decision maker, there is a method required to retrieve insight from the interview. Coding by subject with colours is chosen and the result is presented in Table 5.3. This interview produced 14 responses.

Table 5.3: Coded result of CKPI opportunities of case 3

	Category	# of responses
Information	Data quality	2
4	Requirements	1
	Opportunities	1
Decision making	KPI trade-off	0
1	Reduction strategy	1
	Partnerschips	0
Contextual factors	Legislation	1
9	Consumer	0
	Internal	6
	Technological	1
	Economical	1

5.1.4 Case study 4: Global beverage brewing company

Description

The interviewee does not prioritize the improvement of their CO_2 emission information. The quality of their information is sufficient for the current goals, and additional improvements as more frequent updates of the reports are also already implemented. This feeds the decision making processes on multiple levels (strategic, tactical and operational), which allows for sustainability to be one of four pillars in the decision making processes in the company. Every decision has to fulfill sustainability requirements with the emission reduction targets in mind. *"High impact and low costs projects are selected first and the frequent reports will support this by providing focus points."*

The coming legislation such as ETS will have a positive effect on CO_2 emission reduction. Waiting for legislation to affect the market is not the expected approach, shareholders and consumers have more effect on the decision making process. Since the company is family owned, there is a pressure from the family to act on the values and norms that the family holds dear.*"Sustainability is of great value to the family and thus to the company."* Consumer preferences are expected to be a major driver for the companies' sustainability ambitions. This long term expected pressure is now translated to the net zero targets for scope 1 & 2 in 2030 and scope 3 in 2040. With the rise of electrical trucks, ships and charging infrastructure is a technological development encouraged by the company, with some doubts on feasibility as well. Helping to scale up sustainable logistical innovations is part of the strategy of the brewer.

Additional remarks

When asked upon the marketing function of becoming more sustainable, the interviewee responded that that was not the intention. Contextual factors are identified by the interviewee as useful to increase the priority for CO_2 emissions among market parties such as cargo owners or transportation companies.

Coded response

After summarizing the interview with the logistical decision maker, there is a method required to retrieve insight from the interview. Coding by subject with colours is chosen and the result is presented in Table 5.4. This interview produced 11 responses.

Table 5.4: Coded result of CKPI opportunities of case 4

	Category	# of responses
Information	Data quality	0
1	Requirements	0
	Opportunities	1
Decision making	KPI trade-off	0
4	Reduction strategy	4
	Partnerships	0
Contextual factors	Legislation	1
6	Consumer	2
	Internal	2
	Technological	1
	Economical	0

5.2 CROSS CASE ANALYSIS

The opportunities and challenges for CO_2 emission information are identified by the interviews with cargo owners. A single result is not of any value, whereas the multiple case study might expose commonalities that have more value when it is shared by more than one case. An overview of the key responses in the interview is presented first. A perception per category or framework layer is then added and finally an answer to the second research question is provided.

5.2.1 Overview of cases

Key responses are identified in the interviews and grouped after their similarities with categories and factors from the framework. Table 5.5 shows the attitude, perception or actual quote of a case respondent on the factor from the framework. Since this section covers the opportunities of CO_2 emission information, it can happen that a case respondent did not cover the particular opportunities of that category. If that were the case, it is mentioned in the appointed cell. The structure of the table is similar to Table 4.5, so three categories on information desirability, three categories on the decision making impact, and five on the impact of contextual factors. There are 56 quotes in total that describe the opportunities of CO_2 emission information in the SCDM process of cargo owners.

A remark on the effect of a statement on the emission reduction of port hinterland supply chains, is included in the table by colouring a cell. A red colour indicates a negative effect towards emission reduction, a yellow cell indicates a dubious effect and a green cell indicates a positive effect towards emission reduction. The negative and positive effects are straightforward whereas the dubious effect is not.

Table 5.5: Overview of case study response on opportunities for CKPI's

	Case 1: Automotive engine company	Case 2: Appliance company	Case 3: Global clothing company	Case 4: Global beverage brewing company
Data quality of future emission information	Doubtful, trustworthyness of calculation is not expected to increase anytime soon.	Doubtful, scope 3 remains hard to quantify with certainty	Questionable since there will always be a calculation.	Sufficient, quality of data will not be a concern
Requirements of future emission information	Broadly accepted emission standards and distribution of responsibility are minimum requirements	Trusted incrementally added emission insights on whole supply chain	Customized, level of detail depends on the goal of the emission estimation	No requirements mentioned.
Opportunities for emission information	Activity specific year-comparison	Modal splitt comparison function	Frequent insights equals faster adaptations and more accurate policy	More frequent reports will add adaptation speed to the DM
KPI trade-off in future SCDM	Still cost driven CO_2 remains side catch	Tender will include emissions, yet costs will remain leading	Still cost driven CO_2 remains side catch	Sustainability remains a major DM driver
Emission reduction strategy	Efficiency driven high impact, low costs first	Efficiency driven high impact, low costs first	Efficiency driven	When focus point is determined, low costs high impact first
Partnerships	Making transportation partner change will be difficult	Forwarder will have to report estimated emissions in future	Strategic longer term partnerships are expected to stimulate sustainability	Tenders allow for periodically reconsideration of partners
Legislative influence on DM	Enforcement of emission legislation will be hard	Emission legislation is an impactful means of pressure on SCDM	Legislation will have a positive effect on sustainable SCDM	CO_2 taxes are good for the business case of sustainable options
Consumer influence on DM	No increase expected	No increase expected	Could increase, no strategy if it does	Is of great interest. current initiatives are aimed to mitigate this effect in future
Internal influence on DM	Responsibility is hard to distribute with scope 3 emissions	Shareholders can and will play a big role if they are not satisfied with sustainability performance	Companies should take their responsibility in tackling climate change. Internal resistance against sustainability initiatives should be overcome. Targets should be achieved	Shareholders already play a big role in sustainability targets, increase is not expected unless the progress is unsatisfactory.
Technological development	Technological development will automatically increase sustainability of logistics	Not mentioned	Technology is constantly evaluated on feasibility. If feasible, fast implementation is favored	Technological development might not be the holy grail yet, since charging infrastructure lacks capacity.
Economical influence on DM	Not mentioned	Inflation will be problem for scaling up sustainable initiatives	Inflation will be problem for scaling up sustainable initiatives	Not mentioned

The results in Table 4.5 and Table 5.5 reflect on the consequence for scope 3 emission reductions by colouring a response red, yellow or green. For most sub categories, the response of the decision maker about opportunities for CO_2 emission

information remained in line with the response about the current status of CO_2 emission information in their decision making process. For example, trade-offs are currently never in favor of emissions at the expense of costs, time or reliability with cases 1 & 2, and will not become in favor of emissions in the future (without intervention in the system). This relation is coloured yellow and both positive as emissions are reduced as a consequence of efficiency increases, and negative as emission reduction is never the goal and will thus never be sufficiently achieved.

All relations are in the same line of thought in the current status of CKPI's as for the opportunities of CKPI's except for data quality and internal influence. Data quality is non existing in the current situation and therefore white, but red in the opportunity study because of their major influence on decision makers. Internal influence is not perceived as pressuring to the decision makers in the current decision making processes, but are expected as such in the future.

5.2.2 Coded CKPI opportunities

The interview with the cargo owners contained 56 recorded quotes that contained information about opportunities or expected restrictions for CO_2 emission information. The summation of all the coded responses of the cases in this chapter is shown in Table 5.6.

Table 5.6: Combined coded result of CKPI opportunities

	Category	# of responses
Information	Data quality	7
17	Requirements	5
	Opportunities	5
Decision making	KPI trade-off	2
12	Reduction strategy	8
	Partnerships	2
Contextual factors	Legislation	7
27	Consumer	2
	Internal	12
	Technological	4
	Economical	2

5.2.3 Information desirability

Table 5.6 shows that 17 quotes regarded the opportunities for the actual CO_2 emission information (tools).

In addressing the desire for CO_2 emission information for their SCDM processes, cargo owners often started by questioning the quality of the data and calculations. Cases 1, 2 & 3 were sceptical and identified it as an argument not to explore emission calculation services. Some improvements that these cases mention, despite a lack of trust in the data quality are:

- Broadly carried standards
- Responsibility agreements among SCP's
- Data transparency of fuel consumption
- Customized emission information approaches

Specific practical functions of CO_2 emission tools were explored by assessing the need of the case study respondents. Cases 1 & 2 admitted to "wanting to see" the difference between their current operation and another option. Case 1 specified this to comparisons per year and case 2 wanted to see the difference between multiple logistical activities, with mode choice in particular. Cases 3 & 4 see the added value of a frequent update of the emission performance, since it might speed up decision making processes.

5.2.4 Decision making strategy

Table 5.6 presents a total of 12 quotes that regarded opportunities decision making processes of cargo owners.

The trade-off between CKPI's and other KPI's is not expected to change. Case 1,3 & 4 did not indicate any difference compared to their perceptions in the current situation. Case 2 expressed their intention to include emissions in the tender, which means they are asking transportation service provides to report emissions to the logistical decision maker. However, it was stated that the selection is not affected by emissions and that costs remained decisive for now.

Case 1,2 & 4 mentioned a strategy for when they were to reduce their emissions. High impact and low costs activities would have priority and their response included a remark that port hinterland transportation was not recognized as such. Case 4 added that a focus point based on CO_2 emission information was required before knowing what was high impact. Case 3 did not mention a specific strategy but did remark that when they would have one, it would be efficiency driven.

The need for communication with logistical partner companies is confirmed by cases 1,2 & 3. Case 1 disclosed that communicating CO_2 emission demands to their transportation company would raise questions of responsibility and reporting quality. Case 2 was not intended to make drastic changes in his supply chain partners, reporting emissions was an initial step. Case 3 does not consider becoming more active on the transportation service market. They intend to collaborate to achieve the 'best' sustainability performances. Case 4 has not mentioned any strategy for reevaluating partnerships with transportation companies.

5.2.5 Contextual factor impact

Table 5.6 presents that 27 quotes were containing information that was regarding one of the contextual factors.

All cases identify legislation as a contextual factor with a lot of influence on their decision making. Cases 3 & 4 mention the Emission Trading Scheme (ETS) by the European Union [European Commission, 2023b] to affect sustainable decision making in a positive way. The 2nd case acknowledges the influential power of legislation but mentions (CBAM) [European Commission, 2023a] legislation which is going to affect their scope 1 and 2 emissions. The first case acknowledged the influence of the legislation, but focused on the lack of enforcement power of the government.

Consumer preferences are expected to change according to case 4 and it will affect the demand and sales of their products if they do not comply with these changes. Case 3 did not explicitly mention the consequences for the sales and demand of their product, but they do identify a possible shift in consumer preferences. Case 1 & 2 do not foresee big changes in consumer preferences and thus influence on their decision making. Employees or shareholders are also not determined to prefer

sustainable logistical options for higher costs according to the 1st case. The 2nd case does recognize some pressure from their majority shareholder. Shareholders from the 4th case hold sustainability in high regard and communicate this to the company targets. Employee preferences are recognized by the decision maker in the 3rd case as changing towards a higher regard for sustainability. However, this is merely a benefit for hiring the top tier candidates.

Technological development is a contextual factor that was mentioned by cases 1, 3 & 4 as very interesting. They are all convinced that technological development is required to achieve net zero supply chains eventually. Case 1 & 3 respond hopeful to a possible technological revolution that will drastically increase the sustainable transportation supply market. Case 4 is somewhat sceptical and foresees issues of both electricity and hydrogen as replacements for fossil fuels. Case 2 did not mention anything about the development of technology as a factor that he had in mind that would influence his decision making.

Economical climate is identified as an indirect effect on sustainable decision making. If a consumer were to choose a product based on sustainability characteristics for a higher price, it is stated by cases 2 & 3 that this is only true during prosperous economical times. In case of economical crises or high inflation at least, people will always aim to restore their purchasing power and opt for cheaper alternatives. Their sustainable principles are then neglected (at least for a while, until the economy is back up).

5.3 SECTIONAL CONCLUSION

The aim of this chapter was to answer the second research question:
How can CO_2 information create opportunities to become more sustainable?

A starting point for exploring opportunities is found by stating the desirability of the current situation (see Chapter 4). The case study exposed the lack of desire for CO_2 emission tools. How to grow their desire for the information by assessing their perception of influential contextual factors is explored thereafter.

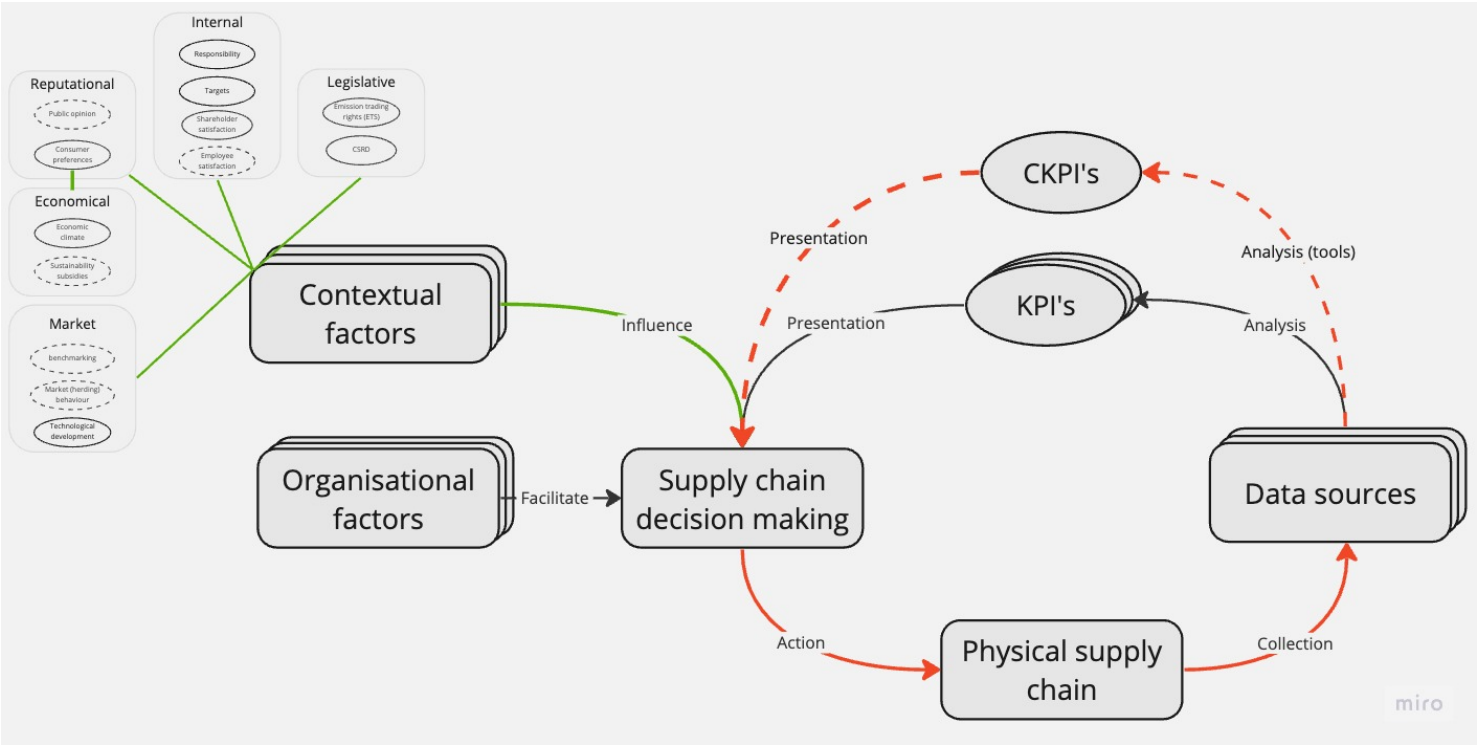


Figure 5.1: Updated conceptual framework based on opportunities for CKPI's

Where all relations indicated red for the current situation in Figure 4.1, the contextual factor influence has become green in Figure 5.1 to denounce a more positive expected relation in the coming years.

Data quality is an initial barrier that prevents cargo owners to acquire CO_2 emission information, which is why it remains red coloured. Doubts on the accuracy of a calculation, the scope of the model and the lack of standards for emission factors are shared among cargo owners. Intrinsic motivation to become more sustainable is another barrier in the pursuit of sustainable supply chains. Costs remain the leading driver for SCDM and that is not expected to change. Reliability and lead times have the highest regard after that, followed by sustainability at the bottom. However, one case has proven that they are willing to trade-off sustainability for higher costs, which implicates a strategy that does include CO_2 emission reduction as a priority. Cargo owners are confronted with influential contextual factors and responded to their potential impact on SCDM.

International legislation turned out to be a pressure factor that the industry deems of impact on the SCDM. Responsibility of scope 3 emissions among SCP's remains difficult and a restriction for establishing change. Changing consumer preferences might affect demand and thus decision making on the longer term. However, the consumer is not expected to collectively make different, sustainability driven, choices. Economical climate is a factor that only affects decision making indirectly through consumer preferences. Market factors are not mentioned in the exploration of opportunities for CKPI's. However, an additional factor: Technological development, is expected to affect the supply chains as well as decision making. However, a rearrangement of priorities regarding KPI's will not necessarily be the consequence of this sustainability increased supply chain, costs will remain the driver.

When pressured to prioritize CO_2 emissions in SCDM, it becomes interesting for cargo owners to acquire insights in the CO_2 emissions, a green arrow from contextual factors to SCDM denotes this effect (in Figure 5.1). Comparison functions and frequent status updates are opportunities that are created by the CO_2 emission information (tools). Agreements and collaborations on distribution of responsibility might cope with the lack of trust in the data quality. These opportunities can allow the decision maker to make better informed decisions with clearer consequences towards achieving probable sustainability targets.

6 OPPORTUNITIES FOR CO_2 EMISSION INFORMATION

The validated and empirically extended framework assumes a crucial relation between contextual factors and the use of a CKPI in SCDM. It also recognizes a role for information tools to serve the decision making process of a cargo owner by determining the KPI's through multiple data sets, methods and emission factors. Developing the tools with the market requirements as input, can help to create opportunities. They might allow for cargo owners to make an optimal use of the tools, to increase their sustainable logistical activities. To assess the opportunities for the CO_2 emission information tools, a number of expert interviews were conducted in Section 6.1. Developers of the tools, data scientists and business managers with the purpose to create the tools were interviewed from the Port of Rotterdam, Routescanner, BIGMile and Districon. The interviews are coded and analysed in Section 6.2 before drawing conclusions in Section 6.3 to answer the following sub question:
What can a port authority do to improve CO_2 emission information?

6.1 EXPERT INTERVIEWS

Five experts in the field of CO_2 emission tools, of which 3 are from the Port of Rotterdam of which 1 works for the Routescanner department, 1 from the company BigMile, and 1 from Districon. All interviewees were involved in the development or use either the Harbour Emission Service Platform (HESP), Routescanner or the BigMile tool. Their roles differentiate within the development of the tools which makes their input diverse and their output more comprehensive according to the Yin [1984] case selection protocols. Their names have been redacted for privacy considerations.

6.1.1 Port of Rotterdam Program manager

This program manager was involved with HESP from the start of the project and helped build both the area emission calculator as the initial chain emission calculator. The extended summary is included in Section C.3.1.

Description

HESP was designed to report emissions, prioritize port projects and enable decision makers and projects in their goal to become more sustainable. From the perspective of 'knowledge is power' it was decided that more insight in the emissions of the port and its users was required and HESP was the tool to provide that insight to the company business managers. The level of detail was not sufficient yet to report the emissions of the Port of Rotterdam at the moment of the interview, but it was planned to do so in the future. Purely sales and service goals are possible for now. Offsetting CO_2 emissions of a PoR client is a use case for HESP that is evaluated now at the Port.

External pressure is required to make companies change their behaviour. Taxing

CO_2 emissions is useful, but HESP (and other tools) are not suitable to cope with the level of detail that a CO_2 tax would require. Other initiatives are supported by the port of Rotterdam, who aim to break certain chicken and egg stalemates. Hydrogen and electrical water-taxi's are an example where the Port or Rotterdam aims to take the first step in developing and investing in alternative fuel powered vessels. Adopting international standards is also a field in which the port Authority feels they can play a significant role.

6.1.2 Business development manager Routescanner

This business development manager is involved with the development on the sales side. She aims to improve the tool by making it fit for the customers needs. The extended summary is included in Section C.3.2.

Description

A cargo owner might approach Routescanner to evaluate their (potential) performance. Either via a comparison function that allows multiple criteria to be prioritized in the search for an optimal supply chain. This includes tradelanes, port of calls and modalities to be evaluated by Routescanner at the request of the cargo owner. Another option is that the cargo owner requests a CO_2 emission report, in which case routescanner uses their expertise and emission calculation method to determine this. In either case there is no responsibility on assessing what trade lanes or activities to focus on.

Routescanner has the ability to actively make a cargo owner make different choices on the trade lanes they propose. Financial regulation is perceived to be useful and pressing for cargo owners, especially if they do not have the information (yet). Larger companies are more inclined to be an early adopter according to Routescanner, the highest impact with the lowest costs are then a common strategy.

6.1.3 Port of Rotterdam data scientist

From an early phase, this data scientist has contributed to connecting all sources of data in HESP. The extended summary is included in Section C.3.3.

Description

Acknowledging the differentiation in needs for customers, could decrease the barrier in gathering CO_2 emission information for a company. HESP is a CO_2 emission tool for internal use, with a lack of detail at this point. Making a generic model to be used by multiple clients should not be the goal of such a tool, however some clients might not need a higher detailed tool at this moment. The more involved a client is with making their supply chains more sustainable the more customization is desired. That approach would require a lot more information that is often not available yet. Transportation companies or ocean carriers for example have valuable data for more accurate CO_2 emission estimations that is not used in HESP at the moment. Without it a TNO model aims to represent the real world by making assumptions and using key figures and as much actual data as possible.

Agreements between market parties about responsibility for their emissions should be made, since that would stimulate information sharing among them. Information sharing might cause a conflict of interest for the port of Rotterdam when they report emission insights that harm certain port of Rotterdam clients.

6.1.4 BigMile Data scientist

This data scientist is specialized in programming the tool and aiming to visualise insights in the CO_2 emissions to increase the sustainability of his clients. He was brought on to the HESP collaboration and is an expert on developing and tweaking the tool to the needs of a customer. An extended summary is included in Section C.3.4.

Description

More cargo owners are becoming aware of the need to gain CO_2 emission insights and request the services of BigMile to do so. Where in the past it was sometimes required to persuade a client of the need to become more sustainable, now with the CSRD legislation coming their way that is not necessary anymore. Even transportation companies have joined the line, sometimes at request of their clients (the cargo owners).

Our tool calculates the emissions based on the company shipping data and emission factors in three options: GLEC (EU), British specific factors and Dutch specific factors. They align almost completely, with slight differences for the regional specifications. The goal is to provide emission reports with a certain methodological validity to be checked in audits and to be compared to similar reports. Data quality can cause disruptions in the discussion which can lead to an undesirable change in attitude that prevents a rapid sustainability increase. Our aim is to refrain from an immediate focus on a detailed emission estimation, but to focus on the information that is reliable and go on further from there. Frequent updates are recommended, but it is up to the client how often that update occurs. Once a year is too few and cannot actively engage the decision makers to decrease emissions.

CO_2 emission information tools can be of value. Applications in supply chains are widely spread and regard mode shifts, fuel shift and even shipment frequencies and sizes already. A reduction of the costs remains of key interest, but with the legislation coming, that might go hand in hand. Without such pressure there will not be any change. However, higher prices could also just mean more costs for the consumers.

6.1.5 Districon senior sustainability consultant

Districon is a sub division of Royal Haskoning and is specialised in 'mastering flow'. This senior consultant was focused on the use of HESP in decision making processes. The extended summary is included in Section C.3.5.

Description

HESP is not a predictive model. It is suitable to give advice based on historical data, but it cannot provide a comparison between options at this moment. Bringing together multiple historical data sources is something that HESP is very good at. At Districon we see an increase in demand for audits on CO_2 emission reports. However, HESP alike requests are not common, since PoR alike varieties of emission sources is not standard. Something that HESP is also aiming to achieve is to add a constant stream of information to the business managers, that can affect their daily decision making. Cargo owners in the market that contact Districon are not looking for information streams to affect their daily decision making. Purely long term (2030) goals are at the mind of decision makers.

Complying with the coming legislation is something that already triggered a few companies to rethink this attitude. Targets set by parent companies are sometimes the reason, artificially attractive business cases as well. Legislation is a measure to make business cases of sustainable alternatives more attractive.

Agreements between market parties about emission responsibilities are desired. They share the responsibility, but in practice it is not the cargo owner who will take first action.

6.2 EXPERT FINDINGS

The expert interviews as shortly described in the previous section have in common that they comment about the current CO_2 emission information tools that they worked on, their perceptions on potential opportunities for their tools and a perception on the role for a port authority in providing the emission information. The interviews have been coded based on the topics that the interviewees touched upon. Corresponding and contradictory statements are looked for and highlighted in the next section. Table 6.1 shows the number of responses per category.

Table 6.1: Combined coded result of experts

	Category	# of responses
Current tools	Model characteristics	4
21	Use of models	9
	Tool market	5
	Flaws	4
Potential	Fears	5
22	Opportunities	11
	Regulation	4
	Conditions	3
Current role of PA	Role of PA	4
Validation	Validation	8

6.2.1 Current CO_2 emission tools

How CO_2 emission information is currently produced, what the qualities and flaws are and how the market for tools currently looks like is commented on by the tool-experts and there are 21 responses identified that regard any of these topics. Table 6.1 specifies the responses for subgroups that are identified during the coding process, after the interviews.

The level of detail of the information determines the way that the tool is used. Some models have a generic approach, with the purpose of making it available for more clients. This approach would encompass a model with publicly available data and acknowledged key figures and standards. However, the more clients are aimed to be served with the same tool (with publicly available key figures), the less accurate it will be for any client. Specific data sources, often from the client who aims to receive CO_2 emission information, are preferred and result in a more accurate estimation. One size fits all proposition is not desired according to the experts.

Regardless that one size fits all is not desired for CO_2 emission information, there is still an advantage for a port authority in providing emission information. With HESP there are a number of confidential information sources that comprehend ship location data, ship engine and fuel consumption data, inland transportation data

sets and some key figures and assumptions to formulate acceptable output. Routescanner uses input from all modalities as well as public data and confidential data to determine travel distances and emissions per trip. Bringing together information streams is an advantage that no other party has and this will affect the responsibility discussion as well as the data quality blockade positively.

The market for both new tools as the demand for the services are growing. All experts acknowledge the rise of CO_2 emission information. Insights are the foundation of change and where early adopters were the main client before, early majority parties are now requesting CO_2 emission calculation services[1].

Detailed estimations to satisfy reporting obligations are not yet possible with all tools. For the tools that are used for this already, it is common that directly affected partner companies of their clients, also request the same emission services. This is referred to as the 'cluster-effect' where a cargo owner has to report their emissions, and require emission information from their partners, and that these partners have to acquire the same services to retrieve the emission information. This helps to increase the available data sources and thus increase the accuracy of the information. However, an important note is that accurate data should not be the initial goal for logistical decision makers. Non-perfect information could already help them to roughly prioritize their activities and set (broad) goals for next periods based on current (inaccurate) baselines.

6.2.2 Potential opportunities for CO_2 emission tools

22 Responses can be filed under the category potential opportunities for CO_2 emission tools. Potential opportunities can arise from a restriction, flaw or fear and some experts elaborated on this. Potential opportunities for the tools itself and its role in the market are mentioned as well as some conditions.

The level of detail and the focus on the level of detail of the CO_2 emission information is crucial in the initial phase of a cargo owner receiving CO_2 emission information. Both the focus and the level of detail should not be too narrow according to the experts. Find an initial estimation and start from there is the consensus.

CO_2 emission tools were initially designed to report the emissions, prioritize alternatives and enable sustainability initiatives. High impact alternatives first and (company) data driven, are common perceptions as is the need for trustworthy and industry wide emission standards. This is desired to be able to compare "apples with apples".

A comparison function is something that all experts acknowledge as a requirement. Multiple functions are mentioned, but the most common are: Comparison over multiple years or time periods and comparison over multiple activities or choice options. Another renowned opportunity for CO_2 emission tools is a frequent update of the sustainability performance. Preferably once a month, although that is more time and resource consuming. An offsetting recommendation function, is mentioned as an opportunity for the tools, however this should only be presented in case no other (insetting) option is available.

Regulation and legislation is identified as institutional opportunity. Companies are reacting already to upcoming legislation, which might affect the business case of sustainable alternatives. Financial incentives are collectively identified as required for motivating decision makers and also why regulation is an opportunity for the

1 This follows the technology adoption life cycle theory and vocabulary

tools.

A calculation methodology, which is included in all tools, must be sound and reproducible for both internal and external audits. Another condition is the formulation of agreements between market parties about responsibility. Without either, there is no use for CO_2 emission tools.

6.2.3 Current activities of port authority

4 responses are recorded as commenting on the current role of a port authority in facilitating CO_2 emission insights, three of which from a port employee.

Breaking a chicken and egg impasse in the market is mentioned as a potentially useful function that a port authority might perform. Since port authorities are mostly public (-private) organisations, they have the responsibility to preserve public goods. Air quality and climate can be seen as such a good. Investing in initiatives that allow the market of sustainable options to start or scale up is then a role for a port authority.

Adoption of international standards is something that requires trust. A port authority can show that they trust a standard by adopting it themselves. With CO_2 emission information, this can be translated to a rapid adoption of the GLEC framework [SFC, 2019] with standards for emission factors.

A neutral role is acknowledged for a port authority. However, providing insight in emissions might harm the operations of some clients, which might make them move to other ports. This will cost the port income, which assumes their neutrality to be somewhat biased.

6.3 SECTIONAL CONCLUSION

The aim of this chapter was to explore opportunities for CO_2 emission information tools and thus answer the following research question:
What can a port authority do to improve CO_2 emission information?

Since CO_2 emission information is relatively new in SCDM, it was not possible to explore opportunities based on existing knowledge. To fill this gap, expert interviews who are specialized in developing CO_2 emission information are conducted.

First it is determined what current CO_2 emission information is provided by some tools, to highlight flaws and starting points for improvements. A distinction was mentioned by the experts on the use and characteristics of the tools that they worked on. Internal and external use differentiated the level of detail and responsibility of the information provider. For external use there was little responsibility for the tool provider and a lot of company specific data and detail required, whereas the internal tool was purely based on generally comparing all sorts of companies and activities to formulate business strategies.

The experts were then asked about their views on improving the CO_2 emission tools, and their unanimous belief was to provide a customized detailed emission update with a relatively high frequency such as monthly or quarterly. Use widely adopted and methodologically sound calculations and standards to make sure that different emission reports from different companies, options and years can be compared. Agreements on responsibility and regulation on emissions such as CO_2 taxes

are mentioned as possible opportunities that do not specifically regard the tools itself.

The port authority is assumed to adopt a relatively neutral role in accepting international standards and breaking market impasses to promote sustainable innovations.

7 DISCUSSION

This chapter will reflect on the results from literature (Section 7.1), case studies and experts(Section 7.2). Policy considerations for legislative bodies and port authorities are then discussed in Section 7.3. Limitations of this research in Section 7.4 will end this chapter.

7.1 REFLECTION ON LITERATURE

Chapter 3 provides an overview of the literature about SCDM and the influence and existence of CO_2 emission information in decision making processes of cargo owners in port hinterland environments. The literature is reviewed and used to substantiate a conceptual framework that formulates relations between physical attributes, data, information, decision making and its contextual environment to be empirically validated in the multiple case study in Chapter 4 and Chapter 5. Literature touches upon CKPI's inclusion in multi-objective decision making models. However, this remained theoretical whereas decision making in supply chains is not. Some literature about decision making in supply chains is presented, yet no explicit distinction between strategic, tactical or operational decision making is formulated in the conceptual framework. CKPI's were deemed to be too premature in decision making to already be detailed in decision making levels.

An estimated linear relation of the trade-offs between the KPI's is posed in Figure 3.6, where every KPI is traded off with costs. Correlations between the multiple KPI's are not included, even though they might exist. Specific options are also refrained from, since supply chains are very diverse and the availability of logistical options is different in every supply chain.

Safety is mentioned as important KPI, but not explicitly compared to other KPI's. There can always be more investments in safety, which indicates some sort of interrelation, however accepting higher safety risks for a cost decrease is (luckily) not often an option (legally). The decision making process is now presented as a static picture in which every decision can be put in a box and labelled. Decision making dynamics or ambiguity is not included in the literature review, but might have had a positive outlook on the interview protocol and thus results.

The framework is based on the theoretical foundation from the Baker [2012] TOE framework, which has some shortcomings. Data driven decision making, including data collection, analysis and integration, are not touched upon by Baker [2012], but are essential for the conceptual framework in this thesis. Other methodological frameworks that included data driven decision making, would have complemented the TOE framework in this regard.

7.2 REFLECTION ON RESULTS

The coloured results tables in Table 4.5 and Table 5.5 show a distinction in quotations that are positive, negative and dubious towards emission reduction in port

hinterland environments. The attitude in the current situation mostly concurs with the exploration of the opportunities, with some exemptions. Data quality is perceived to be a big problem for opportunities of the information and shareholders are perceived as potentially influential on decision making. Opportunities are per definition positive and a future change in trade-off is not expected, since the pressure is not felt at the moment of the interview. Technological development is a difficult factor and has a similar effect as the market pressure. For parties who lay behind it is of bad influence since it gives extra reason to remain behind (in either technology or the market). For front-runners it provides opportunities that can become beneficial, but this is not guaranteed. Caution is prescribed.

7.2.1 Reflection on CKPI status

Chapter 4 shows that CO_2 emission information has a limited role in decision making for all but one case study respondent. Not only is CO_2 emission information not desired at this moment, it is also not easily acquired and thus requires effort from a cargo owner. Emission reduction is a side effect of efficiency increases, since costs remain a leading factor in decision making for every decision. For this reason, there are almost no logistical options selected that increase sustainability at the expense of another KPI. However, all companies have admitted to have opted some sustainable logistical activities in the previous years, but only for the benefit of efficiency increases. So emission information is not required or desired, but sustainable logistical activities are occasionally selected anyway based on efficiency increases.

This spurious effect of not valuing sustainability in your decision making, but sometimes still choosing a more sustainable option should be recognized. However, no company in the case study shows that they feel any type of pressure from a contextual factor, such as shareholders, consumers, legislation or political factors. Thus, they are not inclined to change their evaluation process towards a bigger role for CKPI's even though they might already implement some sustainable logistical activities. If anything, the most influential contextual factor in current decision making processes are market forces. However, this influence is negative at this moment in time. From the perspective of a cargo owner, it is beneficial to remain reluctant and let other market parties such as transportation companies become more sustainable. Their supply chains will then over time become automatically sustainable. This is conceptually depicted in Figure 7.1.

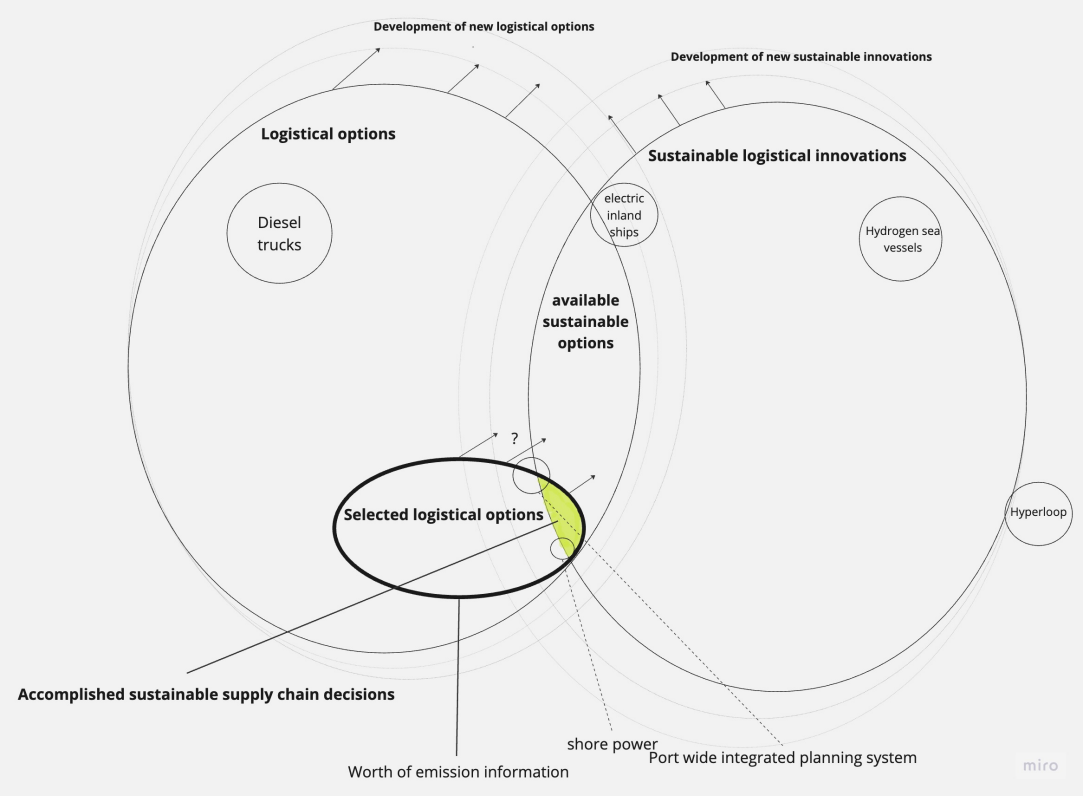


Figure 7.1: Expected shift of sustainable logistical options of reluctant cargo owner

This boils down to the discussion of responsibility of scope 3 emissions in supply chains, an often mentioned void in current supply chain management. A lead in overcoming this and crucial aspect of supply chains of cargo owners is the tendering process in which all types of transportation companies, forwarders and carriers have to compete to win a concession to execute the transport. In practice, this would comprehend an extension of the availability of data sources between parties to determine pieces of the scope 3 emissions, which remain absent for many cargo owners. Assumptions and modelling with key (standardised) figures are the alternative, but data quality of the output of most models is thus of low accuracy and is therefore not trusted.

7.2.2 Reflection on CKPI opportunities

The coloured results tables in Table 5.5 and Table 4.5 allow a quick glance over the colours to draw immediate conclusions about the sustainability performance of a company. A dominant red colored column is undesirable and a dominant green column is stimulating emission reductions.

A major result in this thesis based on literature, case study and expert opinions, is that contextual factors are required to pressure a cargo owner to choose sustainable logistical alternatives over less sustainable logistical options. When assessing the opportunities of CKPI's, this pressure was not present nor expected. A relatively sceptical opportunity exploration was a consequence of this, but with some promising opportunities nevertheless. Chapter 5 recognize a stalemate in the data quality discussion as none of the respondents expect the quality to become better in the

coming years. Common grounds among all case respondents for opportunities for CO_2 emission information were customized emission reports that at least include:

- Renowned emission standards
- Renowned emission calculation methods
- Frequently updated emission reports
- Periodical comparison functions
- Activity option comparison functions

These applications are already available in most tools, which implicates the lack of awareness about the information tools at this moment. This lack of awareness does not extend to the coming legislation about restricting scope 3 emissions by the European Union.

A noticeable result considering the trade-off between KPI's is the willingness to pay more for less emissions in some instances. The literature posed an unknown relation in this regard and it is confirmed by the result from the beverage brewery. It does restrict to only this one company, since the other cases were not willing to do so. The attitude of these companies to prioritize every KPI over CKPI's, will not last seeing the increased pressure of legislation on CO_2 emission taxes from the EU. Not only are the laws making every company gather data, insights and reports, they also exclude all parties from business if they don't (see CBAM example in Section C.2.4). Business cases are also positively shifting towards sustainable options because of potential CO_2 taxes for scope 3 emissions. Technological development is a driver for making sustainable options possible, however they are still used as reason to not adopt, since the technology will develop even further and "why step in now".

Responsibility remains a question for all cargo owners, however some tendering procedures and agreements are within scope to cope with this responsibility issue. Consumers can play a big role by collectively preferring sustainable products including sustainable transport. However, economical status is expected to diminish this effect, people will choose sustainable options if they can afford it. A factor that is neither internal, nor external but of influence on the sustainability increase of supply chains is the size of a company. A simple finding is that the more revenue a company has the more they can invest. However, more elaborate findings are: Firstly, steady and large volume flows are a guarantee for high load factors which would increase the return on investments. Secondly, large companies often have a lot of activities which makes it harder and more time consuming to change all activities before 2030 or even 2040 net zero targets. Often mentioned are the marketing advantages, alternated with 'green-washing', of selecting some very visible sustainable logistical activities to gain more customers or revenue.

7.2.3 Reflection on role of port in tool improvement

The experts presented their view on CO_2 emission information tools and their use in the transportation sector. The use of a tool is very dependent on the goal that is aimed for. A distinction between strategic, tactical or operational choices determines the level of detail and thus type of tool and data sources. It is felt by the experts that the market for tools is accumulating with an increase of demand caused by external pressure from new legislation. However, this is limited to the reporting legislation, whereas the data quality for taxing legislation is not accounted for in the current tools.

None of the experts reflected on the position of the tools in the market. Practical implications were aligning with the industry demands, such as renowned emission standards, frequent updates and comparison functions. Even though these are partly adopted already, it is still acknowledged by the experts that there is room for improvement in this regard.

The current role of a port did not receive much attention from the experts. Providing information to cargo owners, carriers, transportation, or other SCP's was not necessarily a port authority responsibility at the moment. Being the guarantor of public values and thus being able to break chicken and egg impasses for sustainability investments is an acknowledged advantage for a port authority.

7.2.4 Reflection on framework

After discussing the results of the literature and both case studies, an update of the framework is appropriate including multiple additional contextual factors that were identified in the case study and their proposed effect on the framework.

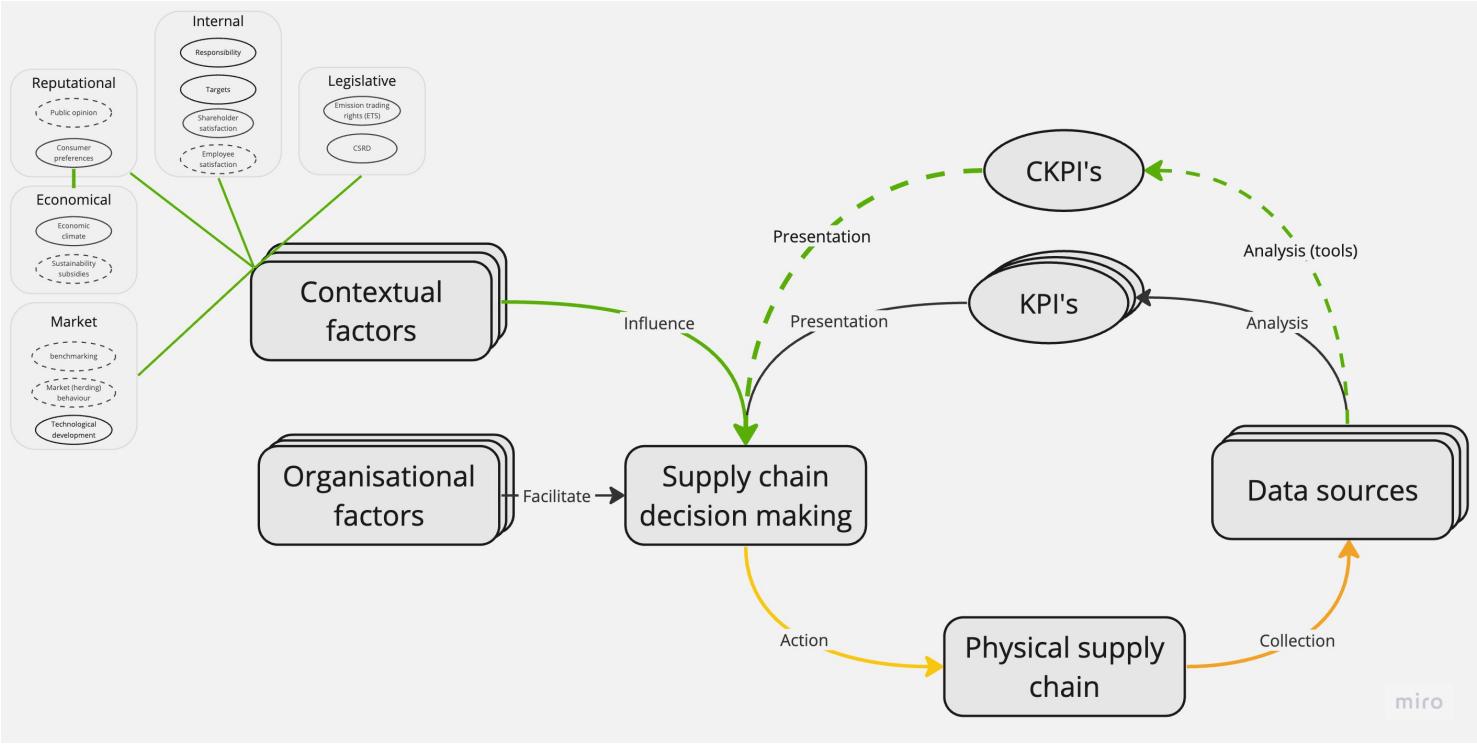


Figure 7.2: Validated SCDM framework including policy projections

Data collection remains a hard endeavor in supply chains, with all its consequences. Shared supply chain data can contribute to improving the quality of the emission information, under the right circumstances. Not if, but when a cargo owner feels they need to come up with CO_2 emission information for either compliance to legislation, consumer pressure or shareholder requirements, emission calculation services are a useful tools. A green arrow is therefore appropriate, especially since the data collection is expected to improve due to the increased awareness among transportation companies and cargo owners. Responsibility discussions are held and this will invoke action on their side to improve their data sets seeing that data quality was their biggest hurdle. This is not a holy grail, since action is not inexplicably coupled to these responsibility discussion, an orange relation indicates doubt.

Safety was not mentioned in the case study, which is quite logical since nothing can be traded off with safety in supply chains. It will remain a KPI in the framework (see Figure 3.6), because it is assumed to be a silent priority of all cargo owners. Subsidies are not mentioned in the case study and neither is public opinion or employee satisfaction. These external factors did not have a validated relation with SCDM or CKPI's. However, excluding them from the framework would not be possible with a case study as small as this one. Specific research would have to be conducted on their role and test with a large N whether they can be excluded. Economic climate remains of influence but in an indirect way through consumer behaviour.

Since impactful decision making has proved to be an option under a lot of conditions, it is assumed that the feedback into the physical supply chain will have positive consequences for more sustainable logistical activities. However, even though sustainable logistical options are pushed by contextual factors, and enabled by insight from CKPI's, there is still a trade-off for the logistical decision maker to make, hence the orange relation.

7.3 POLICY CONSIDERATIONS

The focus of this thesis is aimed at the cargo owners, since they have decision making power over their supply chains. However, as the results present, there is a large role for other institutions in the decision making process of these cargo owners. Some recommendations for these institutions are included in this section.

7.3.1 Recommendations for port authorities

The dominantly red coloured relations in the case study validated framework in Figure 5.1 can be tackled by putting pressure on decision making processes, tackling data quality and responsibility discussions. A community guiding role can be portrayed by a port authority, such as the port of Rotterdam.

A port authority has a responsibility to its clients to facilitate their current and future needs. Promoting innovations and changes for the benefit of society is a role that the port of Rotterdam has adopted in their strive to remain the smartest port in the world. Emissions are new in the transportation industry and it does occur often that companies do not have a strategy for how to deal with that. A port authority can act as connector in the system by providing a rough initial emission baseline and consequently refer other partner organisations for more detailed emission information.

Another consideration for a port authority is to create attention for the detail discus-

sion of cargo owners, transportation companies and calculation services. The focus should not immediately be to provide a detailed (ready for taxing) calculation. Initial baselines are useful for high over prioritization already and a more accurate emission insight can be determined in later stages. Companies tend to adopt a negative attitude towards CO_2 emission information when it is not instantly as accurate as they like it to be. This attitude then reflects on their decision making process, with a disregard for sustainable options.

Implementation

Since a significant role can be assumed for a port authority in sustainability increases of supply chains, a timeline is included to align port intentions to what is required of them. The timeline in Figure 7.3 is specifically designed for the Port of

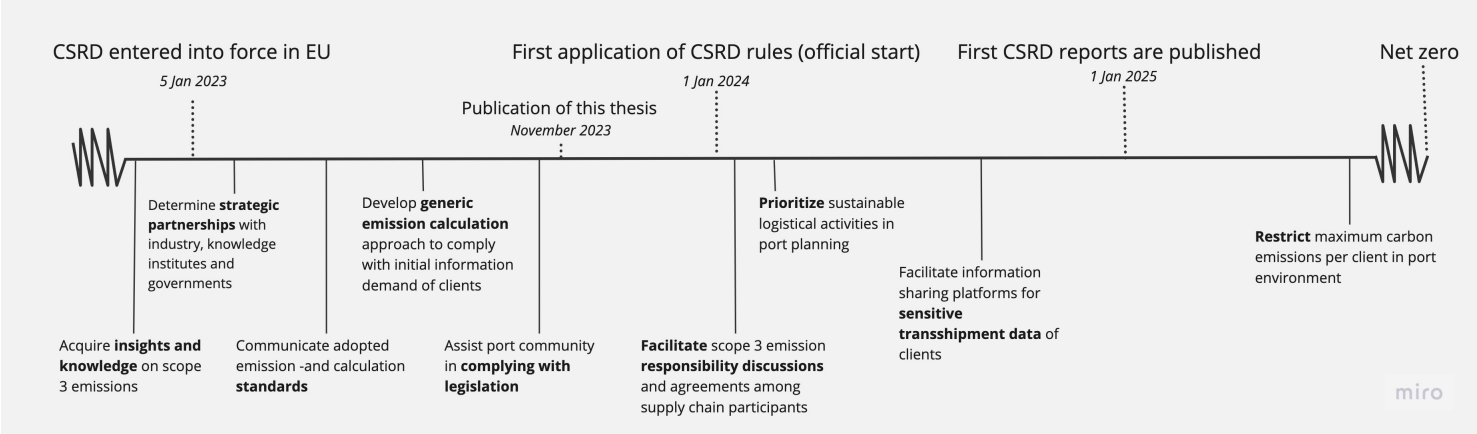


Figure 7.3: Port of Rotterdam timeline

Rotterdam. The European CSRD legislation is the red thread through the timeline, and combined with the knowledge and tools within the Port of Rotterdam, makes them unique in the world. The port of Rotterdam already has the know how on scope 3 emissions from their internal HESP and external Routescanner tools, they have an enforced international legislation that pushes their clients and they have a close connection with a lot of their clients (cargo owners among others) that can allow an emission related data sharing initiation to be a success.

The Port of Rotterdam could adopt a 'roadmap leader' position in collecting and sharing emission related data, using that to produce insights and then using the insights to stimulate the selection of sustainable logistical activities in the decision making processes of cargo owners in Europe and the world. Their guidance could help other ports in Europe within the same (approximate) context, who do not have the expertise on emissions. Other ports in the rest of the world could learn from the circumstances in which the port of Rotterdam acts (read: effective contextual factors) that push logistical decision makers. Lobbying with legislative powers to establish that is within the ability of a public-private company like most port authorities.

Lessons learned in the development and usefulness of calculations, including emission standards and (third) party transshipment data are very valuable for other ports. Red coloured loops could become green faster and with less effort, all in favor of a larger and faster emission reduction.

7.3.2 General recommendations

Education of consumers is the first policy consideration for national and local governments. The positive influence of consumer preferences on decision making processes, is confirmed in this research, and yet not a threat for cargo owners. Cargo owners are inclined to select other logistical options, if their customer would prefer sustainable (transported) products over a non-sustainable alternative. A governmental body could create awareness about the emissions of products and the way they were transported, to push consumers to choose environmental friendly products.

7.4 LIMITATIONS

This research knows several limitations which are summed up in this section. The first limitation is the number of interviewees of the multiple case study. As Yin [1984] describes in his work, it is preferred to interview more than one person from the same case to provide internal validation of the results. This limitation can be extended to the sample size of the case study and interviews on which this thesis is based. Exploring the role of CO_2 emissions in SCDM and the influence of contextual factors on that process can be performed by means of this case study. However it is difficult to exclude certain factor based on this research since there might be a different relation if more companies were interviewed.

The second limitation is debunking for the results of Chapter 6. A workshop was desired since the literature pointed out advantages for that method [Krueger et al., 2012]. However, the competition between experts from different companies and tools hindered a cooperative and productive workshop. The value of the expert interviews is not restricted, but more expressive opportunities for the CO_2 emission tools might have arised.

A third limitation of this research is a lack of perspective in the scope. A focus on the cargo owner because of their responsibility for the production and transport of the products was chosen. Including more SCP's, might have given more insights regarding the responsibility distribution of the scope 3 emissions.

A fourth limitation is the representativeness of this thesis towards port hinterland environments. Port of Rotterdam was represented in this case, in which all case study respondents had a cargo flow through the port of Rotterdam. Other less developed ports would have different contextual factors and even different stakeholders. For example the port of Singapore only has 1 company that operates all terminals of the port. Such players have more power and will cause different decision making processes.

Some impacts on sustainable SCDM are assumed by multiple external factors. A final limitation of the approach of this thesis is that all impacts are deemed as equal by just deeming them impactful. It would be beneficial for policy makers, port authorities or cargo owners to know what factors have the biggest influence compared to the other ones. Policies of either party can be adjusted and budgeted based on exploiting the most impact ones.

8 CONCLUSION

A literature study was conducted to combine scientific knowledge with industry standards into a conceptual framework. Then the sub-questions are answered accordingly, by applying the method from Chapter 2. Table 8.1 shows what question is answered in what chapter. The answers to these questions are summarized and

Table 8.1: Research questions and subsequent chapters

Research question:	Chapter
SQ1: How do cargo owners deal with CO_2 emission information in their SCDM in a port hinterland environment?	4
SQ2: How can CO_2 emission information create opportunities for logistical activities to become more sustainable?	5
SQ3:What can a port authority do to improve CO_2 emission information?	6

presented in the subsection below. This is followed by a concluding section that answers the main question and subsections about the scientific and societal relevance of the work. Recommendations for further research will then be the closing section of the thesis.

8.1 RECAP OF SECTIONAL CONCLUSIONS

Every sub question is answered here separately, with input from the chapter but summarized for the purpose of interpretation later in the next section.

SQ1:How do cargo owners deal with CO_2 emission information of in their supply chain decision making in a port hinterland environment?

Cargo owners currently have limited interest in information on scope 3 emissions of their port hinterland supply chains. Data quality is doubted as neither cargo owner nor any other supply chain participant has sufficient data that can provide insights that are of worth to a cargo owner. Costs are a leading KPI in decision making and CO_2 emission reductions are a side catch of efficiency increases. The stakeholder and institutional context of a company is proven not to be of sufficient influence to value CO_2 emission information more than any other KPI at this moment.

SQ2: How can CO_2 emission information create opportunities for logistical activities to become more sustainable?

Data quality forms a blockade for exploring opportunities of CO_2 emission information. Tackling that blockade can increase the opportunities for emission information and that can be done by adopting renowned emission standards, increasing transparency among SCP's, agreements on scope 3 emission responsibilities among SCP's and customized approaches for every cargo owner. Discussed logistical applications of emission information are mode choice considerations or warehouse location management. However, these decisions remain solely based on efficiency grounds with emission reduction as a side catch. Any reduction of CO_2 emissions is an improve-

ment, but it is not perceived to be stimulating for more reductions if emissions are only valued as a nice side catch.

Legislation in general is perceived as very impactful on decision making processes of cargo owners. However in some instances such as CBAM, ETS or other taxing legislation there would still be an efficiency trade-off at the cargo owners decision making process. In the case of such legislative pressure, it is mentioned by all case study respondents that the high impact, low cost logistical options are selected first. Other factors such as shareholders and consumers can affect the decision making on a different level, with more impact on the trade-offs between KPI's in favor of CKPI's.

SQ3: What can a port authority do to improve CO_2 emission information?

Bringing together information sources is a current strength of port authorities. This could be of value in determining logistical scope 3 emissions that overstep company boundaries. Spreading adopted A-class emission standards, calculation methods and expertise about emission information, are all functions that a port authority can adopt, that increase trustworthiness of CO_2 emission information and put the information to action. Facilitating information sharing practices between SCP's to enhance the data quality of their emission calculations is a significant role for a port authority. Agreements about responsibility can also be a product of this facilitating role, which might require their ability to break 'chicken and egg' impasses.

On an international note, there is an urgent need to apply emission information to decision making processes. A 'roadmap' leading role including all port authority functions as described above would be suitable for a port like the port of Rotterdam. Legislative context is already in place in the EU, which generates urgency in the market, they have knowledge and expertise on logistical scope 3 emissions and have the international connections with other ports that allows close collaboration. Lobbying can be effective to push for certain policies regarding consumer awareness or effective legislation. Technological development has been proven to be of value to decision-makers in the case study, and a port authority can facilitate and (financially) stimulate technological innovation.

Locally there can also be active involvement in addressing the bottlenecks of mode shift policies, for example by giving priority to certain trade lanes with inland vessels or trains over trucks. Well-founded emission reduction projections can be vital in this active port authority approach.

8.2 CONCLUSION ON MAIN RESEARCH QUESTION

Now that all sub research questions are summarized, they can be combined to answer the main research question:
How can CO_2 emission information in a port hinterland environment contribute to making logistics processes of cargo owners more sustainable?

High impact and low cost options are the obvious first choice of every decision maker, whenever a logistical decision has to be made. Emission reductions receive the same approach, so when a logistical decision maker prioritizes emissions and long haul trucking is his biggest emission factor, he will preferably select a replacement modality for his long-haul transport that will win him the most reductions, while at the same time keeping his cost efficiency or even increasing it.

CO_2 emission information tools can contribute to selecting more sustainable logistical options. Providing insight might allow a cargo owner to report their emissions (to whomever might require it), prioritize their (sustainable) logistical activities and enable action by evaluating (previous) actions or policies. However, before these tools are able to add any value, some conditions have to be met. Data quality is perceived to be problematic for using current CO_2 emission information tools. An emission estimation based on models that include key figures, average distances and average load factors are perceived as useless, because the actual emissions might be way off and any reduction will not be noticeable. The expectation of an inaccurate emission estimation, doubted emission standards, combined with a lack of useful data sources to appeal to for a comprehensive scope 3 estimation, refrains cargo owners from attracting CO_2 emission tools and their products.

If SCP's were to share more information that relates to CO_2 emission calculations, such as travel data and fuel consumption, there would be an increase in data quality. Broadly accepted emission standards are already included in almost all available tools, yet still underlined by cargo owners. Comparison functions over multiple modalities or years and frequent updates are also indicated as opportunities by the cargo owners, even though these functions are already available in tools on the market. A reason for cargo owners not being aware of these functions of the tools is that they are not inclined to value emissions in their decision making. Costs are the driver for SCDM processes of cargo owner and emission reductions are a nice side effect of efficiency increases.

A result from the case study is that pressure on the decision making process can have a positive influence on emission reduction of logistical activities. In the current decision making process, there is little influence on the sustainability degree of selected logistical options, but it is acknowledged that this can change for some factors. 1) Legislation is recognized as potentially influential for more sustainability. 2) (majority) Shareholders also have a large role in the norms and values of a company and therefore can influence sustainability strategies. 3) Consumers can influence decision making processes by prioritizing sustainable products which includes its required logistical activities. 4) Technological development will increase the available sustainable options and might thus decrease emissions. However, a limitation is the reluctant attitude that some companies might adopt towards change, 'because the technology might develop a lot still'.

These factors can push a cargo owner to select sustainable options for their logistics, which also favors more use of CO_2 emission information. Responsibility for scope 3 emissions of logistical activities is the next discussion point among SCP's. Agreements are required to determine who is responsible for what, but more importantly to collaborate to reduce the emissions together. Information is the first step for this and as mentioned essential for the (trust of the) data quality. Stakeholders in the supply chain network are key in this regard. A port authority has a strong information position in the port hinterland environment. 1) Lobbying for specific 'effective' legislation is within their abilities, they can 2) facilitate information tools to fulfill the market demand, especially if and when the legislation becomes active, and they can 3) facilitate information sharing processes that collaboration between SCP's. 4) Breaking impasses in the market regarding adoption of new technologies is also a confirmed ability of a port authority that might stimulate sustainable logistical activities.

8.3 RELEVANCE OF RESEARCH

8.3.1 Scientific contribution

There have been no examples in the literature that evaluate decision making processes of industry players for their inclusion of CKPI's. This thesis assesses real world decision making processes by interviewing companies with importing and exporting freight flows in port hinterland environments. The multi-objective approaches in the literature are presumably theoretical, whereas this thesis highlights some limitations in those approaches, considering CO_2 emissions are not valued in decision making processes at the moment.

The supply chain performance literature is complemented with this research as the literature-based framework is empirically validated in the case study. Decision making theory on port hinterland supply chains is complemented with the framework as data driven and KPI producing methods are used in decision making processes in hinterland supply chains. The effect of contextual factors on decision making was estimated in the literature which is validated in this research.

Where the literature focuses on the scoped decision making processes, often modelling studies with assumptions to represent a population alike decision making process, this study encompasses a multi-perspective approach. Decision making is influenced by its context and this affects decisions and emission reductions. Scope 3 emissions have not often been researched for responsibility distribution questions, which is also a scientific contribution of this research.

8.3.2 Societal contribution

The conceptual framework does represent a change in decision making that is broadly carried in society. A transition from gut-feeling decisions to data driven decision making (tools) is happening and even a twin transition is underway, where the data driven decision making can enhance sustainability innovations. The product passports of battery production prove this movement, but lacked of logistical scope 3 emissions in their visibility infrastructure. This exemplifies how the conceptual framework and this thesis in general can complement existing (emission) transparency projects.

A second contribution of this thesis is the exposure of potential handles for policy makers to put pressure on decision makers 'where it hurts the most'. Reduction policies from port authorities, regional, national and international policies can use the findings of this thesis for understanding potential effective contextual factors to exploit. Subsidising sustainable logistics or economical stimuli are not the most effective, compared to reporting or taxing legislation policies.

Thirdly, a policy recommendation aimed at generating awareness is societally contributing of this research. Making consumers aware of the influence that they can have on the decision making process of their suppliers. Even though a consumer might not be interested in a green produced product, its transportation is a big part of the total footprint of a product and by making a consumer aware that there might not be a difference in (homogeneous) products, but a significant one in the transportation, they might choose differently.

Even though there are not a lot of respondents in the case study, their presence on the markets are not negligible. By interviewing them about their attitude on emission reductions, they might be triggered to change their priorities (a little). Every reduction of emissions should be embraced.

A final societal contribution of this research is to strengthen the role of the port of Rotterdam as roadmap leader. Scope 3 emissions are difficult for companies and adopting a community guiding role from a renowned front runner for technology and connectivity as the port of Rotterdam stimulates the whole industry to act on their scope 3 emissions.

8.4 FURTHER RESEARCH

The approach and scope of this research explored certain applications of CO_2 emissions in supply chains that are somewhat generic. This allows for multiple directions for recommendations for further research that can be based on this thesis. The first recommendation is to extend the scope of supply chain activities. A large part of freight transport emissions are left out of the research scope for time limiting purposes. Different power structures between overseas SCP's such as carriers or production facilities might result in different influential contextual factors.

The second recommendation for future research is to isolate specific logistical activities and quantify the influence of emissions on decision making processes by means of stated choice modelling among cargo owners. Quantitative analyses might result in different dominant factors or opportunities for CO_2 emission information in SCDM. A larger respondent set could increase validity of the outcomes. This could ensure that excluding a non-influential factor is plausible.

Another recommendation for further research would be to evaluate the effect of legislation on the decision making. After reporting and perhaps restriction or taxing legislation is in place, it would be recommended to study the consequences of this on the decision making processes and emission reduction of supply chains. A qualitative research based on similar (perhaps a bit more) case study interviews would provide valuable results.

A similar study could also be done for an increased consumer awareness. Model scenario's with varying consumer preferences and link them to product demand. An agent based model would be suited for evaluating scenario outputs based on multiple input variables. The outcome would emphasize on the influence of the consumer on decision making behaviour of cargo owners.

8.5 PERSONAL REFLECTION

A blanco graduation internship was the ideal approach for my thesis even though it didn't feel like it at the time. Starting off with a new angle on modal shift studies every day was very common in the first few weeks, up until the moment where the graduation committee kindly advised me to drop this subject and look for another one. I then took another wrong turn into bottlenecks of container shipping, where I could use all these data sets and previous port of Rotterdam articles. Yet again a dead end with very few potential to write a thesis that would actually contribute. By this time I was already 2 months into the internship and both my Delft as Rotterdam supervisors helped me shape multiple thesis subjects, except I didn't feel convinced that they were the right ones. The port of Rotterdam team I worked in turned out to be my solution. Their current projects and concerns fueled my interest in CO_2 emission information tools, seeing that they were top-class products that had a lot of potential, which was untapped in my opinion.

The slow start then got even slower just when I found my holy grail, because I had a knee surgery after a football incident. The focus was off, but in the back of my mind I kept on thinking about the thesis. With the right guidance I then produced a midterm report in a short period of time after which the confidence about the thesis was enhanced in the meeting and the next steps were clarified. The interviews with the companies and experts were very enjoyable, even though some questions tickled a response that was not to their liking. The thesis kept on getting more shape and the framework stood its ground in the interviews.

The more I kept on explaining what my research was about the more it became clear to me as well and the more I felt that I was actually contributing. Coordinating the scientific and practical needs were no hurdle for me in this thesis as both sides benefit from my work. Writing this reflection I feel that even though I did have some trouble in the beginning, I worked through it and can now proudly present my work to any decision maker with interest.

BIBLIOGRAPHY

Aguinis, H. and Glavas, A. (2019). On Corporate Social Responsibility, Sensemaking, and the Search for Meaningfulness Through Work. *Journal of Management*, 45(3):1057–1086.

Alazzawi, A. S. (2021). Information System Analysis on Cargo Supply Chain Shipment for Decision Making in Bahrain Logistics Zone. *International Journal of Computing and Digital Systems*, 10(1):1263–1270.

Anand, N. and Grover, N. (2015). Measuring retail supply chain performance: Theoretical model using key performance indicators (KPIs). *Benchmarking*, 22(1):135–166.

ATLAS.TI (2022). ATLAS.ti — The #1 Software for Qualitative Data Analysis - ATLAS.ti.

Baker, J. (2012). The Technology–Organization–Environment Framework. pages 231–245.

Bell, D. and Grinstein, M. (2002). The Role of Government in Advancing Corporate Sustainability Background Paper.

Bruijn, J. d. J. A. and Heuvelhof, E. t. E. F. (2017). *Management in netwerken : over veranderen in een multi-actorcontext*. Boom bestuurskunde.

Chae, B. (2009). Developing key performance indicators for supply chain: An industry perspective. *Supply Chain Management*, 14(6):422–428.

Crowe, S., Cresswell, K., Robertson, A., Huby, G., Avery, A., and Sheikh, A. (2011). The case study approach. *BMC Medical Research Methodology*, 11(1):100.

Deterding, N. M. and Waters, M. C. (2018). Flexible Coding of In-depth Interviews: A Twenty-first-century Approach. *https://doi.org/10.1177/0049124118799377*, 50(2):708–739.

Ertimur, Y., Ferri, F., and Stubben, S. R. (2010). Board of directors' responsiveness to shareholders: Evidence from shareholder proposals. *Journal of Corporate Finance*, 16(1):53–72.

European Comission (2023). Corporate sustainability reporting.

European Commission (2018). Reducing emissions from the shipping sector.

European Commission (2021). Emissions monitoring & reporting.

European Commission (2023a). Carbon Border Adjustment Mechanism.

European Commission (2023b). EU Emissions Trading System (EU ETS).

European Parliament (2023). Reducing carbon emissions: EU targets and policies — News — European Parliament.

Gatzert, N. (2015). The impact of corporate reputation and reputation damaging events on financial performance: Empirical evidence from the literature. *European Management Journal*, 33(6):485–499.

Gaudenzi, B., Zsidisin, G. A., and Pellegrino, R. (2021). Measuring the financial effects of mitigating commodity price volatility in supply chains. *Supply Chain Management: An International Journal*, 26(1):17–31.

German Federal Ministry for Economic Affairs and Climate Action (2023). Battery Passport Content Guide. Technical report, Battery Pass consortium.

Gómez-Cedeño, M., Castán-Farrero, J. M., Guitart-Tarrés, L., and Matute-Vallejo, J. (2015). Impact of human resources on supply chain management and performance. *Industrial Management & Data Systems*, 115(1):129–157.

Havenbedrijf Rotterdam (2022). Havenbedrijf Rotterdam en BigMile maken transport-emissies inzichtelijk met digitaal platform — Port of Rotterdam.

IEA (2022). Emissions Factors 2022 - Data product - IEA.

IMO (2004). AIS transponders.

Kallio, H., Pietilä, A.-M., Johnson, M., and Kangasniemi, M. (2016). Systematic methodological review: developing a framework for a qualitative semi-structured interview guide. *Journal of Advanced Nursing*, 72(12):2954–2965.

Kim, N. S. and Van Wee, B. (2009). Assessment of CO ¡sub¿2¡/sub¿ emissions for truck-only and rail-based intermodal freight systems in Europe. *Transportation Planning and Technology*, 32(4):313–333.

Koller, H. (1935). The bill of Lading. *Bankers' Magazine*, 131(6):547.

Krueger, T., Page, T., Hubacek, K., Smith, L., and Hiscock, K. (2012). The role of expert opinion in environmental modelling. *Environmental Modelling & Software*, 36:4–18.

Leavy, P. (2014). Unstructured and semistructuring interviewing. In *The Oxford handbook of Qualitative research*.

Li, G., Yan, H., Wang, S., and Xia, Y. (2005). Comparative analysis on value of information sharing in supply chains. *Supply Chain Management: An International Journal*, 10(1):34–46.

Lin, N. (2019). CO2 emissions mitigation potential of buyer consolidation and rail-based intermodal transport in the China-Europe container supply chains. *Journal of Cleaner Production*, 240.

Lotfi, Z., Mukhtar, M., Sahran, S., and Zadeh, A. T. (2013). Information Sharing in Supply Chain Management. *Procedia Technology*, 11:298–304.

Mamatok, Y., Huang, Y., Jin, C., and Cheng, X. (2019). A system dynamics model for CO2 mitigation strategies at a container seaport. *Sustainability (Switzerland)*, 11(10).

Mansouri, S. A., Lee, H., and Aluko, O. (2015). Multi-objective decision support to enhance environmental sustainability in maritime shipping: A review and future directions. *Transportation Research Part E: Logistics and Transportation Review*, 78:3–18.

Manuj, I. and Sahin, F. (2011). A model of supply chain and supply chain decision-making complexity. *International Journal of Physical Distribution and Logistics Management*, 41(5):511–549.

Mark, J. and Nwaiwu, J. (2015). Impact of Political Environment on Business Performance of Multinational Companies in Nigeria. *African Research Review*, 9(3):1.

Martí, J. M., Tancrez, J. S., and Seifert, R. W. (2015). Carbon footprint and responsiveness trade-offs in supply chain network design. *International Journal of Production Economics*, 166:129–142.

Mason, J. (1996). *Qualitative researching*. Sage publications, 1 edition.

Maylor, H. and Turner, N. (2017). Understand, reduce, respond: project complexity management theory and practice. *International Journal of Operations & Production Management*, 37(8):1076–1093.

Mckinnon, A. (2018). Decarbonizing Logistics: climate change.

McKinsey & Company (2020). How great supply-chain organizations work — McKinsey.

Mitchell, R. K., Agle, B. R., and Wood, D. J. (1997). Toward a Theory of Stakeholder Identification and Salience: Defining the Principle of Who and What Really Counts. *The Academy of Management Review*, 22(4):853.

Port of Rotterdam (2023). Purpose, missie, visie en strategie — Port of Rotterdam.

Portbase (2023). Portbase.

Prater, E., Biehl, M., and Smith, M. A. (2001). International supply chain agility Tradeoffs between flexibility and uncertainty. *International Journal of Operations and Production Management*, 21(5-6):823–839.

PWC (2023). CO2-registratieplicht mobiliteit uitgesteld naar 1 januari 2024.

Radasanu, A. C. (2016). INVENTORY MANAGEMENT, SERVICE LEVEL AND SAFETY STOCK. *Journal of Public Administration, Finance and Law*, (09):145–153.

RD (2020). Rotterdam stopt 125 miljoen in vergroenen van de haven.

Rezaei, J. (2015). Best-worst multi-criteria decision-making method. *Omega*, 53:49–57.

Rose, L. T. and Fischer, K. W. (2011). Garbage In, Garbage Out: Having Useful Data Is Everything. *Measurement*, 9(4):222–226.

Roulston, K. and Choi, M. (2018). Qualitative Interviews. In *The SAGE Handbook of Qualitative Data Collection*.

Routescanner (2023). Routescanner – Make better container shipping decisions.

Royo, B. (2020). Measuring and Allocating Scope 3 GHG Emissions. *Lecture Notes in Mobility*, pages 200–211.

Rukanova, B. ., Henningsson, S. ., Zinner Henriksen, H. ., Tan, Y.-H., Rukanova, B., Henningsson, S., and Zinner Henriksen, H. (2018). Digital Trade Infrastructures A Framework for Analysis Digital Trade Infrastructures: A Framework for Analysis. *Complex Systems Informatics and Modeling Quarterly*, 14:80.

Sato, M., Ciszewska, M., and Laing, T. (2016). Demand for offsetting and insetting in the EU Emissions Trading System.

Scheibe, K. P. and Blackhurst, J. (2017). Supply chain disruption propagation: a systemic risk and normal accident theory perspective. *https://doi.org/10.1080/00207543.2017.1355123*, 56(1-2):43–59.

Schmidt, G. and Wilhelm, W. E. (2010). Strategic, tactical and operational decisions in multi-national logistics networks: A review and discussion of modelling issues. *http://dx.doi.org/10.1080/002075400188690*, 38(7):1501–1523.

Schmidt, M., Nill, M., and Scholz, J. (2022). Determining the Scope 3 Emissions of Companies. *Chemical Engineering and Technology*, 45(7):1218–1230.

Seawright, J. and Gerring, J. (2008). Case Selection Techniques in Case Study Research A Menu of Qualitative and Quantitative Options. *Political Research Quarterly*, 61(2):294–308.

SFC (2019). Global Logistics Emissions Council Framework for Logistics Emissions Accounting and Reporting Smart Freight Centre Led by Smart Freight Centre. 2.

Silveira, G. D. and Slack, N. (2001). Exploring the trade-off concept. *International Journal of Operations and Production Management*, 21(7):949–964.

Song, D. P., Li, D., and Drake, P. (2015). Multi-objective optimization for planning liner shipping service with uncertain port times. *Transportation Research Part E: Logistics and Transportation Review*, 84:1–22.

Stake, R. E. (1995). *The art of case study research*. Sage Publications, Londen.

Teske, S. and Nagrath, K. (2022). Global sector-specific Scope 1, 2, and 3 analyses for setting net-zero targets: agriculture, forestry, and processing harvested products. 4:221.

United Nations (1997). What is the Kyoto Protocol? — UNFCCC.

Viau, M. A., Trepanier, M., and Baptiste, P. (2009). Integration of inventory and transportation decisions in decentralised supply chains. *International Journal of Logistics Systems and Management*, 5(3-4):249–272.

Wilkinson, A., Hill, M., and Gollan, P. (2001). The sustainability debate. *International Journal of Operations and Production Management*, 21(12):1492–1502.

Wolf, J. (2014). The Relationship Between Sustainable Supply Chain Management, Stakeholder Pressure and Corporate Sustainability Performance. *Journal of Business Ethics*, 119(3):317–328.

Wunderlich, S. and Saive, D. (2020). The Electronic Bill of Lading. pages 93–100.

Ye, F. and Wang, Z. (2013). Effects of information technology alignment and information sharing on supply chain operational performance. *Computers & Industrial Engineering*, 65(3):370–377.

Yin, R. (1984). *Case study research*, volume 5. Sage Publications, second edition.

Yu, Y., Zhou, S., and Shi, Y. (2020). Information sharing or not across the supply chain: The role of carbon emission reduction. *Transportation Research Part E: Logistics and Transportation Review*, 137:101915.

Zhang, A. ., Atasoy, Y. ., Souravlias, B. ., and Negenborn, D. R. (2020). Pickup and delivery problem with transshipment for inland waterway transport. *Lecture Notes in Computer Science*, pages 18–35.

A STAKEHOLDER ANALYSIS

Stakeholders determine the environment in which the problem occurs, and at the same time schematizes the solution space towards a better state. Mitchell et al. [1997] discuss the use of a 'power-interest' matrix to map the management strategy towards every single stakeholder. The actual management strategies are shortly touched upon, but will not have a significant role in this thesis.

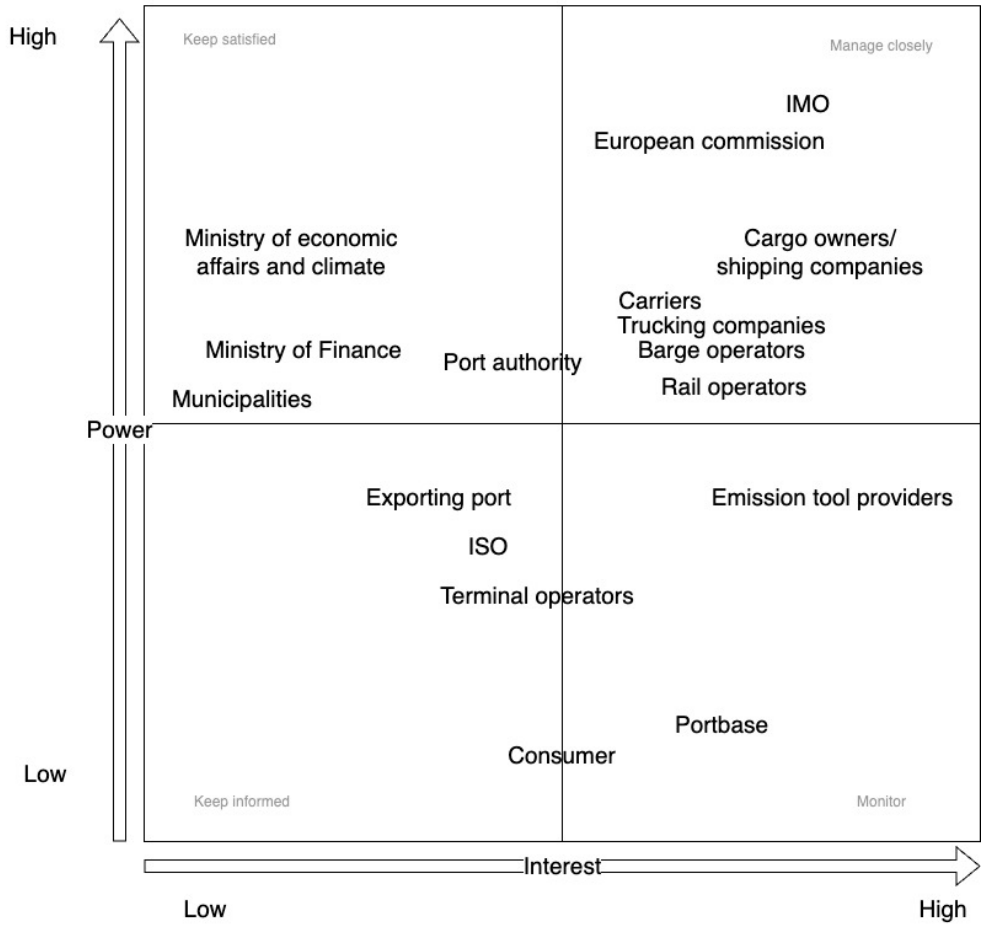


Figure A.1: Power-interest grid of stakeholders

B | CO_2 EMISSION MEASUREMENT TOOLS

A number of CO_2 emission measurement tools is produced by a number of companies. Their common ground is that they provide insight in the CO_2 emissions of a paying customer which is always another company or government organisation.

Table B.1: List of companies that offer CO_2 emission tools in the industry, their added value, output type and a GLEC accreditation indication.

CO_2 emission calculation tools	Market of focus	Converter	Output type	GLEC framework
Salesforce net zero cloud	General companies	Yes	API	No, own method
Good shipping company	Ocean freight	No	Report, certificate and credit system	Yes
Routescanner	Ocean and inland	Yes	Report and API	Yes
Sinay	Ocean freight	Yes	API	Yes
Searoutes	Ocean, inland and air	Yes	API	Yes
EcoTransit	Ocean, inland and air	Yes	Report	Yes
BIGMile	Ocean, inland and air	Yes	Report and API	Yes
ATOS	Ocean, inland and air	Yes	Report	No, own method and CO2emissiefactoren.nl as emission factor source
CO2 AI	General companies	Yes	Report and API	Not found
Fleetmon	General companies	Yes	Report	Not found
GreenRouter	Ocean, inland and air	Yes	API	Yes
Neste	Road	Yes	Report	Not found
Transporeon	General companies	Yes	API	Yes
VesselBot	Ocean, inland and air	Yes	Report and API	Yes
Convoy	General companies	Yes	API	Yes
Flexport	General companies	Yes	API	Yes
Sennder	Carriers and shippers	Yes	Report	Yes
Mearsk/Syngenta	Ocean and inland	Yes	API	Yes

C | INTERVIEWS

C.1 PORT OF ROTTERDAM EMPLOYEES WITH SUPPLY CHAIN AND INFORMATION TOOL EXPERTISE

C.1.1 Business Manager hinterland

13 Jaar bij Havenbedrijf Rotterdam en momenteel bij afdeling commercie Functie: Business manager hinterland. In bullet points, this were the key insights from the interview. The interview was conducted in dutch.

Interview bullet points

- Duurzame initiatieven in scheepvaart: ZES, elektrische trucks.
- Gebruiken van HESP of Routescanner? Wat is waarheid en wat is het verschil?
- Niet alleen kijken naar het havenbedrijf, maar in breder perspectief kijken naar de verladers en de markt.
- Corridors isoleren en specifiek kijken waar wat mogelijk is. Generieke aanpak wellicht niet geschikt voor modal shift vraagstuk?
- Benchmarking is goed, case study is geschikt om een benchmark neer te zetten.
- Kijkend naar de criteria voor modaliteitskeuze valt op dat sustainability onderaan het lijstje staat en dat er dus gezocht moet worden naar een manier waarop de markt wél reageert. Betrekken in andere criteria als kosten en tijd.
    1. Safety
    2. Reliability
    3. Costs
    4. Lead time
    5. Sustainability

C.1.2 Sales en developer Routescanner

3 jaar bij Routescanner (voormalig Navig8) en onderdeel van het sales team van Routescanner en ontwikkelaar van verkoopbare emissie calculator. In bullet points, this were the key insights from the interview. The interview was conducted in dutch.

Interview bullet points

- Routescanner als middleman service aanbieder
- Neutrale service
- Businesscase

  - Routescanner levert een dienst aan klanten die hun vervoer-data leveren aan routescanner waar vervolgens een CO_2 rapportage op uitgevoerd kan worden.
  - Credits verkopen om een X aantal doorrekeningen te kunnen uitvoeren op de Routescanner site

- GLEC framework wordt gebruikt
- Daadwerkelijke scheepsroute wordt gebruikt voor afgelegde afstand in de emissie berekening.
- CO_2 pricing tussen verlader en vervoerder is alleen mogelijk op de spotprijs markt. Lange termijn contracten zijn niet echt mogelijk aangezien de prijzen daarin al vast liggen.
- Als prognose voor de uitstoot van 'klanten' en verladers wordt het gemiddelde van alle scheepsautomotiveen gebruikt.
- 1,15 keer "google maps" distance bij HESP en EcoTransit

C.1.3 Project lead sustainability mobility

2 jaar bij Havenbedrijf Rotterdam afdeling Environmental Management met de functie: Project lead sustainable mobility.

Interview bullet points

- HESP scenario's ontbreken. Nodig om duurzame initiatieven te selecteren/-funnelen. Nu: Gebruik van "CO_2 model" van de afdeling "new business and portfolio" van Port of Rotterdam.
- Electrische trucks in 2030 eerste marktaandeel 2040 op 90% marktaandeel van duurzame vervoerwijzen, electrisch + waterstof (TNO)
- Binnenvaart verduurzamen is lastiger omdat het afschrijven van vrachtwagens 5 jaar duurt en van een binnenvaartschip 50 jaar.
- CO_2 pricing kan nooit vanuit havenbedrijf komen. Niet eens Nederlands beleid zal voldoen. Europees beleid dus nodig.
- Niet dwingen met restricties vanuit PoR, niet te doen aangezien klanten dan weg zullen gaan. Voorbeeld: Walstroom aanleggen leuk, maar het dwingen van gebruik maken van die walstoom moet vanuit de gemeente Rotterdam komen met verordeningen.
- De bereikbaarheid van achterland is belangrijk en congestie kan voorkomen worden door modal shift.
- Volvo kan al elektrische trucks leveren die 700 km kunnen rijden. Scania, Mercedes etc volgen.

C.1.4 Business Manager shippers and forwarders

This Port of Rotterdam employee is specialized in shippers and forwarders and is familiar with the Port of Rotterdam SCOPE project. It was conducted in Dutch.

Interview

The introduction of the interview was a fastforward through multiple carbon emission measurement services as HESP and Routescanner to identify similarities and differences. The fragmentation of all different services was experienced as undesirable as it distracts from the purpose of the tools. Then after the tools and its use were made explicit by me, we proceeded to an explanation on the results from the data sets in the SCOPE project.

Some companies do not have the manpower, expertise or time to analyse their data, so they expect the Port of Rotterdam to provide some insights in exchange for their data. There was no elaboration on the data analysis method, only a confirmation that most results were gathered through conversations with the involved companies.

The first annotation of this business manager was on the current way of integrating information. Now they look at historical performance data, and their objective is to achieve a somewhat real time planning with all involved supply chain participants included. Collaboration is also required in tackling inefficiencies in the supply chain with regard to emissions. Bundling cargo for example is not possible with only one company. This is also a very nice example where efficiency gains will help decrease emissions. This notion is essential for the energy transition as financial arguments will remain determinant in supply chain decision making. This business manager claims that scope 3 emissions will not be tackled by supply chain companies without pressure. There must be some force or incentive, especially if the change is very costly.

In the scope projects there were five recognized bottlenecks (see **??**) this business manager repeated the explanation and cause and deemed the reverse modal shift as the worst for both emissions as costs. Fixing the higher dwell times might be a solution for this bottleneck as there will be more time to complete the transport with inter modal transport options before demurrage and detention costs become too high. To tackle dwell time on terminals, there will have to be some form of information sharing from the terminals towards the port or cargo owners, and this is often very rusty if at all existing. The terminals, as well as the carriers have a lot of influence in the system as their assets are indispensable. They know this and therefore have much leverage in the system. If cargo owners would join forces and approach these powerful companies together they might have a better result. However, this would mean that competitors have to work together and this is very hard in practice according to the business manager.

C.2 CASE STUDIES

C.2.1 Interview protocol

The interview is semi-structured and thus based on questions followed up by a reaction of the interviewee and if required, there is some divulged conversation followed up after the response. Depending on the response there may be other subsequence questions but they are not included in the interview protocol. The summary covers these if they were deemed important to the author. Data management was verbally agreed upon by the interviewee, which included a summary of the interview and the destruction of the recording after a two year period at TU Delft servers if that was stored. Also names and specific titles in some cases were excluded to prevent the interviewee from any exposure. **Introduction**
De aanleiding voor dit onderzoek is de groei van aandacht voor het verduurza-

men van bedrijven en hun activiteiten. Scope 3 emissies worden in de industrie als lastigst meetbaar geacht, omdat het meerdere soorten activiteiten en partijen behelst.(Dit vereist een mate van verantwoordelijkheid voor uitstoot die niet direct gerelateerd is aan de eigen bedrijfsvoering.) Tools die verladersdata omzetten naar CO_2 informatie aan de hand van emissie factoren en wiskundige formuleringen als het GLEC framework van SFC kunnen gebruikt worden als een methode om een stuk van die scope 3 emissies te bepalen. De eerste vraag fungeert als opwarmer en om kennis te krijgen van het bedrijf en haar operaties.
Hoe ziet jouw supply chain eruit? Welke producten, import export, etc.

DEEL 1 SQ1
"How do cargo owners deal with carbon information in their supply chain decision making in a port environment?"
Vanaf het uitladen van de container van een zeeschip op de kade tot het moment dat de container het warehouse bereikt zijn er een aantal activiteiten (lees verplaatsingen) waarbij emissies vrijkomen. De aanname is dat er per verlader (cargo owner) meerdere opties zijn om die activiteit uit te voeren. Dit leidt tot de eerste vragen:

1. Welke keuze momenten zijn er voor u in uw supply chains?
2. Wat zijn voor u de belangrijkste criteria voor bepaalde keuzes. Wat vindt u belangrijk in de overweging om bepaalde opties wel of niet te overwegen/-maken?
3. Welke factoren zijn van invloed op de besluitvorming over uw supply chain? en in hoeverre wordt uw besluitvorming beinvloedt door de context waarin uw bedrijf opereert?

   Aansluitend op deze vraag, een deepdive in emissies en met name CO_2 emissies
4. Waarom zou uw bedrijf uw uitstoot willen verminderen?
5. U heeft CO_2 uitstoot in zowel productie, energie gebruik als transport, hoe kijkt uw bedrijf hiertegen aan?
6. Heeft u een rol in het beperken van emissies en zo ja welke rol?

   Weten wat je uitstoot is geweest is niet meer groundbreaking nieuw, het handelen naar die informatie wel.
7. Heeft u een doelstelling om net-zero te worden? Zo ja, per wanneer en welke stappen onderneemt u nu om die te behalen?
   a) Eerste stap is wellicht het rapporteren van de scope 1,2 en 3 emissies aan de overheid op 1 Januari 2024 (ESRS van het CSRD)
8. Maakt u onderscheid in operationeel, tactisch en strategisch niveau wat betreft supply chain besluitvorming? Waar ligt momenteel de meeste nadruk op in jullie emissie beleid?
9. Bent u bekend met co2 informatie over jouw supply chain, ben je zoekende, heb je er bepaalde ideen over of staat het op de planning.

DEEL 2 SQ2
"How can carbon dioxide information create opportunities to become more sustainable?"

De intentie om te veranderen is wellicht niet alleen berust op interne motivatie, maar ook afhankelijk van de omgeving. Daarbij hoort het politieke klimaat (investerings bereid of niet), Economische omstandigheden (hoog -laag conjunctuur), Wettelijke klimaat, Technologische mogelijkheden (vergroten van aantal 'goede' opties), Aandeelhouder meningen, Consumenten voorkeuren, Reputatie (marketing etc.) & Competitie. Deze omgeving zorgt voor bepaalde mogelijkheden en beperkingen.

1. Heeft u het idee dat het weten wat de uitstoot is per aanbieder, activiteit of container trip bijdraagt aan het daadwerkelijk verminderen ervan? (eerst vragen of ze een dienst hebben die de uitstoot meet en rapporteert)
2. Wat mist u nog aan kennis om duurzamere keuzes te maken in uw supply chains tussen haven en warehouse?
3. Hoe zou dat kunnen veranderen als er een CO_2 belasting wordt geheven?
    a) Wordt er rekening gehouden met toekomstige belasting op CO_2 uitstoot, bij nieuwe projecten (in de funnel) wat betreft terugverdientijd etc.
4. Hoe kan CO_2 informatie bijdragen aan het creeren van mogelijkheden om duurzamer te worden?
5. Welke toepassingen van CO_2 informatie per movement/activiteit zou u kunnen verzinnen die de totale emissies vermindert?
6. Hoe denkt u dat een extra informatiestroom uw besluitvorming kan beinvloeden?

C.2.2 Automotive company

This interview was conducted with a senior logistics manager of the company in the offices of their warehouse facility near Amsterdam. This logistics manager is responsible for managing the distribution of parts accessories and complete built units. They have six distribution centers across Europe and one production facility in France, but the biggest share is imported from the production facilities in Asia. The interview was conducted in Dutch.

Interview

Statistieken van Nederlandse tak
24.000 TEU geimporteerd per jaar
35% via Rotterdamse haven.

Sourcing
Verzonken kosten van productie faciliteiten in Japan zijn een feit. De keuze om daar te produceren is niet meer heel makkelijk te veranderen naar een keuze voor Europese faciliteiten.

Gesprek over andere verladers. Twee andere Nederlandse bedrijven hebben een samenwerking wat betreft het bundelen van goederenstromen om leeg vervoer te verminderen. Andere sourcing is voor hen wel een optie, maar voor deze automotive producent niet. Dus ook andere strategien wat betreft Co2 emissie kosten. De logistieke besluitvormer verwacht dus meer Near shoring.

Multimodaliteit
Bepaalde locaties zijn wel geschikt om multimodaliteit in te zetten. Alphen aan de rijn of Amsterdam is aanbevolen in eerdere gesprekken met PoR. Maar terughoudend omdat er nog steeds een truck nodig is. 4 a 5 dagen extra lead time is dan wel een gevolg. Inventory carrying kosten zijn hoger bij een langer durend transport. Voorbeeld van een cash flow die wordt benadeeld door het verlengen van een transport met een duurzamere optie. 1% carrying kosten per maand. 250 euro aan kosten voor een lead time van 4 a 5 dagen langer per container.

Lokale dienstverlener
Logistiek dienstverlener wordt ingehuurd door de besluitvormer is met name een lokale transporteur met ongeveer 20 trekkers. Vanaf de rotterdamse haven is de "last mile", duidend op de verbinding tussen de haven en het warehouse, met truck. Relatief kleine maar betrouwbare transporteur, ten opzichte van de grote spelers die weer onderaannemers hebben, waardoor het overzicht en toezicht afneemt. Deze zijn minder betrouwbaar maar wel goedkoper. Weten waar je aan toe bent, gemak met chassis wisselen en een bekende. Iedere ochtend in de stress of ze er wel zijn of dat het de goede container is. Lokale partijen worden geprefereerd om in control te blijven.

CO_2 uitstoot bij tender
Ze zijn er het afgelopen jaar anders naar gaan kijken. Maar voor nu nog geen directe golden nugget qua opportunities voor CO_2 informatie. Op dit moment meer geloof in wegtransportverhaal. Andere brandstoffen voor over de weg wordt wel als optie gezien, dit is voor het stuk zeetransport is nog geen optie. Oceancarriers zijn in sommige gevallen wel bezig, maar allemaal pilots dus nog geen mogelijkheden.

Op dit moment wordt er niet naar CO_2 gekeken bij de overweging voor de lokale partij op het weg transport stuk tussen haven en warehouse. Zo ver zijn we nog niet

en bovendien wordt het "last mile" stuk wordt als verwaarloosbaar gezien. Eerst naar de grotere uitstoot stukken kijken, grote line haul van lille naar marseille kijken of je wat kunt aanpassen. Dan draag je iets significants bij. De hele industrie verandert, maar wij gaan niet voorlopen. Wachten op een verandering van het aanbod van de bekende lokale partij. Wel nu al in Duitsland bezig met het betalen van hun vervoerders om de belasting te compenseren, alleen van de meest duurzame trucks op dit moment. Als ze kiezen voor een EURO 4, 5 of 3 dan betaalt deze verlader de Maut niet. Dit is reactief en niet proactief.

Als we gaan verduurzamen is de eerste strategie om high impact tradelanes aanpakken. Als bijvangst, pak je wel wat mee van de verwaarloosbare stukken aangezien een aanpassing van 1 vervoerder op een long haul (high impact), die je ook gebruikt ergens anders voor een kleiner stuk, zal ook op dat stuk een stuk meer duurzaamheid gerealiseerd kunnen worden.

Product en consument eigenschappen
Product eigenschappen zorgen ook voor een andere strategie. De producten van deze automotive producent zijn voor plezier gebruik en gaan over het algemeen erg lang mee. "Stel dat er over 10 jaar geen nieuwe producten meer op de markt (mogen) komen zullen zij nog een erg lange tijd (+/- 30 jaar) business hebben aan de verkoop van onderdelen." Actieradius van competitie die elektrische voertuigen maakt, is nog te weinig en verkoopt dus ook niet. De klanten van dit bedrijf zijn over het algemeen niet de mensen die zich met duurzaamheid bekommeren.

CO2 informatie
De exacte informatie is vooralsnog onmogelijk, ga maar na hoeveel brandstof er is verbruikt met welke truck en hoeveel producten uit die truck van welke eigenaar waren. De kwaliteit en validiteit wordt nog in twijfel getrokken en dit is ook een reden om nog geen handelings strategie te hebben. Hoe bedeel je de legere schepen die alsnog brandstof gebruiken. Voorbeeld van eerder genoemde Nederlandse bedrijven, vol heen met de producten van de één en vol terug met de producten van de ander. Pure winst vanuit efficiëntie oogpunt.

Hoe groter de afstand tot de haven wordt, hoe interessanter mijn vraagstuk is. Afstand tot haven wordt door besluitvormer te klein geacht om werkelijk iets te veranderen om CO2 te reduceren.

Laag hangende fruit eerst aanpakken. Met beperkte capaciteit zo veel mogelijk invloed willen maken. Wat dan daaronder valt maakt niet zoveel uit, als het maar de meeste impact maakt. (1) Nogmaals bijvangst genoemd ook. (2) voortschrijdende wetenschap, technologie etc. zal ontwikkelen en uiteindelijk gaat dit de markt op en zal er meer aanbod komen met bijvoorbeeld waterstof trucks.

Een andere producent maakt verschillende waterstoftrucks beschikbaar voor hun carriers/vervoerders. Echter is die producent, een factor 1000 groter dan deze automotiveproducent, dus zij kunnen dat doen. Meer geld over, maar ook meer volume en dus meer gebruik van die waterstoftruck. Zelfde met een elektrisch schip van bijvoorbeeld Heineken. Steady flow bij hun supply chains, dus ook minder risico. Albert heijn ook genoemd als voorbeeld, met een steady flow.

Op basis van een achterkant van de envelop methode kijken naar eventuele duurzamere (nog steeds diesel) trucks. Gegarandeerde flow met Hamburg trips is geschikt voor eventueel duurzamere.

De wal gaat uiteindelijk het schip keren, de technologie verschuift van fossiele brandstoffen naar een alternatief. Geen druk vanuit consument aangezien ze "geen

heilige boontjes" zijn. Ook zeker vanuit producten, vollebak leisure en plezier met slechte verbruik labels.

Wel bezig met bepaalde inefficienties vanuit monetaire optiek: Zonde van veel verpakkingen weggooien, of halflege containers laten varen en met name als die container vreselijk duur is, corona crisis ook genoemd voor het verkrijgen van dit inzicht.

We zullen niet voorop lopen maar we zullen wel volgen zolang het niet een al te grote financiele impact heeft. Maar enkel bij enkele procenten duurder, vele tientallen procenten zal zorgen voor tegendruk. Marketing argument wordt genoemd als hoofdreden voor een hypothetische voorloper om nu al te verduurzamen.

Kwaliteit van de informatie
Brons zilver en goud is een erkend onderscheid in data kwaliteit. Vergelijking met belastingdienst wordt gemaakt. Belasting is erg tastbaar en exact, terwijl Co2 metingen dat niet heeft. Twijfel wordt gezaaid bij werkelijke uitstoot kan nooit echt aangetoond worden.

Scenario:
Stel er is een verlader die zijn uitstoot meet en in jaar X + 1 10% minder wil uitstoten dan in jaar X. Hij koppelt dit terug naar zijn vervoersvraag, door met zijn vervoerder(s) af te spreken dat ze zuiniger rijden, andere routes nemen, langzamer rijden, andere trucks/brandstoffen etc. De vervoerders zullen dan zeggen, ja maar jij hebt de dealer dicht bij mij gesloten en eentje 50km verderop geopend, dit zorgt natuurlijk voor meer uitstoot dus ondanks dat ik die 10% minder uitstoot niet kan realiseren presteer ik wel een stuk beter dan in jaar X. Of de business is 10% groter of kleiner geworden. Het productportfolio kan ook anders zijn geworden met meer volume of gewicht etc.

Het probleem in dit scenario is het benaderen van de CO_2 op de bottom line. Dus een CO_2 rapport die de transport uitstoot tussen port en warehouse bepaald, moet exacter worden om een verschil af te dwingen. Nog een voorbeeld van exacter worden is het meetpunt van de CO_2. Als een vervoerder aan de cargo owner gaat rapporteren wat zijn uitstoot was, hoe kan die cargo owner dan bepalen of dat zo is? Een paar ton meer of minder kan nooit bepaald worden aangezien het nog geen exacte getallen zijn. Aantal liters per zending. De vervoerder zal die input moeten leveren. Ook als routescanner in beeld is. De besluitvormer zal verantwoordelijk zijn voor een geschikte audit.

De besluitvormer heeft begrepen dat het gewenste plaatje is om per truck die iedere dag die gaat rijden en dat er exact wordt bijgehouden hoeveel die bepaalde truck heeft uitgestoten en hoeveel daarvan op rekening van welk bedrijf komt. Dan zit je op Goud (tov zilver en brons).Behoefte aan een standaard die voor al hun 30 vervoerders geldt.

Accountability
Nog een voorbeeld. Als de vervoerder meerdere vrachtsoorten vervoert en er een schommeling is bij de andere producten, moet de vrachtwagen alsnog rijden. Het is niet zo dat die vrachtwagen dan minder ver moet rijden voor de producten van deze besluitvormer, dus de uitstoot die voorheen nog over die andere producten bedeeld kon worden, gaat nu op rekening van hem terwijl hij en de vervoerder in principe niks verkeer doen. De besluitvormer vraagt zich af hoe accountable hij zal zijn voor de uitstoot die gemaakt wordt door zijn (lokale) vervoerder.

Laat niet die verlader die aangifte doen maar laat die vervoerder de aangifte doen.

Dit gaat dus om de accountability van de aangifte, hoe kan de besluitvormer de kwaliteit van die aangifte waarborgen? Nuanceren dat niet de volledige verantwoordelijkheid dan verschuift, want dat kan nog steeds gewoon verdeeld worden.

"Ik zie dat wij een kritische view moeten hebben op hetgeen dat er qua rapportage aangeleverd wordt door onze vervoerders". Trends herkennen en vragen stellen bij trendbreuken is wat bij mijn rol past. Maar ook 100 redenen kunnen verzinnen om die trendbreuk te verklaren.

Externe factoren
Ik kan me ook voorstellen dat externe factoren invloed hebben op de wil om te veranderen, en dat hierdoor de gewenste vermindering van uitstoot een jaartje niet bereikt wordt.

In welke mate denk je dat de CO2 politie langskomt om te controleren of jouw rapportage klopt. Pas vergelijking trekken met belastingdienst en Co2 rapportage zodra de ladingsgraad en liters benzine per specifieke truck inzichtelijk zijn. Één standaard voor heel europa gewenst: GLEC

Hoe zit dat met een hele grote vervoerder, moet die dan aan al zijn verladers/-cargo owners/clients aantonen wat ze wanneer hebben uitgestoten? Als die grote vervoerder bedrijven moeten rapporteren en ook nog eens met hun klanten moeten overleggen of die metingen wel juist zijn, verwacht de besluitvormer dat het niet houdbaar is voor die vervoerders.

C.2.3 Global beverage brewing company

Global beer brewing company, based in the Europe. The interviewee is a sustainability manager at the brewery.

Interview

Ambitie
Scope 1 2 emissies Net Zero CO_2 in 2030 en scope 3 net zero CO_2 in 2040. We werken nu aan groene stroom voor alle brouwerijen, al zal dat in sommige landen niet eenvoudig zijn ivm politieke klimaat.

De scope omvat de CO_2 footprint van alles brouwerijen en de bijbehorende logistiek. In de huidige situatie gebruiken wij zo'n 0,2% van het wereldwijde containertransport.

Vliegen van en naar een brouwerij en de hele portefeuille van de productie op die locatie, dus ook de logistiek on site. Vorkheftrucks moeten elektrisch worden en gepaard met de hernieuwbare energie sources bij productiefaciliteiten, kan dit lukken. Vanaf heden moeten alle nieuwe vorkheftrucks electrische zijn in plaats van diesel of gas.

Met name in de kortere afstanden in de grotere logistiek is er al een deel elektrisch (in Europa). Een deel daarvan is voor rekening van de derde partij die is ingehuurd om de logistiek te organiseren (scope 3). In sommige landen organiseert de drankfabrikant haar eigen logistiek, in die gevallen valt het transport onder scope 1 en 2 emissies.

Verantwoordelijkheid over emissies
Aanbesteding van de materialen en grondstoffen wordt wel al gekeken naar emissies bij ontginning of productie, voor logistiek is dit te vroeg mede ook door het gebrek aan technologie en mogelijkheden. Voor de grondstoffen als aluminium, glas maar ook mest wordt er actief met de leverancier samengewerkt om te verduurzamen. Actief in de zin van, leveranciers (partners) waren er nog helemaal niet mee bezig dit te produceren maar op aandringen van de logistiek besluitvormer en zijn collega's is het figuurlijke vlammetje aangezet. Vb. Elektrische ovens (furnaces) worden ontwikkeld en moeten binnen nu en een aantal jaar geïmplementeerd worden gezien de verplichte non-stop productie van glas over een levensduur van 15 jaar.

Er worden nu selectief duurzamere producten aanbesteed, ook bij een hogere kostprijs. De geïnterviewde is zich ervan bewust dat het op de aanbodsmarkt dus een voordeel biedt voor de producenten (lees leveranciers) om een duurzamer product neer te zetten, "we forceren de verandering". Waar in het verleden de goedkoopste producent gekozen (uiteraard voor acceptabele kwaliteit), maar nu echt een switch naar duurzamere producten ook tegen een hogere prijs.

Besluitvorming
Het doel is net-zero, we hebben een target en we gaan beslissingen maken die leiden tot het behalen van dat target. Er moet een balans zijn tussen sustainability, free operating cashflow, operating profit, return on net assets. Als bijvoorbeeld een nieuwe brouwerij wordt gebouwd van 100 miljoen, dan moet daarin ook de sustainability voorkomen, dus een percentage van de investering is specifiek gericht op sustainability.

Logistiek dienstverlener
Nagenoeg alle logistiek in Nederland loopt via een derde partij. Biofuels wordt ook

aan gewerkt. Een deel van de logistiek is nog vervuilend met reguliere trucks, maar de binnenvaartschepen en de Rotterdamse haven zijn al elektrisch.

CO_2 Rapportage
De brouwerij heeft een centraal systeem waarin alle lokale productiemaatschappijen elke maand hun data uploaden. Alle data, waterconsumptie, elektriciteitsconsumptie, productiviteit, kilogrammen van alles wordt gemeten, gerapporteerd en ge-audit. De brouwerij maakt op basis daarvan hun eigen CO_2 rapporten middels berekeningen met emissie standaarden van het International Energy Agency. De tonnen en liters brandstof, danwel benzine, gas, diesel, stookolie etc, staan ook in dat centrale system. Alle materialen die worden aangekocht, heeft in de invoice of bill of lading een vermelding van de footprint. Op de locaties waar de exacte data niet gedetailleerd genoeg is of simpelweg niet is ingevuld, doet de besluitvormer een schatting op basis van gemiddelden.

Oud bestaand systeem waarin productiviteit werd gemeten, maar ook verbruik en materialen is gecombineerd met nieuwe input en er zijn dus meerdere systemen aan elkaar geknoopt die leiden tot eenvoudig maandelijks te bepalen CO_2 rapporten.

Frequentie van rapportage en gevolg voor besluitvorming snellere rapportage leidt tot de mogelijkheid om sneller te handelen en dus ook tot tactische en operationele besluitvorming die meer richting CO_2 mitigatie gaat. Voorbeeld over oude Oost-Europese treinrails, die wellicht weer in gebruik genomen kunnen worden om transport uit te voeren (met name mout). Ook een actieve zoektocht naar waar de warehouses het best gebouwd kunnen worden.

In sommige landen heeft dit bedrijf geen eigen warehouses, maar slaat haar producten met name op in de warehouses van de logistiek dienstverleners. Daarbij worden er wel eens dubbelafstanden gemaakt werden bij de leverancie naar en productie van dezelfde stad komen, maar eerst via het warehouse lopen. “die verantwoordelijkheid hebben we wel, om die afstanden zo kort mogelijk te maken”.

Bijkomend voorbeeld over Brazilie, waarbij de langere trade lanes binnen het land geoptimaliseerd worden door middel van het vullen van de empty returns met non-competitieve producten van strategische partners.

Vertrouwen in ontwikkeling van technologie
De groei van het aantal elektrische trucks en het de beschikbare oplaadcapaciteit moeten afgestemd worden met elkaar. Als de lokale productiefaciliteit alle in en uitgaande trucks zou moeten opladen kan ook het lokale netwerk in de meeste gevallen de enorme stroomvraag niet aan. Elektrische trucks hebben daarom nog niet de overhand in onze duurzaamheidsintenties, maar de trein of (elektrisch) binnenvaartschip daarentegen wel. Waterstof wordt door de interviewee niet als oplossing van het probleem gezien. De opwekking van waterstof is erg inefficiënt en elektriciteit gebruikend. Het is alleen mogelijk om waterstof van overtollige elektriciteit te maken in extreme gevallen. In Nederland zal dit enkel het geval zijn, wanneer snachts de wind erg waait en er weinig vraag is of wanneer er veel wind en zon tegelijk is en er weinig vraag is. Echter heeft de industrie ook wel interesse in die overtollige, goedkopere elektriciteit. Zo kunnen brouwerijen ook die beschikbare thermische energie opslaan na het omzetten van electrische in thermische energie met E-boilers.

Zodra er meerdere partijen zijn die gebruik willen maken van de goedkopere overtollige energie wordt de prijs hoger en heeft het minder voordeel om voorloper te zijn in het duurzaam omgaan met energie. Het is een geen overweging geweest bij dit bedrijf om vroeg deel te nemen aan de energietransitie om op die manier

voordeeltjes als deze te kunnen oogsten, die voordeeltjes waren enkel een bijvangst. "Verduurzamen wordt echt gezien als een morele verplichting en we weten ook dat het niet even makkelijk is om overal sustainable te zijn."

Druk op besluitvorming
Consumenten vragen op termijn meer van een bedrijf en verwachten wel een eerlijk antwoord, dit kan doorsijpelen in de druk op de merknaam. Consumentendruk wordt wel als aanwezig beschouwd. Ook aandeelhouderdruk is erg aanwezig en deze zullen dit op het bestuur van het bedrijf overbrengen.

Werknemerdruk bestaat niet maar is een bijvangst van voorloper zijn. De werknemer vindt het belangrijk en door voorloper zijn werf je de betere werknemers uit de arbeidsmarkt. Wel plaats gedreven, aangezien er ook landen zijn waarbij de behoeftes en waarden en normen nog erg verschillen met die in Europa, wat inhoud dat ze sustainability niet zo hoog op hun prioriteitenlijst hebben staan bij het bepalen voor welk bedrijf ze willen werken.

Vanaf 20 Mwatt omvormen val je onder de ETS regulering. Voorheen werden de rechten gratis afgegeven, maar nu moet het gekocht worden. Met ongeveer 100 euro (ETS prijs) per ton CO_2 gaat het wel invloed hebben op de business case.

Wel druk geen inzicht
Veel bedrijven zijn dat nog niet, die betalen gewoon, want dat is hun wettelijke verplichting. Het zijn niet de allerhoogste bedragen, wel miljoenen maar op de totale balans gaat het om procenten.

Alle logistiek dienstverleners zullen op den duur met een emissie label en inschatting in hun tenders moeten komen, waarna de cargo owner kan bepalen of dat acceptabel is of niet.

Samenwerking met leverancier of transporteur om te verduurzamen Wel in de glas industrie, maar daar zijn simpelweg nog geen betere aanbieders, met andere woorden. Wij kiezen constant de beste aanbieder die dus op duurzaamheidsgebied ook zeker goed scoren. *" Wij doen nu niet aan carbon credit, off setting"* Na doorvragen toch wel de conclusie dat op termijn wel offsetting mogelijk moet zijn. Er zijn plekken op de wereld waar verduurzaming wordt bemoeilijkt door overheid (met veel olie en gas in bezit) of erg lastige veiligheidsproblemen die het onmogelijk maken om zonnepanelen te installeren omdat ze altijd gestolen worden.

Scope 1 en 2 emissies zijn erg duidelijk. Bepaalde landen en productiefaciliteiten scoren slecht op sustainability, wat wel 1 van de 4 pijlers was van de besluitvorming binnen het bedrijf. Het vinden van het focuspunt wat betreft innovatie en duurzaamheid is het grootste voordeel van het hebben van de informatie. Laaghangend fruit is dan een voorbeeld van een strategie.

Trade-off tussen kosten en duurzaamheid
Er is bereidheid om de minder kosten efficiente oplossing te kiezen ten faveure van¨ sustainability. Je kan er voor kiezen een leverancier te verkiezen die een hoog sustainability scorende productiefaciliteit heeft om de net-zero doelen te halen. Wel moet daarbij gezegd worden dat bij heel grote volumes gewoon veel wordt geinvesteerd in duurzaamheid in plaats van het sluiten van de faciliteit. Je neemt bij het sluiten van een productiefaciliteit ook mee dat de consument een negatiever beeld krijgt van het bedrijf in geval van het openhouden van de productiefaciliteit terwijl hij totaal niet duurzaam is. Er zijn ook brouwerijen waarbij het besluit om te sluiten wel gewoon wordt genomen.

Op de caraiben is nog erg weinig duurzame energie, maar dit bedrijf heeft daar wel de ambitie om net-zero te worden. Dus wordt er samen met de energiebedrijven en overheden gezocht naar manieren om het dan zelf/samen te produceren. Vertrouwen op de economie en marktwerking is in die ontwikkelingslanden nog niet aan de orde.

In ons besluitvormingsproces hebben wij wel als regel: Additionality. We bouwen daar met providers extra capaciteit op het netwerk, die de faciliteit dan vervolgens gebruikt. Het is niet zo dat die productie dan de duurzame capaciteit gebruikt en dat de bewoners eromheen nog met gas en kolen hun stroom opgewekt krijgen.

C.2.4 Appliance-tool -and materials distributor

Worldwide company with a Japanese nature and Asian production facilities. The main holding has a very diverse product portfolio and its appliance-tool and materials division is focused on importing and selling construction appliances, tools and accessories to mostly businesses and some dealers. The logistical decision maker was responsible for whole import and distribution of the European market. The interview was conducted in dutch.

Interview

Introductie
Dit bedrijf importeert een variëteit aan producten vanuit productiefaciliteiten verspreid over Azië. Is een tak van het grotere concern met een schaal van 2000 TEU ten opzichte van het totaal van de grotere holding van 160.000 TEU. Oorspronkelijk Amerikaans bedrijf is 3 jaar geleden overgenomen door de holding uit Japan. Europees distributie netwerk van kleine onderdelen van bouwproducten als elektrische bevestigingssystemen, verankeringsproducten, diamantslijpgereedschappen en industrie specifieke oplossingen.

Na samenvoeging, werden een heel groot aantal decentrale distributiecentra (60) opgedoekt en daar kwamen 6 centrale grotere centra voor in de plaats. Vanuit die centra worden een klein aantal dealers geserveerd, maar een groot deel wordt vanuit de DC direct naar de eindgebruikers gedistribueerd. De logistiek besluitvormer ziet zijn bedrijf niet als transporteur of producent maar als midden partij ofwel " dozenschuiver".

Tender
1 keer in de twee jaar doen ze een tender voor inkomend transport uit Azie. Taiwan, China, Vietnam India. Daarin staan 17 voorwaarden met onder anderen levertijd, vaartijd, factuur eisen etc. Als een transportbedrijf (forwarder in deze context) aan 1 van de voorwaarden niet kan voldoen, doet hij niet meer mee met de competitie om de tender te winnen. Mede ook om een bepaalde gelijkheid te borgen onder de aanbieders. Uitstoot zit nog niet in de tender, maar dat gaat wel komen. Wel zit er een bepaalde verplichting in om van haven naar DC 3 opties aan te bieden waarna de besluitvormer in kwestie de keuze maakt voor 1 van de drie (dit is overigens het enige moment dat ze zich bemoeien met de logistiek, de rest is aan de forwarder). Op dit moment is bargen naar Lelystad en Treinen naar Valkenswaard de modaliteit in play. Mochten er vertragingen optreden is er de optie om te trucken.

Voorbeeld van redenatie uit de tender, twee forwarders boden de optie tot bargen en trucken en de derde forwarder bood enkel trucking aan. Het ligt voor de hand dat de derde dan geen optie meer is omdat de efficiëntie voordelen te zwaar wegen bij het bargen. CO_2 is daarnaast een mooie bijkomstigheid. Kosten is echt leidend in het bepalen van de forwarder. Langere lead times zijn beter dan snellere lead times, want langer is te plannen. Er wordt ook de aanname gedaan dat langere lead times ook goedkoper zijn.

Externe factor: CBAM
Een erg invloedrijke factor voor mijn besluitvorming die eraan zit te komen is CBAM (carbon border adjustment mechanism). Gaat niet direct over het transport zelf, maar de forwarder gaat er wel mee te maken krijgen. De besluitvormer wordt verantwoordelijk voor het opvragen van de emissies bij hun leveranciers. Ze moeten CO_2 informatie krijgen van de bedrijven uit Azie. De EU-regelgeving werkt volgens een default percentage CO_2-heffing van 80% in het geval dat het bedrijf dingen uit China importeert en daarbij geen CO_2 informatie rapporteert over de

uitstoot, inclusief die van de leveranciers. Dit gaat over 80% per ton gewicht. Er moeten certificaten gekocht worden tegen een prijs van 10 a 15 euro per aangifte HS code. Elk product heeft een HS-code en valt onder een bepaalde categorie. Voor bijvoorbeeld de import van nietjes is er een importheffing van 2,7% over de waarde van de producten, daar komt nog de transportkosten bovenop (voor de aangifte bij de douane). De certificaten staan relatief los van de CO2-heffing per ton gewicht, maar komt er bovenop.

Voorbeeld, stel dat de leveranciers alles hebben berekend en er is een X aantal emissie uitstoot per ton gewicht productie. Daarna wordt dit vergeleken met de standaarden en komt er een percentage Y uit wordt vermenigvuldigd met het gewicht van de ingevoerde producten. De appliance-tool en materiaal importeur moet dan boven op de certificaten en de invoerheffing, die extra heffing betalen. Het is nog niet volledig uitgekristalliseerd, maar het komt eraan. Volgende maand kreeg het management team iemand van de EU over de vloer om uitleg te geven over deze maatregel.

CO2 rapportage
De eerste vragen die de besluitvormer zich afvraagt, is hoe die rapportage eruit moet zien en wat moet erin staan. Voorbeeld van schroevenproductie met 4 a 5 bedrijven die halffabricaten maken en naar de volgende partij sturen. Zorgen zijn groot over hoe hij achter de (Scope 1 en 2) uitstoot van die staalfabrikanten en verwerkingsfaciliteiten moet komen. Er is geen contact met al die bedrijven. De besluitvormer heeft een klacht ingediend bij de EU omdat het nooit kan weten wat al die bedrijven uitstoten. Hoogstens de fabrieken waarmee ze in contact staan kunnen een inschatting maken. De logische aanpak zou zijn om met het leveren van de producten elke keer naar de upstream producent te rapporteren wat de uitstoot tot dat moment is geweest en dat dat vervolgens als input wordt gebruikt door de downstream producent. (de auteur van deze samenvatting ziet hier mogelijkheden voor de informatie tools door functies toe te voegen die per leg een uitstoot weergeeft met daarbij de bedrijven die erbij betrokken waren en hoeveel belasting erover betaald is en tegelijkertijd uitdagingen met consistente berekeningen en standaarden in Azië tov Europa). Echter, wordt er van de besluitvormer verwacht dat zijn bedrijf per 1 Oktober begint met bijhouden en 1 Januari 2024 begint met rapporteren en dat is volgens de logistiek besluitvormer veel te kortdag. Vooralsnog is dat alleen maar rapporteren, maar er kan na een aantal jaar met terugwerkende kracht een belasting worden geheven.

Nog een uitdaging die herkend wordt is de motivatie van Aziatische bedrijven om de CO2 uitstoot te rapporteren terwijl zij die verplichting allemaal niet hebben. Verschuiving in de markt gaat plaatsvinden, want de bedrijven die niet rapporteren krijgen per definitie de default heffing van 80% over hun het gewicht van hun producten. De besluitvormer zal dan op zoek moeten naar bedrijven die wel kunnen rapporteren en onder die 80% liggen. 30 jaar lang samengewerkt, maar nu toch echt (veel) te duur. Er kan ook gekozen worden om alsnog wel samen tot een oplossing te komen en gezamenlijk te verduurzamen door elk jaar te gaan verminderen totdat het tot een behapbaar percentage is gezakt. Overstappen kan namelijk ook veel duurder worden omdat iedereen geconfronteerd wordt met deze tarieven en de al duurzame partijen zullen dus veel aantrekkelijker en dus duurder worden. Wel een positief effect op de aanbod markt.

Europees beleid
Logistieke besluitvormer verwacht dat het stimuleren van nearshoring een reden is geweest van de EU om op deze manier belasting te heffen. Europese productiefaciliteiten hoeven niet te rapporteren. Het wordt gezien als bescherming van de eigen markt en opvoeding van de Aziatische producenten dat ze bewuster moeten

produceren.

Scope 3 emissies van vervoer zijn lastiger te bepalen dan de ook al lastige scope 3 emissies van productie. (eigenlijk scope 1 emissies van de producenten binnen de keten). Om een begin te maken zijn er gesprekken aan de gang met de huidige lokale vervoerder, over welke vrachtwagens zij gebruiken. Hele prille gesprekken, maar ze zijn wel bezig met elektrische trucks. Vanderwal is een voorvechter in Nederland om emissies te verlagen van trucks en zij zijn ook in gesprek met de lokale vervoerder van het appliance bedrijf.

Trade-off kosten en uitstoot
Noodzaak van informatievoorziening wordt benadrukt en de invloed van overheidsdruk op de markt dmv die CBAM zorgt ervoor dat niet kosten en prijs leidend is bij de keuze voor een leverancier, maar dat de uitstoot en de rapportage daarover een voorwaarde is op dit moment. Het vooruitzicht van CBAM daargelaten, heeft CO_2 en het inzicht daarop voorlopig nog geen consequentie, dus heeft het verkrijgen van de informatie nog geen nut. Zolang ik nog niet op de vingers word getikt en het is kosten effectiever om een vervuilendere modaliteit te kiezen, dan doe ik dat". Als er echter maatregelen zullen komen zoals CBAM, dwingt het de producent om een duurzamere optie te kiezen, want zo niet zijn de prijzen voor zowel leverancier, distributeur als de consument veel te hoog. Een voordeel aan CBAM is dat het de hele markt betreft en dat het concurrentieposities niet per se in gevaar brengt om dus duurzamer te worden en een tijdje lagere winsten te moeten slikken. Iedereen zit daar namelijk mee.

Inflatie
Nu is de prijs voor duurzame producten nog relatief hoog, omdat het duurzame transport ook duur is omdat de markt nog klein is. Consumenten zullen bij hoogconjunctuur nog wel kunnen besluiten om een duurzamer product te kiezen, maar bij een laagconjunctuur of recessie en hoge inflatie en weinig koopkracht, zullen mensen toch altijd weer switchen naar de goedkopere producten om de broek hoog te houden.

Verduurzamen moet lonen
Je moet het verlagen van je emissie uitstoot een beloning maken en het zijn nu kosten. "Los van dat mijn informatie stroom fantastisch is en de uitstoot heel duidelijk is, moet ik toch betalen. De certificaten moeten gekocht worden en die zijn gekoppeld".
Anti dump
Vaak te maken met het fenomeen anti-dump. Voorbeeld van kartelvorming vanuit china die de prijzen dusdanig verlaagt dat westerse producenten eruit worden geconcurreert, wordt tegengegaan door de EU met de anti-dump wetgeving die een extra taks kan heffen op Aziatische producten. Dit is met name bedoeld om de bedrijven met staatssteun uit te bannen.

Informatie over uitstoot tussen port en warehouse
Wij hebben helemaal geen informatie over de uitstoot tussen port en warehouse. Wij baseren nog steeds alles op kosten en de bijvangst is het verlagen van de uitstoot als je van de dure trucks af stapt. Wat de uitstoot is, dat weten wij niet. Ik zou willen zien wat het verschil is tussen de trucks en de andere modaliteiten. Maar onze gekozen Forwarder is ook nog niet zo ver. Ik ben heel benieuwd hoe ze het gaan doen in de distributie per klant en watvoor berekening het wordt. Theoretisch of empirisch? Hoe werkt het bepalen van de uitstoot van 1 truck of bus die meerdere adressen moet afdoen. Twijfels werden genoemd over de verantwoordelijkheid van de uitstoot en wie het moet rapporteren. Wij hebben alleen geen vraag gehad van onze klanten, op het moment dat onze klanten vragen wat onze CO_2 uitstoot is

voor bijvoorbeeld het leveren van 50 pallets per week in 5 leveringen. Dan moeten zij gaan kijken wat zij kunnen doen om het te verminderen, door bijvoorbeeld niet elke dag te bestellen, maar bijvoorbeeld 1 keer in de week met 30 pallets. "Die vraag die leeft nog niet bij onze klanten dus zijn ze daar nog niet mee bezig."

Volgende week krijgen we een interne audit vanuit Japan. De week erna gaan we met ze in gesprek over hoe zij het in Japan doen qua CO_2 uitstoot. Zij zijn er al een stuk verder en strikter in. Wij staan echt nog in de kinderschoenen. Hoe het meestal gaat is, zij gaan vertellen hoe ze het doen, dan verwachten ze een geboekt resultaat na een aantal maanden en als wij dan dat resultaat niet halen gaan ze ons vertellen hoe we het moeten doen. Als zij ons iets opleggen, dan moeten we gewoon. De aandeelhouder bepaalt dan in dat geval.

Het is niet per se van belang om je uitstoot te weten, met name het financiële voordeel speelt nog erg in de overwegingen van de logistiek besluitvormer. Het ligt aan je product, aan je de marges die je op die producten hebt en of je dus een klap kunt hebben. Onze marges zijn vaak laag, dus dan kunnen we relatief duurdere tenders niet hebben.

C.2.5 Global clothing company

Clothing company with big brands under their wings. Global supply chains with Asian origin countries and western markets to serve. This interviewee is responsible for decision making on the supply chain logistics and has already made changes in his 5 years at the company that significantly affect the performance, as mode changes and warehouse locations.

Interview

Prioriteit van duurzaamheid en huidige gang van zaken
De kledingindustrie staat niet heel erg bekend als duurzaam. Zo ook de transport sector niet. In onze targets zitten ook duurzaamheids aspecten en wij zoeken naar innovaties die circulariteit stimuleren qua textiel, maar we zijn ook de afgelopen jaren erg bezig met de scope 3 emissies van transport. Er is in de laatste vijf jaar veel veranderd, zoals het aanpakken van trucking met producten vanuit Europese productie landen. Dat had meerdere redenen en sustainability komt daar bij als reden, maar ook als een mooie bijkomstigheid.

Als je een duurzame supply chain wil opzetten zul je altijd moeten rekenen en plannen wat het meest efficient is, want als je efficient bent, ben je in principe al duurzaam. Efficient plannen betekent niet per se dat je de snelst mogelijke modaliteit moet kiezen. Voorbeeld van import uit Turkije, waarbij trein of short sea vessels ook opties zijn. Truck was 6 dagen lead time, trein was 10 dagen en short sea 17. Lastige overstap, want we sourcen (die producten) dichtbij om ze snel te kunnen hebben. Vergelijking met truck en trein, komt ten voordele uit van de trein, want het is goedkoper (truck heeft 2 man nodig), er past evenveel in en het is duurzamer, ook positieve balans tav de trein als de empty returns meegenomen worden in de berekening. Het enige nadeel is dat het wat langer duurt, maar dat is planning technisch ook om te zetten in een voordeel. Als namelijk de standaard modaliteit al de snelste is, kan er bij een disruptie per definitie uitgegaan worden van een vertraging van het product. Als er echter een 1 na snelste optie gekozen wordt als standaard, dus de trein, zal er altijd een last-minute optie zijn om bepaalde producten alsnog met een truck te vervoeren. Wat voor ons goed werkt is een versneld transport met truck, Ro-Ro naar italie, italie met de trein naar Ruhrgebied Duitsland en dan laatste stuk met truck (naar Venlo).

"Inmiddels zijn we zover dat we alle import uit Turkije per schip doen als standaard." 4 levels van urgentie, zeevracht is dus standaard, trein komt daarna (istanbul -italie-duitse grens) en laatste stuk met de vrachtwagen, daarna komt intermodal en daarna direct trucking als er echt hoge nood is. Nogmaals herhaald dat trucks echt niet gewenst zijn, twee chauffeurs; stops onderweg en met name het zeer lastige plannen, waardoor de distributie centra met ongeregeldheden zitten. Dit voorbeeld van Turkije is door de besluitvormer doorgetrokken naar de logistieke ketens van andere Europese landen, zoals ook Portugal, waar de standaard inmiddels ook per short sea schip gaat. Trein is niet echt mogelijk.

Lead times zijn belangrijk, maar de 'escape' functie van een langzamere standaard modaliteit is leidend in de overwegingen. Betrouwbaarheid is dus van groots belang, met als achterliggende gedachten dat het tijdsgebonden high end fashion product niet te laat in de etalage mag staan. Met trucking is ook een groot aantal pallets betrokken, die nodig zijn om het uitladen te versnellen. Die pallets is allemaal loos vervoer, soms ook twee kanten op en ze worden soms ook weggegooid bij het DC, want die kunnen niks met pallets.

"We zijn nu heel erg bezig met hoe kunnen we onze containers het beste benut-

ten, hoe kunnen we überhaupt alles in containers krijgen, dus meer van de weg af". Trucking vanaf Rotterdam zijn we 5 jaar geleden mee gestopt. Alles moet zo gefixt worden dat het of een binnenvaartschip naar Moerdijk gebruikt, of een trein naar Venlo. Helaas is er geen geschikte spoorverbinding naar Moerdijk. Er is wel een spoor maar in ieder geval geen dienst vanuit Rotterdam en "als die er komt wil ik er graag gebruik van maken." In Venlo wel, daar was een grote terminal gepland en daar wilde wij bij (dus een DC locatie keuze gebaseerd op de treinverbinding). 5 of 6 treinen per week richting die terminal.

Luchtvracht
Het is heel gebruikelijk in de kleding industrie om luchtvracht in te zetten. Alles heeft te maken met planningen, met seizoenen, bijna 12 collecties en alles moet in de winkel komen zoals je het gepland had. Scheepvaart bracht te veel risico's voor een in de war geraakte supply chain door vertragingen etc. dat vaker luchtvracht gekozen werd. Interviewee geeft aan dat hij jaren in de luchtvracht heeft gewerkt en dat hij veel ervaring heeft met kledingmerken die voornamelijk luchtvracht gebruikten om het op tijd te hebben. De volgorde van de supply chain is van groots belang door en voor de planningen. Wat een negatieve kant is van dat versnellen met andere modaliteiten is bijvoorbeeld een container die te laat was voor het schip in China, wordt ingevlogen en vervolgens 3 weken te vroeg aankomt en dus ook in het DC opgeslagen moet worden. Past het dan nog in de stroom, is het dan nog in te voegen? Ja, er is wel wat flexibiliteit dus qua producten kan dat gewoon en zal er iets in de collectie eerder gepresenteerd worden dan voorheen was bedacht. De productie en verkoop zal dan niet significant in de war raken, maar het transport is wel op een duurdere en minder sustainable manier gedaan. Dit gebeurt niet vaak en ons luchtvrachtpercentage is erg laag.

Tender
Ons hele grote geheel aan zeevracht vanuit met name Azie is nu aan het innoveren met 1 rederij die op eco/bio fuels loopt. Dit betreft onze scope 3 emissies en dit is eigenlijk ongeveer hetgeen wat we tot nu toe kunnen doen. Op termijn (als de technologie wordt ontwikkeld) zullen er mogelijkheden met methanol of waterstof etc in schepen mogelijk zijn. Waterstof zou de beste manier zijn mits het ook groen geproduceerd wordt. We volgen dit op de voet en hebben nu ook in onze "ocean RFQ" (soort tender) van vorige jaar opgenomen dat de partijen een echt voorstel hebben voor sustainability om met een plan te komen om gezamenlijk de uitstoot te verminderen. Het resultaat is dat we tot en met 2025 hebben gecommit met de huidige carrier om eco fuels te blijven gebruiken. We betalen daar een kleine premie voor, dus het is iets duurder allemaal. Waar de container en transport prijzen tijdens corona door het plafond rezen en de premie voor eco-fuels niet zo significant was, is dat nu procentueel een veel groter deel van de totaalprijs, bij pak hem beet 200 euro premie per container.

CO_2 targets
Er zijn targets om CO_2 uitstoot te verminderen, maar hoeveel precies en aantallen behoort nog niet tot de kennis van deze logistieke besluitvormer. Targets komen van het Corporate Responsibility Team waar sustainability deel van uitmaakt. Zij weten beter hoe alles gemeten wordt en waar we mee bezig zijn.

"We gebruiken externen om die rapportage van (het oceaan gedeelte) CO_2 uitstoot tot stand te brengen, "want we willen natuurlijk wel snappen wat we doen". Logistiek besluitvormer geeft aan dat hij daar geen verstand van heeft. " Als mij gevraagd wordt, wat we met sustainability doen zeg ik altijd dat je gezond verstand moet gebruiken".

"Je moet in het grotere geheel denken en als je niks doet dan verandert er ook

niks. Zo ben ik er mee begonnen en gecommit voor een paar jaar. Ik denk dat we nu gewoon ons ding doen en ook de industrie een beetje helpen om op te schalen, want uiteindelijk is het natuurlijk het kip en het ei verhaal."

Initiatief
We zijn geen klein bedrijf, maar onze volumes deden er twee jaar terug niet toe voor de grote rederijen. Die schepen zaten toch wel vol. Nu is dat wel anders en kunnen we in gesprek gaan alsook qua tarieven niet de volle pond betalen. Je probeert een strategisch partnerschap aan te gaan met die partijen en waar je ook nadenkt over de toekomst en sustainability daarin. Onze partnership met Mearsk bevalt op dit moment goed met de eco fuels en het oog op verdere verduurzaming. De 'rest' van de rederijen loopt hierin nog wat achter.

Sourcing
Er verschuift toch wel een bepaald stuk van onze sourcing vanuit china naar omliggende landen. Politieke gevoeligheid en transport looptijden zijn nadelig voor de productie en betrouwbaarheid met name. Overvolle terminals zorgden ook voor disrupties verderop in de keten.

CO_2 KPI's
Op dit moment is er nog geen operationele KPI op CO_2 uitstoot, laat staan een target van hoe hoog je mag zitten. "Als die er wel zou zijn, denk ik dat ik goed zou zitten met die zeevracht, laag percentage luchtvracht, intermodaal en eco fuels". Nogmaals, ik zet me erg in om het nog beter te maken en nog minder trucks te gebruiken, maar niet vanuit de drijfveer om meer sustainable te worden, maar om efficiëntie te stimuleren. Trucks zijn duurder, zit meer risico aan en het is vervuilender en daarnaast wil het DC ook helemaal geen internationale vrachtwagens voor de deur (liever die containers op een terminal want dan kan je nog kiezen wat je wanneer leeg trekt, die internationale trailer moet gelijk leeg. Vooral irritant als daar spullen in zitten die je niet per se nu nodig hebt).

Je hebt als bedrijf een maatschappelijke verantwoordelijkheid om er mee bezig te zijn. Veel initiatieven, ook bij de productie en textiel gebruik, water gebruik, logistiek etc. Of je nou per se een dashboard nodig hebt die alle sustainability omvangt of niet. Wel degelijk ben ik gestuit op statistieken van uitstoot in het Turkije project, als je alle modaliteiten vergelijkt. De inzichten in de uitstoot van die specifieke tradelane zorgden naast de verhoogde kosten per truck voor een extra zetje in de richting van de duurzamere vervoermiddelen.

Als je echt iets gaat veranderen, moet je dat intern wel kunnen verkopen. Dan zul je dus met een verhaal moeten komen waarvan in ieder geval bij een paar punten er veel overtuiging heerst. CO_2 was daar 1 van. Niet gekwantificeerd in absolute getallen maar wel een procentuele verandering.

Verbetering van de informatie
Valt de uitstoot wel echt kwantificeerbaar te berekenen? Er valt bij de transporteurs echt nog wel wat te halen wat dat betreft. Nu leggen we in onze systemen vast wat de inkooporders zijn, met welke modaliteit ze gaan of welke combinatie. Port of loadings weten we en ongeveer het aantal containers op een schip, dus er kan een inschatting gemaakt worden wat ongeveer de uitstoot was. Hier kan bijvoorbeeld een "good shipping company" aan de hand van standaarden een berekening kunnen maken. De besluitvormer was sceptisch in de omvattendheid van die berekeningen aan de hand van standaarden, hij denkt dat zijn gebruik (op sommige stukken) van eco fuels niet wordt meegenomen in die berekeningen.

Mearsk heeft wel een certificaat afgegeven (elk jaar) met de vermindering van de

uitstoot van het jaar ervoor op ocean freight. Dus daarmee kunnen we wat meer hard maken. Wat weet de gewone freight forwarder nou meer dan het gebruiken van de industry standards. Het initiatief van het havenbedrijf om ook zo'n tool te maken is zo verkeerd nog niet. "Het moeilijke aan het hele verhaal is om het te gaan toewijzen." Transport is niet onze core business, dus daar moeten die vervoerders in duiken om te kijken hoe ze hun scope 1 emissies kunnen verlagen. De dikke winsten bij een rederij (toen de containers 15k per stuk waren) worden gezien en geaccepteerd maar er wordt wel naar gekeken dat ze dan ook met die winsten de juiste dingen doen. LNG schepen van CMA zijn ook een stap duurzamer dan stook olie, aan de andere kant als je toch miljoenen investeringen doet, doe het dan goed en gebruik geen gas.

Externe factoren
ETS is goed voor de industrie. De vervoerder zal het moeten rapporteren en terugvragen. Voorbeeld van een effectief beleid vanuit de IMO is het very low sulphur gehalte in de brandstof/uitstoot. Meerdere consequenties voor de vervoerders in hun operaties, maar wel een behaald resultaat. Wel is het lastig om de rederijen te dwingen, wat dus een successfactor was de globale schaal waarop de nieuwe regels gingen gelden. Als Europa zegt, jullie moeten belasting betalen over je CO_2 en de rest van de wereld kijkt toe, zullen de rederijen zich ook gewoon op een andere markt kunnen richten.

Neem je verantwoordelijkheid, dat is eigenlijk waar het allemaal om gaat. Uiteindelijk denk ik ook dat degene die die eerste stap gaat maken, dat die een voorsprong kan opbouwen waar ze hun voordeel uit kunnen halen. Creeren van een unique selling point met bijvoorbeeld waterstof, waar op termijn veel vraag naar gaat zijn en waar de rest nog op achter loopt.

Consumenten druk durft de logistieke besluitvormer nog niet te noemen als drijfveer, wel merkt hij op dat consumenten steeds kritischer worden. Behalve in tijden van crisis, want dan gaan alle principes overboord en is de goedkoopste optie aantrekkelijk. (product technisch meer richting PRIMARK etc.) In de richting van consumentendruk, is er wel een bepaald verlangen om niet achter te lopen in bepaalde ontwikkelingen. Je wil niet te boeken komen als het merk dat niet mee loopt. Werknemerdruk om bij een duurzaam bedrijf te werken wordt ook steeds belangrijker. Slechte reputatie wil je van wegblijven als persoon maar ook als bedrijf. Niet alleen de logistiek maar ook het product en de productie moet goed zijn.

Afsluiter
"Ik denk dat we het qua emissies goed doen, maar inzicht krijgen via de genoemde dashboards kan best nuttig zijn. Wat heeft een keuze nou voor effect op... Veel sneller handelen is ook een voordeel van meer informatie hebben."

C.3 INFORMATION EXPERTS

C.3.1 Program manager Port of Rotterdam

This program manager has built his expertise in sustainability and the energy transition at the port of Rotterdam. The interview was conducted in Dutch.

Interview

Since this program manager is familiar with the concept of a carbon dioxide measurement tool, and this was already stated upfront to the researcher, it speeded up the introduction to come to a quick answer to the following question:
Does the port of Rotterdam use a carbon dioxide measurement tool to report their emissions already and if so, did they use their own tool?

The answer was no. It was to be expected in the near future but not at the moment. Current applications of the tools were on a sales basis. Rotterdam representatives could use the carbon information to persuade potential clients (cargo owners) to use the Port of Rotterdam for importing and exporting their freight. It was recognised by the program manager that there is more potential for carbon dioxide measurement tools, but that taxing for example was not yet a feasible application. The results have an error margin that is too large still and imposing a tax would then produce unfair situations. The program manager compared it with a speeding ticket without proper measurement machines, a 30km/h error margin is not feasible for imposing a tax on the logistical sector. The program manager differentiated a tax from an emission trading system (ETS) and explained that it was more likely to impose the emission rights on companies than charge them an additional tax on every product.

When asked upon responsibility in the emission reduction goals, it was stated that there is a need for (external) pressure before companies adapt their decision making. However, knowledge is power so knowing about the emissions is already an important first step towards reducing the emissions. An example that was mentioned for this was an offsetting project where companies could invest in bio-based vessels to transport cargo somewhere around the world that was not within their own supply chain. The reason for this was that is was practically not possible to change something at their own supply chain so they chose to compensate for it by reducing the emissions somewhere else in the world. The option to go for a more sustainable supply chain should be available or otherwise nobody can choose it.

This was a bridge to the role of the Port of Rotterdam in reducing the emissions of supply chains. It was recognized by the program manager that there was a chicken and egg situation in this regard, since companies or people can't choose a sustainable option there won't be anybody that will invest in being the first. The Port of Rotterdam aims to break some of these chicken and egg situations by taking iniative in purchasing a hydrogen and electrical water taxi. This is leading by example and is something the Port of Rotterdam likes to promote.

Within standardisation questions there is also a role for the Port of Rotterdam in corresponding with international standards and adopting them rapidly (or at least aim to do so). Up until now the IMO has had the biggest impact on climate change with their fuel standards to reduce the sulfur margins on maritime diesels.

C.3.2 Business development manager Routescanner

Routescanner is a sub division of Port of Rotterdam and this business manager is involved in developing the tool and attracting clients. She has worked there for a year. The interview was conducted in dutch.

Interview summary

Routescanner offers two types of services to their customers, the first is a planning wise estimation of a certain trade lane or trip that then shows the associated logistics providers, with estimated costs, lead times and emissions. This tool can actively motivate a cargo owner to choose a different route, partner, or port of call to minimize the prioritized KPI. The other service that Routescanner offers, is a carbon report that transposes a transshipment dataset of a client into trustworthy carbon emission information that is reported back to the company.

Size of a cargo owner matters in their intentions to become more sustainable. A bigger company might be inclined to change early because they have the resources to do so, but smaller companies are possibly not yet eager to become more sustainable, unless they are somehow pressured. Financial regulations on emissions are perceived as useful, yet not all companies in the field are aware of the new regulations. "What we see at Routescanner is that our clients want to change, but that the steps to become more sustainable are incremental and high impact first intended". At initiative of the client, Routescanner will assess the tradelanes that emit the highest amount of emissions. Routescanner will provide advice to the client where they can best focus on. Because the client has the initiative, there is no responsibility for Routescanner to assess what tradelanes produce the most carbon emissions.

A new feature of Routescanner can also be a comparison function that can show the improved trip with either barge or train in comparison to the baseline trip with a truck. Lead times, cost estimation and emissions are then shown as a way to convince the consumer of the sustainable intentions of the company.
Sitting down with competitors is not something we are interested in, speaking for Routescanner. The advantage of a workshop would be that both parties share insights with the rest and a discussion arises from which best practices and lessons learned can be retrieved with the ultimate goal to reduce greenhouse gas emissions in the whole industry.

C.3.3 Data scientist Port of Rotterdam

This Port of Rotterdam data scientist was involved in the development of HESP from an early phase and has been an expert on Port of Rotterdam data integration and visualisation.

Interview

HESP is divided in two parts, one being the port area emissions calculator, which includes all emitting entities, and the hinterland chain emissions calculator. For the port area calculator there is AIS data which is transposed to carbon emission data, by using PXP. The location data from the ships, but also ship type, engine type and fuel usage is determined here. The TNO-model uses the location data as wel as the ship type data to produce an additional data set being carbon emission information. This data set is then compared to the harbor dues data set that the port already has

to come to usable data for HESP[1]. Container data can be separated from breakbulk or liquid bulk.

For the hinterland chain emissions calculator there is much less available data, since only a few larger trucking companies have available (location) data, whereas every sea going vessel is included in the AIS data sets. Raw averages that distribute all transshipment to Rotterdam over the multiple modalities can be based on the modal split surveys among clients. The modal split is then multiplied by the total volume and the average distance to country middle points based on ISL data and Google Maps. The carbon emission information for the hinterland side is thus not that trustworthy yet. Cargo owner has the exact data themselves and thus have the ability to go to more depth for their own carbon emission information. They will not recognize their own share in the broad and huge emissions that are produced by the HESP tool.

The port area emission function is complemented with a monitor of heavy industry. This will include chemical factories and its emissions. The cargo owners with global supply chains and containerized goods are less interested in this HESP function. HESP is thus suitable for internal use, not external use. Shippers and forwarders teams have been included, whereas the carrier teams remain absent in HESP usage while the tool does allow for visualizations and insights per carrier, trade lane and or country. Potential for improvement is there, yet initiative is not taken. However, a current disadvantage of HESP is the one size fits all proposition. That type of solution is not desired and counterproductive since it will not be suitable for anyone. The one company (probably the frontrunner) has a great need for carbon emission information on a high detail level, whereas the other company has a need for some general bottom lines.

Another doubt is the conflict of interest where the port aims to become more sustainable and provide insight in the sustainability of the port as well as the operations of the customers, while at the same time this might cause some clients to be impacted by this information in a negative way. That will be a loss of income that on the other hand might lose clients to competing ports and on the other hand increase the sustainability of the port. Commercial department then has to focus on being the most sustainable port to compete. For actual use with differentiated clients, HESP is too broad and lacks detail. Routescanner is a little further in this regard.

Who takes responsibility for the carbon emissions that are produced? There is someone and if the responsibility for carbon emissions are delegated to the transporting company, then the insurance and other transport related responsibilities are also doubted, so altered agreements have to be formulated that copes with this doubt.

C.3.4 Data scientist BIGMile

This data scientist is a software expert at the carbon emission tool company BIGMile. He was involved in developing HESP in collaboration with the Port of Rotterdam. The interview was conducted in dutch.

Interview

Voorheen was het vaker een early adapter die hun footprint omlaag wilde brengen. Ook gebeurde het wel eens dat een grote verlader of een klant CO2 eiste, dat zien we nog steeds wel veel. Bij grotere bedrijven die moeten rapporteren aan hun hoofd-

1 There is now an internal discussion at the (new) tool developers that the current visualization is too computing power consuming that the coding has to be rewritten in order to save computing power.

kantoor. Nu met die nieuwe Europese richtlijn, de CSRD, zien je dat alle bedrijven hier mee bezig moeten gaan zijn. De grote bedrijven zijn als eerst aan de beurt met rapporteren en die kloppen wel bij BIGMile aan om een rapportage te krijgen. De transporteurs kloppen ook aan en hebben ook interesse in hun CO_2 inzicht, omdat zij dat weer van hun klanten (de verladers) als eis krijgen. De verlader gaat om zich heen slaan en ook richting de transporteur omdat die meer informatie hebben dan zij. Dat activeert elkaar allemaal, met als beginpunt dus die CSRD europese richtlijn.

Zowel vervoerder als verlader zijn verantwoordelijk. Zeker als de CO_2 taks straks geheven gaat worden. Een extra heffing op een zending: "Hoeveel CO_2 heb ik nodig om een klant te bedienen?". Wij kunnen helpen om dat inzicht te krijgen, al is het niet zo ingewikkeld. We hebben bepaalde standaarden om het gewicht en het aantal kilometers mee te nemen in een CO_2 berekeing die 'eerlijk' is voor alle zenders. (dit gaat over de warehouse naar klant distributie). Brandstofverbruik gegevens van de vervoerders is hiervoor het beste, kengetallen en benaderingen kan ook. Bigmile biedt drie soorten aan, Nederlandse kengetallen per voertuig type, Europese kengetallen en met name GLEC, en Britse kengetallen maar die zijn voornamelijk regionaal. Het verschilt niet veel allemaal, maar door Bigmile wordt GLEC wordt veel gebruikt (ook in HESP van Hbr) en is fijn omdat het vaker gebruikt wordt en je dus appels met appels kunt vergelijken. De EU CSRD richtlijn is niet per definitie gericht op GLEC, maar GLEC is wel compatibel met de richtlijn.

Verladers gebruiken het dashboard om echt andere keuzes te maken. Van hoog tot laag echt alle kanten op. Van andere modaliteiten, andere brandstoffen, lanes en ook shipment sizes en frequenties (consolideren in uithoeken van service gebied). Wel is het zo dat de kosten in die gevallen ook lager worden en dat de vermindering van de uitstoot ook gepaard (moet) gaan met een vermindering van de kosten. Er worden ook wel keuzes gemaakt voor duurdere brandstoffen die beter zijn qua uitstoot, dus het gebeurt wel.

Doorberekenen van de extra kosten voor uitstoot dmv een taks op de consument is wel een gevaar, echter is het wel de verwachting dat de partijen die het nu goed doen op duurzaamheid ook een lagere kostprijs zullen hebben op termijn.

Iets wat beter kan aan de huidige presentatie van informatie is dat het nooit helemaal precies goed is. Er is altijd wel wat onzekerheid achter de komma en dat is met meer dingen waar je minder zicht op hebt. Focus moet zeker in het begin niet gelijk op achter de komma liggen. Neem het overgrote deel van het inzicht mee en ga vanaf daar verder kijken. Aannames moeten goed op orde zijn en beargumenteerd kunnen worden. Ook in de verdere stappen, met oog op de rapportage is het belangrijk dat de audit ook het rapport en de logica kan volgen, ongeacht watvoor CO_2 er wordt gerapporteerd.

Bevestiging door A dat de twijfel in data kwaliteit kan zorgen voor een volledige impasse en dat er vervolgens een houding wordt aangenomen die afwachtend is, tot er een betere kwaliteit beschikbaar is. Antwoord van A, is dat die partijen uiteindelijk ook met hun data aan het werk moeten, of ze dat nou willen of niet. Een grote uitdaging voor een aantal bedrijven zal toch ook zijn dat ze hun data voorziening op pijl zullen moeten krijgen. Met name ook bedrijven die als tussenpersoon fungeren en weinig echt zelf transporteren zullen moeite krijgen om hun data te verkrijgen.

Een mogelijk conflict kan optreden tussen partijen in de haven die een kennis monopolie hadden/hebben en op basis daarvan hun boterham verdienen en de huidige informatievoorzieningsdrang. Hoe meer kennis de verladers en transporteurs hebben hoe minder macht die partijen waaronder ook forwarders zullen hebben, tenzij ze een rol gaan spelen in het informatie voorzieningstraject.

Lobby tegen het gebruik van CO_2 informatie platformen wordt niet herkend en is ook niet de verwachting. Wel een geluid gehoord van een soortgelijke partij (forwarder) die wat weerstand bood door de kwaliteit en autoriteit van een bigmile berekening in twijfel te trekken. Dit specifieke voorbeeld is uiteindelijk wel tekenend want diezelfde partij is uiteindelijk alsnog terug naar Bigmile gekomen om alsnog naar de emissies te kijken. Bevestiging dat die aankomende wet en regelgeving toch wat met die bedrijven doet.

In 1 jaar tijd zijn de gesprekken met onze (bigmile) klanten zo veranderd. Waar we in het begin nog klanten moesten overtuigen dat het verlagen van de emissies echt noodzakelijk was, komen ze nu zelf al met een flinke dosis aandacht, energie, intentie om die emissies in kaart te gaan brengen. (Voornamelijk Europese) Wetgeving ligt hier zeker aan ten grondslag.

Een aantal bedrijven zal uit zichzelf wel veranderen, maar het gros niet. Eigen maatschappelijke verantwoordelijkheid is niet de drijfveer die doet handelen. "Een klant (cargo owner in deze thesis) zal soms ook wel pushen met de vraag: Als jij volgend jaar mijn transport nog wil doen, zul je wel CO_2 informatie moeten laten zien." Dat is ook een drijfveer om naar ons te komen.

De frequentie van een update van de CO_2 informatie kan door de klant (van bigmile) bepaald worden, kan elke dag, week, maand, kwartaal, jaar etc. Wel is het voor de besluitvorming richting duurzame alternatieven interessant om meer frequente updates te doen. Hoe vaker hoe beter eigenlijk, maar dat kost ook weer extra tijd, moeite en geld. 1 keer per jaar is wel te weinig, dan is het gewoon elk jaar weer hopen dat het wat lager is en eigenlijk weet je het gewoon niet.

C.3.5 Senior Consultant sustainable logistics at Districon

Districon is a sub company of Royal Haskoning and is specialized in mastering flow. Logistics is their expertise, and they aim to keep on improving supply chains with a (partly) focus on sustainability. This senior consultant is familiar with HESP and has expertise on the use of carbon information in supply chains. The interview was conducted in Dutch

Interview

De gebruikers zijn niet door mij gedefinieerd. HESP is primair als tool ontwikkeld voor intern gebruik door de business manager. Het doel ervan was het rapporteren, prioritiseren en het enablen van projecten die emissies kunnen verminderen. HESP is niet gelijk het antwoord op alle vragen. Wel geeft het richting in waar er verbeteringspotentieel zit. Bijvoorbeeld bij het evalueren van het mogelijke effect van walstroom. Echter, HESP is op dit moment geen voorspellend model. Op termijn was het wel de bedoeling om HESP zo in te richten dat er informatie uit gehaald kon worden om scenario's door te rekenen. Dat kan nu niet omdat het daadwerkelijke energieverbruik van een walstroom installatie niet beschikbaar is. We weten niet of partijen daadwerkelijk gebruik maken van de walstroom ondanks dat het wel geïnstalleerd is. Als je de walstroom kasten mag koppelen kan dat uiteraard wel.

Wat HESP nu wel goed kan is het samenbrengen van allerlei informatie. Je hebt databases waarin alle informatie over de schepen staat, over de soort automotiveen in het schip, hoeveel generatoren met watvoor vermogen, hoe groot is het schip, brandstofverbruik en ook geschiktheid voor walstroom. Deze databases worden

constant geüpdatet en zo is er dus ook informatie van het aantal schepen met een walstroom installatie aan boord en dus ook een inschatting over hoeveel schepen dat dan ongeveer gebruiken. Het doel van HESP is nu dus om een inschatting te geven van het waarschijnlijke aantal emissies wat het je gaat schelen. Zonder HESP weet je wel dat je minder uitstoot, maar hoeveel?

Straks is het natuurlijk zo dat de ETS kosten voor je brandstofverbruik. ETS bestaat al wel, maar voor brandstofverbruik. 1 ton CO_2 kost nu 88 euro en de verwachting is dat dat omhoog zal gaan. Dat is gewoon belasting op emissie. Ook door bepaalde ontwikkeling van technologieën als elektrische trucks, zal de marktwerking meer in het voordeel komen van de duurzamere technologieën ten opzichte van de vervuilende gevestigde orde. Beide zijn dus vormen van invloed op de markt.

De aanbodsmarkt kan worden gestimuleerd om duurzamer te worden door voorlopers in de verladersmarkt. Vervoersvraag bepaalt in hoeverre die vervoerder verandert. Als een verlader een vervoersvraag naar enkel duurzaam vervoer, zal er een verschuiving op de aanbodsmarkt van vervoer plaatsvinden. Dit kan dus alleen zodra er ook vraag zal zijn naar duurder duurzaam vervoer. Echter is de verwachting dat de meeste bedrijven afwachtend zullen zijn. De verwachting is ook dat de grotere bedrijven wel kunnen voorloper en het ook kunnen gebruiken als marketing mechanisme.

Wat je nu steeds meer ziet is dat derde partijen, vervoerders, ook een audit laten doen over hun CO_2 rapportage, maar ook dat er steeds meer contracten tussen vervoerder en verlader expliciete afspraken vastleggen over de verantwoordelijkheid over de emissies. Dat dus bijvoorbeeld de vervoerder verplicht is om aan de verlader te rapporteren wat de uitstoot is geweest van zijn vervoer. Enkel de informatie die gebruikt kan worden om de emissies te berekenen kan ook, dus bijvoorbeeld brandstof verbruik, herkomst bestemming, vervoerder lading etc.

De meeste bedrijven willen wel services afnemen voor een rapportage, maar hebben geen behoefte aan een eigen tool. Het verschil tussen Havenbedrijf Rotterdam en andere partijen in hun CO_2 informatie vraag. Bij het havenbedrijf zijn heel veel verschillende soorten informatie van meerdere partijen uit meerdere systemen gecombineerd. De reden hiervoor is dat de uitstoot van een haven door veel verschillende factoren komt en dus ook een andere benadering vereist. Een verlader is echt geïnteresseerd, voor scope 3 emissies, in het trade-lane transport stuk en de emissie analyse daarvan, veel eenvoudiger en dus ook een ander soort tool.

Wat wij in de markt zien is dat het belangrijk is om te weten wat je CO_2 uitstoot is maar ook wordt het verplicht om je uitstoot te rapporteren. Doordat je het weet kun je ook iets aan doen dus verminderen. Het verminderen van je uitstoot hoeft niet eens altijd duurder te zijn, er zijn ook allerlei maatregelen die je kan nemen waardoor je productie of transport etc. goedkoper is. Met andere woorden, het wordt ook gewoon een steeds interessantere business case. De Duitse maut die is ingevoerd van zo'n 200 euro per ton CO_2, dan heb je heel snel je elektrische vrachtwagen terugverdiend.

Voor een belasting moet je exact weten wie hoeveel heeft uitgestoten. Als het gaat om stadsdistributie met meerdere pakketjes met meerdere eigenaren en bestemmingen in 1 vrachtauto, moet je precies weten welk deel van de uitstoot aan wie kan worden toebedeeld. De vervoerder moet de belasting betalen en zelf maar kijken hoe hij zijn geld terugkrijgt bij zijn opdrachtgevers. Zowel de verzender van het pakketje als de vervoerder zijn verantwoordelijk en het doorberekenen van de kosten zal in de praktijk zeker wel gebeuren. In eerste instantie zal die vervoerder het wel gewoon moeten betalen, vergelijkbaar met tol. Alle CO_2 wordt toegewezen

aan de lading. Bij elke berekening zit de verrekening van het gewicht in het totale conto van een bedrijf. Met name BigMile is hier goed in.

Wat ik een beetje merk bij bedrijven die ons benaderen is dat CO_2 uitstoot hun dagelijkse keuzes niet beïnvloed, maar dat ze wel erg bezig zijn met de beoogde beperkte van de uitstoot per 2030. Wat kan ik doen om de uitstoot van mijn transport te verminderen en welke keuzes kan ik maken om dat doel van 2030 te halen.

De bedrijven, of moederbedrijven, hebben nu vaak SBTI (Science based targets initiative) targets opgesteld. Heel vaak hebben ze geen idee wat ze daarmee moeten, dus dan komen ze bij ons (Districon) om te kijken of ze überhaupt haalbaar zijn en zo ja, hoe dan.

Heel veel bedrijven willen nu eerst gewoon compliant zijn met die wetgeving en gaan pas als ze dat zijn verder kijken naar een bepaalde strategie.