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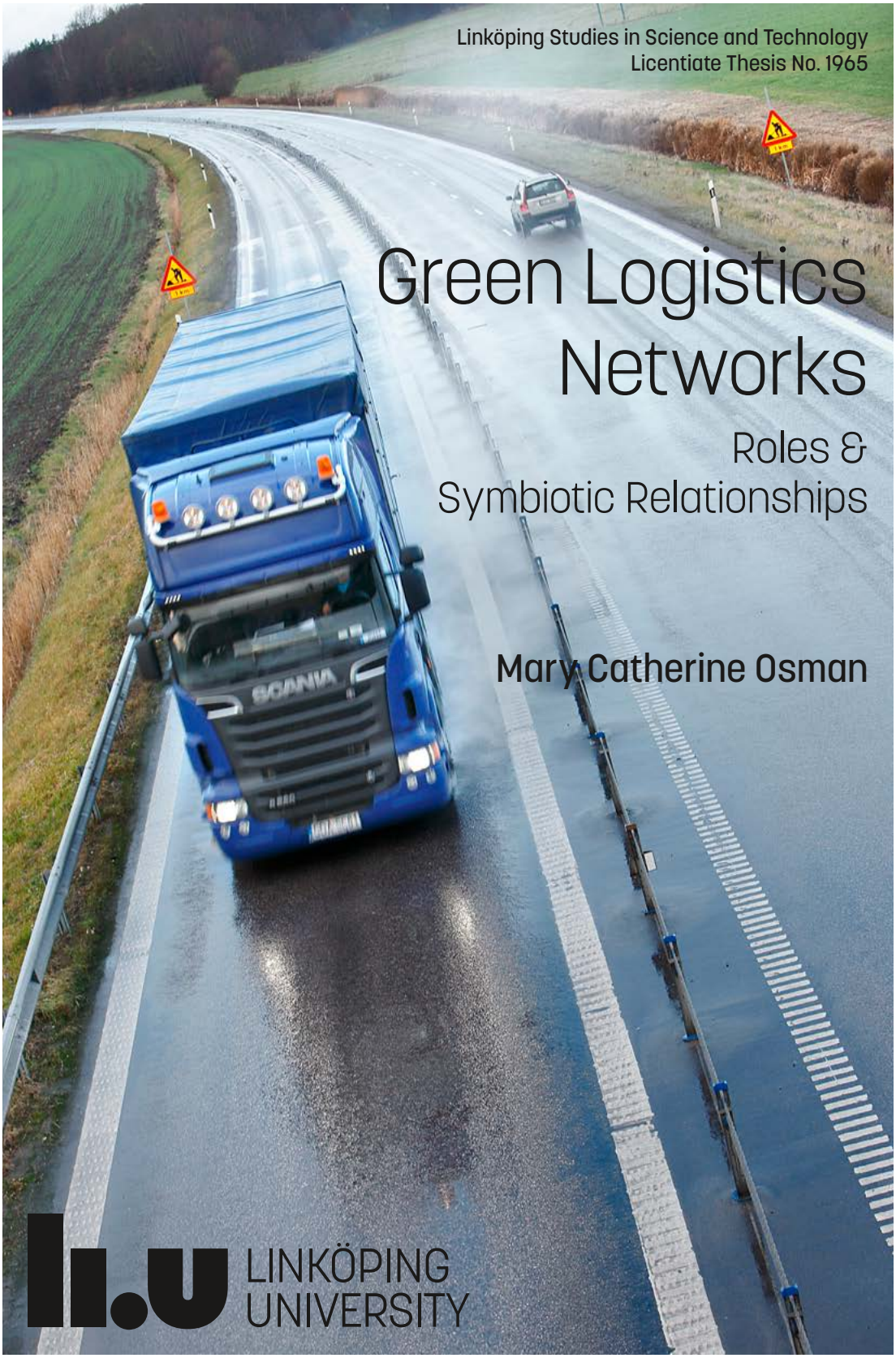

Green Logistics Networks

Roles & Symbiotic Relationships

Mary Catherine Osman

LINKÖPING UNIVERSITY

Linköping Studies in Science and Technology. Licentiate No. 1965

Green Logistics Networks:

Roles & Symbiotic Relationships

Mary Catherine Osman

Logistics and Quality Management
Department of Management and Engineering,
Faculty of Science and Engineering
Linköping University, SE-582 83 Linköping, Sweden
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Linköping University

Department of Management and Engineering

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Abstract

Logistics actors such as the transport buyer, freight forwarder, and haulier are currently in a transition phase towards more sustainable practices typically referred to as Green Logistics Practices (GLPs). One of the more progressive GLPs is completion of freight transport using fossil-free fuels such as biomethane. Despite knowledge that fossil-free fuels are effective in reducing the amount of carbon emitted, logistics networks need to move faster in transitioning.

This licentiate thesis looks at a successful implementation of biomethane in freight transport in Sweden with the purpose: *understanding value creation in implementation of biomethane in freight transport from the point of view of the logistics actors.* The research takes an abductive approach. The research is built upon a systematic literature review and literature study which lead to a series of interviews and eventually two different case studies of a regional and national network using biomethane. The systematic literature review and interview study of Paper 1 provided a knowledge base for understanding the status of GLP use and logistics actors' roles. Paper 2, an embedded case study of the regional network, gives a better image of a network's drivers and barriers in biomethane implementation including network dynamics. Paper 3 as a multiple case study including both the regional and national network allows for deeper understanding of a network's dynamics, relationships and value propositions for value co-creation.

Use of symbiotic relationships from biology inspired the analysis of the relationships between logistics actors and the value propositions which drives value co-creation. Building from the empirical data and analysis of both the individual papers and kappa, four value propositions were identified: communication, innovation, determination for success and perceived support. The analysis highlighted the weight of different value propositions may carry for the different actors in value creation. A constant finding through the analysis was the importance of communication in the relation in that the actor leading the communication tended to benefit more in value creation.

The kappa's results and analysis which builds on three papers that are part of the licentiate thesis suggest three points that can be used as a base for future research. Firstly, regional networks and national networks act differently. The studied Regional Network was committed to biomethane-fueled transport as it reflected the desires of the customer and community. Whereas the studied National Network had a wider range of customers to satisfy, therefore less commitment to biomethane-driven transport specifically. Secondly in the Regional Network, where the Regional Haulier was identified as a key actor due to its on taking of investments and the importance the other actors in the Regional Network place upon it. Finally, perception of support was realized as one of the more prominent value propositions. If organizations perceive support either from the market or politicians, then they are more likely to be emboldened to take the risk and invest in competencies necessary to transport freight using fossil-free fuels.

This licentiate thesis contributes both academically and managerially. In the research field of green logistics, the kappa furthers studies on value creation, relationships between logistics actors pertaining to fossil-free fuels in freight transport and introduces the application of metaphors from biology into logistics that could be built upon in the future. Managerially, the thesis begins to expose how different networks relate to fossil-free fuel use.

Sammanfattning

Allt fler logistika aktörer såsom logistikföretag, åkerier och transportköpare har börjat intressera sig för miljövänliga åtgärder, på engelska så kallade Green Logistics Practices (GLP). En av de mest progressiva åtgärderna är användning av fossilfria drivmedel såsom biogas. Även om användning av fossilfria drivmedel effektivt minskar koldioxidutsläppen och är viktigt för att uppnå klimatmålen så finns det en hel del utmaningar för företagen som ska implementera dessa drivmedel. I dagsläget försöker såväl företag som olika myndigheter hitta lösningar för att underlätta användning av fossilfria drivmedel.

Denna licentiatavhandling studerar användningen av biogas för godstransporter i Sverige i två olika nätverk, ett regionalt och ett nationellt. Syftet är *att öka kunskapen om värdeskapande och implementering av biogas i godstransporter utifrån logistikaktörernas perspektiv.* För att uppfylla syftet har fallstudier använts som huvudsaklig metod där två nätverk, ett regionalt och ett nationellt studerats.

Avhandlingen bygger på tre artiklar. De har fokuserat på användning av biogas som en av flera GLPs, drivkrafter och barriärer bland logistikaktörer för införande av biogas, samt värdeskapande vid införande av biogas. Kappan, som bygger på tre artiklarna, ha inspirerats av teorier grundad i biologiska symbiotiska relationer för att beskriva och förstå relationer mellan logistikaktörer och hur värde skapas. Ur analysen identifieras fyra faktorer av betydelse för värdeskapandet: kommunikation, innovation, beslutsamhet att lyckas och uppfattning av stöd. Inkluderade 3 papperna bidrar till kappan med ett djupare förståelse av aktörernas roll, deras relationer och värdeskapandet.

Ett mönster som upprepas genom forskningen var vikten av kommunikation. Aktörer som kommunicerat bra hade stabila relationer och skapade därigenom värde tillsammans. Inom enskilda relationer var den aktör som var drivande ledde kommunikationen också den som drog mest nytta av värdeskapandet.

Kappan presenterar tre huvudsakliga resultat som kan tas vidare i fortsatt forsning. För det första så beter sig regionala nätverket och nationala nätverket på olika sätt. Logistikaktörerna i det regionala nätverket var mer engagerade i biogasanvändningen än logistikaktörerna i det nationella nätverket. En anledning till det skulle kunna vara att det fanns tydligare önskemål från kunder och från samhället i det regionala nätverket. För det andra så är det inte alltid den största aktören som är nyckelaktören, vilket också överensstämmer med relationer inom biologiska symbiosen. Slutligen konstaterads det att upplevt stöd för införande av fossilfria bränslen var en av de mest framträdande värdeerbjudandena. Om organisationerna vet eller åtminstone uppfattar att det har stöd från marknaden eller från politiker så är det troligare att de är villiga att ta risken och investera i den kompetens som krävs för att transportera gods med hjälp av fossilfria bränslen.

Licentiatavhandlingen resulterar i värdefulla teoretiska såväl som praktiska bidrag. De teoretiska bidragen finns att finna i en ökad förståelse för värdeskapandet och relationer mellan logistikaktörer som använder biogas och möjligheten at använda teorier inom biologiska symbiotiska relationer för att analysera just detta. De praktiska bidragen avser hur olika nätverk relaterar till fossil fria bränsle och ger verktyg till företag att identifiera sin position i nätverk och en ökad förståelse för olika relationer inom ett nätverk.

Included papers

Paper 1

Mary Catherine Osman, Maria Huge-Brodin, Jonas Ammenberg & Jenny Karlsson (2022). *Exploring green logistics practices in freight transport and logistics: a study of biomethane use in Sweden*, International Journal of Logistics Research and Applications, DOI: 10.1080/13675567.2022.2100332

Paper 2

Mary Catherine Osman, Maria Huge-Brodin & Linea Kjellsdotter Ivert (2022). *Actors' Drivers and Barriers when implementing biomethane: An embedded case study*. Manuscript developed from a conference paper presented at NOFOMA 2022 at University of Iceland: Reykjavik, Iceland. Will be submitted to a journal.

Paper 3

Mary Catherine Osman, Linea Kjellsdotter Ivert & Maria Huge-Brodin (2022). *Business Practices for Transition to Biomethane for Freight*. Presented at LRN 2022 Conference at Aston University: Birmingham, UK.

Acknowledgements

One day, for no particular reason, I just started writing. I wrote quarantined in Estonia. When it was time to go home, I wrote at home with a puppy on my lap. When Sweden decided to forget about that corona thing, I wrote at my office at the university. When I got tired of that I wrote at VTI. When it was time, I had fika. And when it was time to go to conferences, I had to be personally escorted through an airport by migration police. I wrote and I wrote. For two straight years. Till one day I just didn't feel like writing anymore, so I stopped. People seemed to like what I wrote. So now that I've stopped writing I can finally thank all the people that wrote alongside me.

First and foremost, thank you to Trafikverket and Triple F for the chance to pursue a PhD and contribute in my own way in moving towards a greener world. Thank you to all the involved parties who took part in my research – your participation and enthusiasm made this possible.

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To all my fellow PhDs at both LiU and VTI: '*We few, we happy few, we band of brothers. For he today that sheds his blood with me shall be my brother; …* [and others] *shall think themselves accursed they were not here'* (Shakespeare's Henry V, Act IV, Scene III). Strange how Shakespeare can encapsulate both war in Medieval England and doctoral studies. May we never allow the other to have empty coffee mugs nor dwell over stupid comments from half-crazy reviewers.

Thank you to all my other co-workers at LiU and VTI for making this process so enjoyable and memorable. It's an honor to have you as both co-workers and friends.

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Till Han som ska få all ära
Mary Catherine Osman
Linköping, April 2023

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Key Concepts

This section presents a list of central terms and definitions according to how they will be used by the researcher in this thesis.

Biomethane -Biomethane is a fossil-free fuel source created through the anaerobic digestion of organic materials (Biogas Research Center 2019).

Fossil-Free Fuel -Fuels that have an energy source not derived from a fossil source and may be used in a variety of ways– heat, energy, vehicle fuel, etc. Some examples include: HVO, biomethane and electricity.

Freight Forwarder -A freight forwarder 'link[s] buyers and sellers, creating economic value by effectively delivering products to customers' (Shang and Lu 2012, 64)

Green Logistics Practices (GLP) -Green Logistics Practices (GLPs) are practices implemented to create a more environmentally sustainable logistics operation (Dekker, Bloemhof, and Mallidis 2012; Jazairy and von Haartman 2020).

Haulier -Hauliers is an organization that completes transport on behalf of another and typically owns their vehicle fleet (Coyle, Bardi, and Cavinato 1990).

Keystone Species-Within the biological context, a keystone species is a species without whom the biosphere would suffer and struggle to survive (Zook 2002). In the adapted logistical context, the keystone species has great responsibly for the efficient functioning of the logistics network and without whom the network may struggle in the short-term but eventually will find or develop similar competencies elsewhere.

Service Dominant Logic -Service Dominant Logic (SDL) is a mindset of viewing value creation through a process called value co-creation (Freeman, Harrison, and Wicks 2007).

Symbiosis -A relationship occurring between two or more parties (traditionally, two different species). This relationship has the ability to take multiple different forms and may be life-long or temporary (Paracer 2000).

Value Co-Creation -This is the process, according to SDL, in which value is created. Value is created through a feedback loop between organizations through a menage of activities such as communication or service offering (Ngoc et al. 2017). In literature, these activities are called value propositions and will be referred to by that name in this thesis as well (Vargo, Maglio, and Archpru 2008).

1. Introduction

Between COVID-19 induced chaos, mishaps in the Suez Canal and the amount of Greenhouse Gases emitted through logistical activities, the importance and presence of logistics can no longer be ignored in today's ever growing global economy. In Europe and a majority of the western world, transportation is one of the largest causes of Greenhouse Gas emission with an estimate of a fourth of the transportation-caused emissions coming from heavy freight trucks (European Commission 2019b; Trafikverket 2012). Wu and Dunn (1995) wrote that logistics is the last puzzle piece in providing environmentally sustainable transport solutions to consumers and in the last few years society business, and politics have begun to make progress (European Commission 2019a). Yet the lack of knowledge, skill and perceptions of difficulty continues to hinders large-scale progress (Jazairy *et al.,* 2021).

One possibility for this slow progress could be that logisticians are stuck in old thinking patterns and practices. Change may not occur if one continues to act or perform in the same manner, never learning and adapting from previous mistakes. Green Logistics Practices (GLPs) include various practices adopted to create a more environmental logistics operation such as recyclable packaging, route optimization or fossil-free fuels. Many GLPs are similar to traditional logistics practices yet shift the logistics mindset towards being more relationship-centric rather than profit-centric. This may be the shift required to bring about the change Wu & Dunn predicted almost 25 years ago (Hall et al. 2022).

Transitioning towards a more relationship-centric mindset in logistics, the concept of value and participating value creators is challenged. Previously in business operations, value was more given without input from the consumer in terms of worth for price paid or utility according to Goods Dominant Logic (GDL) (Lusch, Vargo, and Brien 2007). However, through Service Dominant Logic (SDL) value may be co-created between actors through value propositions. SDL and its disposition lend itself well to understanding the value created in service based industries such as logistics as knowledge and exchange of skills rather than tangible goods typically provide value (Vargo and Lusch 2014; Vargo, Maglio, and Archpru 2008). Value propositions are any characteristics or actions that actors use to assess the value creation of a service in an evaluation loop (Hall et al. 2022; Vargo and Lusch 2016). This evaluation loop and co-creation of value allows for core competencies and competitive advantages to develop as well as fortifying a relationship between actors (Taghizadeh and Rahman 2022; Vargo and Lusch 2008).

Both the development of new and strengthening of existing competitive advantages are drawing logistics actors to utilizing the SDL in their business operations (Yazdanparast, Manuj, and Swartz 2010). The service offering of GLPs is a roughly charted area in relation to how value could be created in the logistics network such as that seen in Jazairy, von Haartman and Björklund (2021) and Yazdanparast, Manuj and Swartz (2010). Vargo and Lusch (2017) state that SDL could be used to clarify complexities between actors in the market as well as advance environmental sustainability solutions. Thus, understanding how value co-creation occurs and through which value propositions when implementing GLPs may make actualize fossil-free freight transport sooner.

1.1. Transition to Fossil-Free Fuels in Freight Transport

In terms of GLPs, implementation of fossil-free fuels would most aggressively aid countries and organizations to meet any prescribed mandate to decrease GHG emissions. McKinnon

(2016) emphasizes the point by stating: “nothing less than a transformation of logistics energy use will be needed to achieve the deep carbon reductions required over the next few decades. This transformation will entail both a step change in energy efficiency and a dramatic shift from fossil to renewable energy” (McKinnon 2018, 161). Estimations from the European Environment Agency (EEA) (2021, 2022) predict a continued increase in transport across the EU member states and by default an increase in GHG emissions. This positive correlation of transport and GHG emission motivates the importance of finding appropriate fossil-free solutions in the freight industry that will allow for economic growth without further harm to the environment.

Within the sphere of freight transportation, there are multiple possible fossil-free fuels available to potentially replace fossil fuels and there are predictions that a fully fossil-free society will be built upon several fossil-free fuel alternatives (Karlsson, Kjellsdotter Ivert, and Brunner 2021; McKinnon 2018). The alternative best suited may depend on many factors such as geographic layout, distance, available infrastructure, and other available resources (Hoen and Zondag 2014). The technical improvements for electrical vehicles have made their use more feasible on a large scale. However, there is still uncertainty about their range, thus making electric vehicles currently better suited for urban transport and shorter distances (Ammenberg et al. 2018; Takman et al. 2018). Biomethane seems to be better suited for heavy, long-haul trucking or water transportation due to its longer range and general likeness to fossil fuels (Karlsson, Kjellsdotter Ivert, and Brunner 2021; Takman et al. 2018).

The European Union has adjusted their budget to reflect their initiatives in bringing member states towards their carbon-neutrality and emission goals (European Commission 2019a). Some of the EU member states have passed political and financial support to aid in the switch to fossil-free fuels. As stated previously, the general public wants to see a new era of a normalization of environmentally sustainable practices (de Moor et al. 2021).

Sweden is one of the EU member states that has been more progressive in becoming independent of fossil-fuels across various sectors. Karlsson, Kjellsdotter Ivert and Brunner (2021) explain that between 2010 and 2018 carbon emission from domestic transport reduced 18,9% which in part was due to the country’s increase of HVO use. According to Bengtsson *et al.*, (2022) carbon emission from transport decreased slightly between 2020 – 2021 due to steady increase of both biomethane and electric vehicles. Wehner *et al.* (2023) determine that the Swedish freight industry did not experience any large hinders or changes in volume of freight transport during the Covid-19 pandemic, so the decrease in carbon emission is most likely derived from an increase of GLP implementation. While this decrease in emissions is admirable, prognosis indicate that with this continued rate of decrease Sweden’s 2030 climate goal will not be reached (Karlsson, Kjellsdotter Ivert, and Brunner 2021; Takman and Trosvik 2020) .

To ensure this goal will be reached, Sweden is actively testing different GLP implementations, particularly, fossil-free fuels across sectors and industries. In Eriksson (2022)’s report, *Grönt ljus 2030: goda exempel som ger ökad klimatnytta i närtid*, different regions and cities across Sweden are highlighted for their innovative ideas and plans to aid Sweden in reaching its goal. Certain regions have invested in biomethane digestors to relieve societal issues such as waste management or green vehicle fuel (Biogasmarknadsutredningen 2019; Eriksson 2022). Use of biomethane in Sweden is more common in vehicles for public

transport, but existing infrastructure allows for expansion of use (Hårrskog et al. 2022). To attract and further the progression of biomethane, Sweden was among a few of the EU member states that provided tax reductions for the use of biomethane (European Environment Agency 2022). As of the composition of this kappa, the future of these tax reductions remains unknown as there are ongoing discussions of how and what they will entail going forward. Despite any changes that may come, a primary infrastructure and willingness for biomethane seems to have set root in Sweden marking the context and focus on biomethane in this licentiate thesis relevant.

1.2. Implications of Fossil-Free Fuels on the Logistics Network

Christopher (1998) describes the objective of a logistics networks with its nodes and links to optimally plan and execute necessary logistics activities to achieve highest quality at lowest costs. Inherently, this objective entails interaction between actors including building of relationships. To operate efficiently, it is beneficial that all actors understand their role in the network. The numerous actors comprising a logistics network may take on more active roles than others in the transition to fossil-free fuels (Huge-Brodin and Sweeney 2021). This could be due to their purpose in the logistics network or due to bargaining power they possess (Aronsson and Huge-Brodin 2006; Karlsson, Kjellsdotter Ivert, and Brunner 2021). Every network has a unique operation and involved actors, but three actors typically comprise a logistics network: freight forwarder, transport buyer and haulier. Freight forwarders coordinate the transport on behalf of the transport buyer while the haulier completes the transport.

Logistics research has begun to piece together the different logistics actors' roles and their motivations to support the transition from fossil fuels to fossil-free fuels, but there are still unanswered questions (Centobelli, Cerchione, and Esposito 2017). From their literature review of sustainable transport research between 2000- 2019, Zhao *et al.*, (2020) found that topics such as logistics management and involvement of stakeholders were some of the most researched topics, but that more research needed to be completed to understand the benefits of sustainable transport including a possible method of benefit assessment. Additionally, the ALICE (2019) report harps the importance of stakeholder collaboration and individual actor roles in the transition towards freight transport decarbonization.

Research has begun to understand different logistics actors' role in GLP implementation, but there is more to understand. The alignment of expectations and proper communication between freight forwarder and transport buyer seem to be important. However according to Huge-Brodin, Sweeney and Evangelista (2020), the two actors root their expectations in different sources. Freight forwarders looking to their customers for basis of service expectation whereas transport buyers draw expectations from standards and legislation. Dahlgren and Ammenberg (2022) agree that misalignment between the freight forwarder and transport buyer hinders implementation of a GLP. This is one such instance of many in the logistics context where use of SDL could improve alignment between actors and create value in service offering. Research such as this licentiate thesis investigating biomethane use and implications may aid in understanding the alignment.

1.3. Research Questions & Purpose

It is well documented which actors typically are involved in a logistics network. With the exception for modernization and globalization, the roles of transport buyers, freight

forwarders and hauliers have changed little since some of the research published in the 1990s (Christopher 1998). There is still uncertainty around their behavior in logistics networks implementing GLPs particularly those completing transportation with a fossil-free fuel, such as biomethane which is the focus of this licentiate thesis. McKinnon (2018) explains that the urgency that some logistics networks to become fossil-free may undermine partner choices possibly leading to profiteering of certain actors if actors do not feel secure in their network role. Additionally, Sallnäs and Huge-Brodin (2018) propose that when implementing GLPs the weight of various checkpoints differ compared to in a fossil fuel network. Such checkpoints concern the actors' ambition level, competency, or financial limits in allowing them to actively proceed in the network implementing a GLP. Ensuring that actors in the logistics networks are functioning efficiently and to the network's best advantage, a mapping of the involved actors and their roles may prove beneficial. Leading to the first research question:

RQ1. What is the role of the logistics actors when involved in implementation of biomethane?

In its basis a logistics network is a series of nodes correlating to actors and links which may correlate to relationship, information flow or product flow depending on the actor (Lumsden 2012). As previously stated, the relationships in a network operating on fossil fuels have been researched to length. However, there is continued uncertainty about how introduction of GLPs, like biomethane-fueled transport, will affect operations and relationships in a network. Use of SDL may reveal relational attributes of the actors through which value propositions are utilized. Moreover, Dehling, Edvardsson and Tronvoll (2022) state that there is a lack of research across fields on how actors coordinate to achieve value creation. This leads to the second research question:

RQ2. How do the relationships of these logistics actors contribute to the value creation for implementing biomethane in freight transport solutions?

Between the identification of logistics actors' roles and their relationship to one another in any value created in biomethane-fueled freight transport, the logistics network may be able to manage any unresolved concerns previously mentioned. Thus, fulfilling the purpose of this licentiate thesis:

Understanding value creation in implementation of biomethane in freight transport from the point of view of the logistical actors

1.4. Research Scope & Limitation

This research has contained itself within a certain scope. Therefore, the scope with its limitations should be presented.

Supply Chain Management is typically referred to when discussing networks and partners and therein it any necessary relationships as per Harrison and van Hoek's (2011) definition: "*a supply chain is a network of partners who collectively convert a basic commodity into a finished product that is valued by end-customers, and who manage returns at each stage"* (Harrison and van Hoek 2011, 7). However outgoing from the purpose and research questions of this kappa which both consider relationships and the active participation of value co-creation between actors throughout the process important, the mindset and definition of logistics is better suited: "*the task of coordinating material flow and information flow across supply chain to meet end-customer needs"* (Harrison and van Hoek 2011, 7). Additionally,

this kappa does not focus on an activity in a supply chain that could provide value such as manufacturing, procurement of raw material or packaging rather the coordination of actors to implement an activity (distribution) strengthening the argument of keeping the research within a logistics scope.

This research is confided to the Swedish context where industries and organizations are encouraged both from politicians and the public to become more environmentally friendly. Researching GLP implementation in this context may affect the results compared with conducting similar research in a not as environmentally progressive context.

The networks studied in the case studies (Paper 2 & 3) which is described in more detail in both Chapters 2 & 3, consists of a successful implementation of biomethane in freight transport. Thereby the positive influence of the implementation may affect the viewpoints and responses of the actors participating in the study. Different results and conclusions may have been drawn if a different case study, phase of implementation or success rate of the implementation had been studied.

The use of biological symbiotic relationships in logistics research may be surprising. Inspiration from the researcher's personal interest has led to this meeting of two worlds. Biological symbiotic relationships in this kappa should be seen as a metaphor and a descriptive aid for the reader. Taking one concept most have a basic understanding of such as symbiotic relationships and using it to explain or guide readers through a topic in which they may not have as much knowledge like the complexities of a logistics network hopefully makes for more enjoyable reading and higher comprehension. Further discussions of the use, parallels, and limitations of biological symbiotic relationships in this kappa are explained in Chapters 2, 6 & 7.

Between the context and biomethane success, this research proves both interesting and limiting to study. Interesting in the respect that learning and understanding how a network succeeds may aid in future implementation of biomethane in other networks. Yet limiting in that this success may allow the research to overlook issues that may occur as they are not properly captured in the data, or their importance is not properly conveyed in the results and conclusions.

1.5. Outline of the Licentiate Thesis

The remainder of this licentiate thesis is structured as follows:

Chapter 2: The Methodology is presented to give the reader insight into the research approach and design of the studies, including papers and analysis conducted in the thesis.

Chapter 3: A Case Description is provided including information about the logistics actors included in the case and the regional context particularly pertaining to biomethane use and production.

Chapter 4: A Frame of Reference provides literature as a background for the phenomenon but also to expose the areas in which this research plans to fill and a proposed theoretical model.

Chapter 5: The Appended Papers are summarized along with their contribution to this work.

Chapter 6: A Discussion uses the theoretical model developed in the Frame of Reference to answer the kappa's two research questions.

Chapter 7: the Conclusions and Future Research are presented.

2. Methodology

The following chapter covers and discusses the research methodology. First, the research approach and process that the researcher took will be discussed. Thereafter the methods for data collection and analysis are described. The utilized method will be discussed in relation to each paper in this chapter as well as in Chapter 5. All papers are included in their full form at the end of the kappa.

2.1. Research Approach

Choosing an appropriate research approach to undergo is determined by, among other factors, the starting point of the researcher, the research subject or phenomenon and the overall goal of the research. The research approach chosen dictates the starting point of the research either in empirical data as in inductive research, theory as in deductive research or a combination as in abductive research. The abductive research approach is flexible allowing researchers to go back and forth between empirical data and theory before bringing forth any conclusions or theory. Abductive research also has by nature a creative aspect which leads itself well to exploring and understanding new phenomenon thus lending itself well to case study research (Kovács and Spens 2005). This approach is appropriate as it aids in creation of new knowledge in an area where uncertainty remains, such as the logistics actor's role and effects on the network when implementing biomethane (Patel and Davidsson 2011).

The research took an abductive research approach and process. This can be seen in the case study research design of Paper 2 & 3 as there was a forward circular thought process, as described in Kovács and Spens (2005), between empirical data and theory. One input providing inspiration for the other slowly building upon one another eventually leading to conclusions or propositions about the studied phenomenon. From this abductive approach, the researcher was able to begin to understand the actor's roles and relationships amongst them in a logistics network through identified value propositions.

This licentiate thesis is based upon the findings of data collection over two years which resulted in three papers and an additional analysis for the kappa based upon the collective findings. This study leaned heavily on qualitative methods which is supported by the licentiate thesis' goal to understand and discuss roles in the logistics context (Halldorsson and Aastrup 2003). Details of the research process for each study and respective paper as well as the analysis undergone in the licentiate thesis will be presented in the remainder of this section.

This research was financed through a project and initiative by Triple F. Triple F is a research initiative funded by Trafikverket (Swedish Department of Transportation) to find and implement solutions to create fossil-free freight transport in Sweden.

2.2. Research Process

The research process leading up to this kappa could be seen as an ongoing two-year process resulting in three papers. As there were no set beginning and end dates of different data collection components, this allowed the researcher to be abductive flowing between theory and empirical data to best understand the phenomenon as inspiration or discovery arose.

The doctoral process began in early 2021 when the researcher conducted a systematic literature review complemented by an interview study resulting in Paper 1. The findings of the systematic literature provoked questions and interest leading to the interview study to further

dig into the phenomenon and understand how it behaves in the research context of biomethane use in Sweden. After the interviews conducted for Paper 1, the researcher still had queries about how the interviewed actors overcame certain obstacles to have a successful implementation of biomethane juxtaposed with the current literature and media. The researcher took the interviews from Paper 1 and developed the interview guide further so to fill gaps in understanding the drivers and barriers of biomethane implementation. These interviews began in the late fall of 2021 and ran until early 2022. As the researcher conducted and analyzed the interviews, she realized that the actors in discussing the drivers and barriers of biomethane implementation also revealed value propositions of biomethane use. These value propositions and accompanying value co-creation lead to Paper 3. Narrative literature reviews of Paper 2 and 3 were conducted simultaneously with data collection and composition of the respective papers.

After the summer of 2022, Paper 1 was published. Paper 2 will be submitted to a journal in the fall of 2023. The version of Paper 2 included in the licentiate thesis is a reworking of a conference paper after gaining feedback in the late fall of 2022. The composition of the kappa began in the winter of 2022 and continued until early spring of 2023. Therefore, the positioning of the papers in Figure 1 correlates with the versions utilized in this thesis.

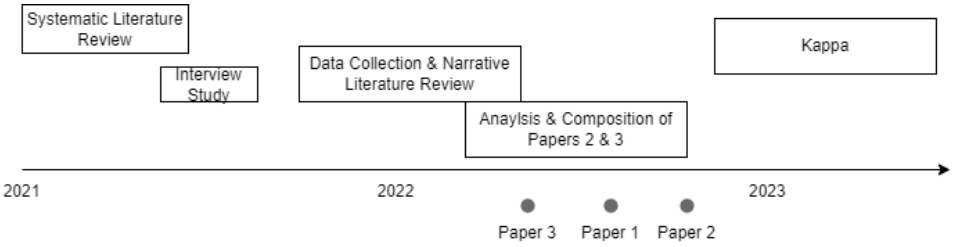

Figure 1 Research Process

The research process contributes to this licentiate thesis by providing an overview of the field through literature as well as better understanding of the current developments and actor's relationships through the case study. This combined contribution provides knowledge to answer the two research questions posed in this kappa as seen in Table 1. The table below is broken down by paper to provide the reader with an understanding of how the papers contribute to the kappa and is further explained in conjunction with their summary in Chapter 5.

Paper	RQ1	RQ2
1	X	
2	X	X
3		X

Table 1 Knowledge Contribution from Papers to RQs

2.3. Research Methods

The research methods chosen reflects the abductive research approach and aim to understand the ongoing phenomenon. Each of the resulting papers and their methods attempt to clarify certain aspects of the phenomenon as they were discovered during the collection of empirical data. Paper 1 has a two-fold purpose. In a more general sense, the systematic literature review allows the researcher to understand which GLPs are being used by practitioners and

researched by academics. Secondly, the interviews provide insight for the actors' role in GLP implementation and what thought process may be undergone prior or during implementation. The GLP in focus was biomethane, however information encompassing other GLP implementation was discussed. Seen in Paper 2, the drivers and barriers experienced by the different actors helps bring understanding of the different roles as well as how experiences or perceptions of these drivers and barriers may affect the actors' relationships. Paper 3 attempts to shed light on the value propositions different actors in a network may introduce to create value for themselves and the network when implementing biomethane.

The methods utilized in the three studies are outlined visually in Table 2. A short description of each method and its motivation is given in the remainder of this section.

Study	Systematic Literature Review	Narrative Literature Review	Interview Study	Case Study
Paper 1	X		X	
Paper 2		X		X
Paper 3		X		X

Table 2 Methods Used in Studies

Chapter 3 – Case Description will provide more information about the networks and the included actors, the case selection resulted in 2 networks: Regional Network and National Network. The Regional Network consists of a Freight Forwarder, Fuel Supplier, Regional Haulier & Transport Buyer. The National Network consists of a Freight Forwarder, National Haulier and the Market. The Freight Forwarder is the only actor represented in both networks.

Literature Reviews

Literature Reviews provide both the researcher and eventual readers of the research with a base understanding of the topic at hand and what has previously been written about the subject. Providing a thorough literature review allows the researcher to confidently state and frame their own research in a gap and motivate for its importance and necessity in a given subject area (Bryman and Bell 2007; Jesson, Matherson, and Lacey 2011). One can perform either a systematic or narrative literature review. A basic overview of systematic and narrative literature reviews and how they were conducted in relation to this thesis will be discussed.

Systematic Literature Review

To begin the licentiate thesis' research process, a systematic literature review was conducted. The systematic literature review has long been an effective manner to understand what has been researched within a field while shedding light to the pockets of research gaps in a structured manner. Durach et al. (2017) propose a systematic literature review detailing 5 steps that is geared towards conducting systematic literature reviews within Supply Chain Management making it suitable for this type of research as logistics and supply chain management mindset is linked as discussed previously. The 5 steps were utilized in the systematic literature review conducted by the researchers (see Figure 2). As the literature search was conducted in early 2021, the literature and thus the results and analysis reflect collected literature published up to that point.

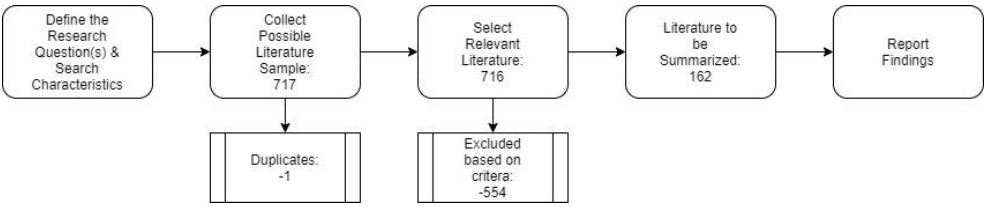

Figure 2 Six Steps Conducted in Paper 1's Systematic Literature Review from (Osman *et al.,* 2022, p. 3)

The literature selected to be included held to the following inclusion criteria:

- Published in peer-review journals
- Written in English
- Studies focusing on actions and practices to create more environmentally sustainable freight transport

Any literature not meeting those three criteria were excluded. The final 162 papers included in the study represent a 25-year span of research on the topic of finding and implementing more sustainable logistics. One could see an increase of research output correlating with the major international events such as the Kyoto Protocol in 1997 and the Paris Climate Accord in 2015, however the majority of the articles were published between 2016 and 2020 with the largest contribution coming from Europe. A general synthesis of the literature was conducted based upon actor, practice, practice motivation and industry. This synthesis was then juxtaposed with the data gathered from the interviews. The suggested GLP categories resulted from this manner. A more detailed description of how the researcher conducted the systematic literature review is explained in Paper 1.

Narrative Literature Review

Papers 2 and 3 both include narrative literature reviews which were conducted depending on the focus of the paper. A narrative literature review follows a similar yet not as rigid process as a systematic literature review allowing for further interests to be explored as they are discovered. Typically a narrative literature review will include deciding upon keywords, a literature search, choosing appropriate literature, and summarization of the literature (Jesson, Matherson, and Lacey 2011). The researcher used Scopus to conduct the initial literature search for each paper, but also during the duration of the interviews to either find clarity or knowledge gaps. For Paper 2, search strings were formed as to find literature pertaining to drivers, motivators, barriers, hinders for general implementation of GLPs as little research has been published about drivers and barriers of fossil-free fuel adoption from the logistics point of view. For Paper 3, keywords such as service, value, co-creation, business practice and stakeholder theory were utilized to find appropriate literature. Then due to snowballing, additional relevant literature was added after the initial literature search (Bryman and Bell 2007). One could view the literature searches as building upon each other across the studies and papers, much of the literature found from the systematic literature review was able to guide the research group. More in-depth accounts of how the narrative literature reviews were conducted can be found in the attached Papers at the end of the kappa.

Interview Study

An interview study aids in gaining first-hand information and insight into a phenomenon however usually without the depth of a case study. The interview study conducted as a

complement to the Systematic Literature Review in Paper 1 comprised of five semi-structured interviews all conducted digitally lasting between 30- 60 minutes (see Table 3). The first two (with the Freight Forwarder and Fuel Supplier) were explorative and semi-structured allowing for the research group to gain a general understanding of the major occurrences within the field as it is novel. The findings of the first 2 interviews led to a further 3 interviews which while still semi-structured were less so in comparison to the first 2. A semi-structured interview gives both the researcher and the participant the flexibility to allow the interview to unfold depending on the responses given yet with a loose structure ensuring that all key elements are covered. All interviews were recorded and two researchers participated in the interviews as to ensure validity (Yin 2011).

Actor	Respondent Title
Freight Forwarder	Branch Manager
Fuel Supplier	Product Manager
National Haulier	Sustainability Manager
Regional Haulier	CEO & Co-Owner
Transport Buyer	Sustainability Manager

Table 3 Respondents in Interview Study

Case Study

One conducts a case study when attempting to make sense of a current phenomenon. Hopes of conducting a case study is to come closer in answering how or why the studied event or phenomenon occurs. Case studies may utilize several different methods if appropriate to the purpose or phenomenon (Yin, 2011). Biomethane as a vehicle fuel in road freight transport has many unanswered questions yet the present phenomenon of environmentally sustainable freight transport proves important to society as a whole therefore lending itself well to a case study. As case studies are explorative in nature this suited itself well to the research questions and purposes of Papers 2 & 3. The two different case studies resulting in Paper 2 & 3 were based upon the same collection of interviews just differing in design depending on the purpose of the respective paper.

Paper 2 includes only one network (Regional Network) while Paper 3 comprises of 2 networks (National & Regional Networks). The interviews were semi-structured to allow the researcher freedom to prod and explore as the interview unfolded while still having a structure to ensure that certain topics were covered that needed to be covered. The semi-structured and explorative nature of these interviews allowed for multiple different analyses. As discussed previously, necessary literature to inform researchers was collected simultaneously as the case study was conducted following an abductive research approach.

It should be noted that these interviews were conducted in the wake of the Russian invasion of Ukraine during which there was much speculation and concern over energy security. These geo-political events and concerns may have influenced the responses of the respondents. Additionally, these interviews were conducted prior to the change in the tax subsidies for biomethane use in Sweden. Before March of 2023, the use of biomethane was subsided by the Swedish government, but due to restrictions from the EU Commission continued provision of subsidies is not possible. With these changes, Svensk Biogas has announced they will take on some of the taxes on behalf of their customers to not discourage biomethane use (Tekniska verken 2023). It is possible that some of the responses may change if similar questions were asked in the current tax policy.

Case Selection
Case selection may arguably be one of the more important aspects in research design. The case selected should reflect appropriately the phenomena while being aligned with the purpose of the study (Patton 2014). Following in the abductive nature of the research, the researching group started with one actor participating in the case study and shortly thereafter broadened their participant search dependent on actor's suitability according to interviews and literature using the first actor as a contact point.

The actors included in the case study were chosen due to:

- Use of biomethane in freight transport
- Generally positive experience with biomethane
- Commitment to environmental sustainability
- Willingness to participate in research

Case Study Design & Analysis of Paper 2 – Actors' Drivers and Barriers when Implementing Biomethane: An Embedded Case Study
Only the Regional Network was included in the design and analysis comprised in Paper 2. Choosing the Regional Network solely created a single, embedded case study. Both exploratory and semi-structured interviews were conducted. The round of explorative interviews conducted after the systematic literature review in Paper 1 gave the research group a basic understanding of the interviewed actors and the phenomenon. Then a second round of semi-structured interviews were conducted based on an interview guide which was developed from the findings of the explorative interviews. Respective respondents, their titles and interview type can be seen in Table 4. All interviews were held digitally lasting between 45-75 minutes and recorded. However, only the semi-structured interviews were transcribed verbatim. The analysis included two units of analysis later allowing the researchers to pattern match the coded material from transcribed interviews with the literature from the narrative literature review.

The embedded units of analysis for the case study were the drivers and barriers of biomethane implementation. The interviews were coded according to the dimensions defined in the framework: technology, customer, management, costs, relationships, society and political. These dimensions were used as units of analysis and compared with literature (Miles and Huberman 1994). This design allowed the researchers to gain a good assessment of the drivers and barriers occurring according to the dimensions revealed through literature; described in detail in Chapter 5 and included in appended papers. Yet this design proves difficult to generalize due to the limited scope of including only one case (Yin, 2011).

Actor	Respondent Title	Interview Type
Freight Forwarder	Sustainability Manager	Semi-Structured
Freight Forwarder	Branch Manager	Explorative
Regional Haulier	CEO & Co-Owner	Both (2 interviews)
Energy Supplier	Product Manager	Both (2)
Transport Buyer	Sustainability Manager	Both (2)
Transport Buyer	Transport Manager	Semi-Structured

Table 4 Paper 2 Respondents and Interview Type

Case Study Design & Analysis of Paper 3– Business Practices for Transition to Biomethane for Freight

Analyzation of both Regional and National Network with serval units of analysis allows the case study design in Paper 3 be classified as an embedded multiple case study which also aligns with its purpose of describing business practices provision of value to a freight forwarder's stakeholders (Yin, 2011). The interviews included in this paper are those depicted in Table 4 as well as the semi-structured interview with the Sustainability Manager representing the National Haulier from Paper 1. These interviews borrowed from Paper 1 aimed to understand the National Network at the same level as Regional Network. The interviews were coded by the research group according to the business practices identified through the narrative literature review: collaboration, pricing, workplace culture and new service offering. Upon coding different themes within each identified business practice allowing for a cross-case analysis to be conducted. Compared with the analysis conducted in Paper 2, a cross-case analysis permits generalization as well as deeper under understanding with the possibility to explain the phenomenon at hand (Miles and Huberman 1994). A variable-oriented analysis was conducted where the themes found through the narrative literature study were used as the variables and for each individual actor in the network (Miles and Huberman 1994).

2.4. Licentiate Thesis Analysis

Beginning the analysis of the licentiate thesis, the researcher took the data from the two studies and results from the three different papers desiring to see the phenomenon on an overarching level. Each paper could be seen as building blocks for the whole. Between a first overview of the data and knowledge of published or ongoing research, it was revealed that the importance of relationships in logistics networks when implementing fossil-free fuels was an overarching theme in the research. As far as the author's knowledge, research has yet to explain fully the phenomenon. This realization led to the licentiate thesis' purpose and RQs.

Due to the researcher's personal interest in nature and hiking, the inspiration of using biological symbiotic relationships as an aid and metaphor to explain logistics networks relationships took form. Per the researcher's knowledge, there has been little logistics research using such a comparison. Yoon, Moon and Lee (2022) conclude in their literature review that potential exists for use of symbiotic relationships in terms of business ecosystems, but more research needs to be done. Using symbiotic relationships as a metaphor, the researcher attempts to visualize and possibly simplify the phenomenon by drawing in inspiration from other fields. As stated in the introduction, the pressure to move away from fossil fuels in freight transport has been present for some time yet minor steps in practice and academia have been made to understand the innerworkings that could be hindering the transition.

The competitive nature of the logistics field in which, according to Spekman et al. (2002), the more robust logistical firms will remain while the weaker will disappear echoes the Darwinian theory typically found in biology textbooks (Spekman, Spear, and Kamauff 2002). The school of Darwinism and traditional evolutionary theories, both argue that symbiotic relationships are a manner in which nature determines the surviving and suffering species (Cianco 2016). The idea of symbiotic relationships forming to aid species to survive may shed light on how logistical actors and networks may evolve to survive a shift to more environmentally sustainable business practices (Cianco 2016).

In a biological ecosystem as in a logistics network, the relationships between actors are complex and not easily separated. However due to the time allotted and the data collected, the scope of the logistics network is restricted to logistics actors who participated in Study 2. To follow a similar structure from biology, a keystone species was identified from each network. A keystone species whose presence is vital to the survival of the biological ecosystem. Understanding the relationship structure of the networks considering the roles of each actor, allowed the researcher to identify the networks' keystone species. Providing structure to the analysis, a symbiotic relationship analysis is done for each actor with the keystone species and is described in more detail in the Frame of Reference.

As biological symbiotic relationships are based on the continuous evaluation of certain propositions that may bring value to the involved species such as ability to find food, reproduce or protect a habitat, the symbiotic relationships in logistics networks also are built upon value propositions. The value propositions used to determine the relationship status of logistics networks were determined by finding common themes in the data and literature that either supported, rejected, or allowed the researcher to propose new propositions of value co-creation in the logistics context (Miles and Huberman, 1994). These propositions led the researcher through the analysis of the relationships - identifying if one or both involved actors benefited, harmed, or were left unchanged. As a result, the researcher was able to better grasp the complexity of the relationships amongst logistics actors answering the posed research questions.

While there exist similarities, no metaphor is perfect. The researcher cannot simply borrow symbiotic relationships without adjustments being made to become better suited for the logistics context. Such adjustments are introduced when applicable in the Discussion.

2.5. Research Quality

In order to produce research that is valuable to others in the field, researchers should take into consideration different criteria of research quality (Bryman and Bell 2007). According to Hallodorsson and Aastrup (2003), many criteria of research quality centers around the question of trustworthiness that build upon factors of truth, applicability, external judgment and neutrality of findings. Two such criteria for qualitative research are validity and reliability. Design of the case studies and data collection for both studies considered these criteria as defined by Yin (1994) so that the studies could be assessed as achieving such validity and reliability as to be of value to others. The following table (Table 5) breaks down how this thesis and the research done to complete this thesis ensured to fulfill different research quality criteria.

Criteria & Definition	Implementation
Construct Validity – "establishing correct operational measures for the concepts being structured" (Yin 1994, 40)	-defined network(s) included in each study that met requirements in aiding researchers come closer to answering the research questions or purpose set for each paper -creating a chain of evidence through several sources of evidence - respondents given summary of findings and responses for approval
Internal Validity – establishment of a relationship showing link(s) between conditions (Yin, 2011)	-Pattern-matching in the case studies between empirical data and theory
External Validity – applicability to other contexts; generalizability (Yin, 2011)	-interview process did not change within the study and analysis was the same for each paper -extensive literature search -relate empirical data to literature
Reliability – The research may be repeated and prove similar results (Yin, 2011)	-case study protocol & database created -interview guide written for each study -two researchers present for each interview -several researchers active in analysis (Paper 1, 2, &3)

Table 5 Research Quality Criteria

2.6. Evaluation of Utilized Methods

Reflection after completion of a study proves to be important as it can hinder future mistakes both by the researcher themselves, but also other researchers interested in the field.

Choice of majority qualitative research represented in this licentiate thesis is due to the novelty of the research and desire to begin to scratch the surface of understanding the phenomenon of not only biomethane use in freight transport but any fossil-free fuel. Qualitative research allows the researcher to view occurrences through different perspectives and experience to produce a holistic description of the phenomenon (Merriam and Tisdell 2016).

A combined systematic literature review and interview study were appropriate method choices to achieve the purpose and the research questions of Paper 1. The systematic literature review was a vital element not just for Paper 1 but the entirety of the doctoral project. The researcher entered the project with a basic knowledge of GLPs so by conducting the systematic literature review, the researcher was able to gain increased knowledge and skill to take further into the data collection for Papers 2, 3 and any future studies. While the interview study conducted was thorough and covered many actors, the breadth of contexts in which the actors operated could have contributed to the validity of the results. The case studies of Papers 2 & 3 could have included more varied data collections rather than only including multiple interviews of each actor. Other types of collected data such as observations would have contributed to the reliability of the case study. However, due to the Covid-19 restrictions at the time of data collection such data collecting methods were impossible.

The actors included in this research have brought with them advantages and disadvantages. All participants were very eager to be a part of such research due to their positive experience

with biomethane. However, this positivity may not be reflective to biomethane use in freight transport on the whole, therefore the research group needs to be aware of bias statements. Additionally, all actors operate in Sweden and in a region within the country that is pro-biomethane in terms of political and societal support. This support does not exist in the same manner in other countries producing biomethane as a vehicle fuel thereby leading again to possible biases.

3. Case Description

In this chapter, the networks and their actors represented in the case study will be presented. The Networks and respondents chosen to reflect the researcher's decision to focus between the logistics actors and biomethane implementation. While the implementation of biomethane does concern actors outside the logistics network such as vehicle manufacturers or politicians, the aim of these case studies was to understand the phenomenon of biomethane implementation in a logistics context from the perspective of logistics actors.

While some of the included actors operate internationally, the Fuel Supplier and their biomethane production is regional therefore creating the focus on regional and national freight transport rather than long-haul or international travel in which regulations, policies and conflicting societal views could overshadow the focus on logistics networks and any relationships occurring between those actors. The Freight Forwarder is the only actor that is included in both networks. The following table shows which networks are included in respective papers (Table 6).

Paper	Regional Network	National Network
Paper 2	X	
Paper 3	X	X

Table 6 Networks Represented in Papers

3.1. Regional Network

Regional Network operates mainly on a regional level in eastern Sweden consisting of a Freight Forwarder, Transport Buyer, Regional Haulier and Fuel Supplier as depicted in Figure 3. This constellation of actors has been doing business together for many years and in 2019 decided to start using biomethane to transport goods per the request of the Transport Buyer.

The county in which the Regional Network operates is located on the east coast of Sweden with a population of 466,000 according to accounts from 2021 (SCB 2021). The county is estimated to grow 8% by 2040. The county holds 13 different municipalities where two combined accounts for half of the county's population. One of these municipalities is the public owner of the Fuel Supplier. The county has several large employers. There are several large international organizations within the technical industry plus a university with multiple campuses. However the county has a strong foundation in the agriculture industry with multiple types of farming and farming activities represented such as meat or dairy production, forestry and various crops (Jordbruksverket 2021). Biomethane has proved important to both the economy and sustainable development of the county in which the Regional Network's actors take part.

Freight Forwarder is a freight forwarder operating on an international level with a strong commitment to environmental sustainability. They organize the transportation on behalf of the Transport Buyer who is one of their largest customers and the Regional Haulier is one their most contracted hauliers at the regional level. Most of the transportation they manage regionally is via road. The organization has the goal to be climate neutral by 2040 and within Sweden cut their emissions 70% by 2030. While this is a global organization, main daily operations are generally on a regional or national level with occasional collaboration on the global scale. The size of the organization allows them to communicate and learn from other regions what practices have worked or have not when reaching their emissions goals. Freight Forwarder prides themselves on providing their customers with quality and timely service

rather than the lowest price tag. They will work with individual customers to provide a service that best meets the needs, desires, and demands of the customer. It is rare that a customer specifies a fossil-free fuel to be utilized, so they typically choose the most suited fossil-free fuel to the transport route. However, the Transport Buyer in this network did specify transport to be done on biomethane and the regional biomethane infrastructure support this fuel choice.

The Regional Haulier has existed and served the region for 40 years, seeing growth in the last few years buying another regional haulier thus merging their operations. An additional 7 trucks have been purchased to create a fleet of 39 total trucks. At the time of data collection, two of the trucks in the fleet were biomethane-fueled and they had purchased a third but due to long manufacturing times the calculated arrival would not be until five months after the interview. They own their trucks but received some financial support from the vehicle manufacturer for the purchase of the biomethane-fueled trucks. The organization has not directly stated a climate goal but understands the importance and trend of becoming more environmentally sustainable in transport thus they allow their customers' requests to guide their way forward in becoming more environmentally conscious. Roughly 95% of their transport is organized by Freight Forwarder, of which Transport Buyer takes up the largest portion.

Transport Buyer is a manufacturer of material handling equipment doing business globally with its main production facility located in eastern Sweden. Globally, the organization has ambitious environmental goals but given the freedom to determine the best path of achieving these goals on a regional basis. In 2015, one of their industrial machines underwent small alternations to be able to run on biomethane. The ease of implementation, environmental impact and existing relationship with the Fuel Supplier spurred the idea of also implementing biomethane in transport with the first delivery completed in the summer of 2019.

Owned by one of the municipalities in the region, Fuel Supplier is the regional provider of biomethane and additionally serves the community in other capacities such as waste collection. The Fuel Supplier operates one digestor plant located in the municipality and 11 public tanking stations across the region. One tanking station is located optimally for the Regional Haulier and Transport Buyer, allowing for routes to be well supported. Biomethane is produced from organic waste collected from households, various regional industries (i.e., animal farming, slaughterhouses) and both public and private businesses in region (i.e., schools, restaurants, grocery stores). From these sources of waste, the Fuel Supplier can produce biomethane constantly and provides biomethane at a stable price level. The other products of anerobic digestion such as the sludge produced after digestion is used as biofertilizer in the region attempting to create closed resource loop on a regional scale.

Information and goods flows are represented in Figure 4 with arrows, while the relationship between the Fuel Supplier and Transport Buyer pertaining industrial machinery and outside the scope of the case study is represented with a dotted line.

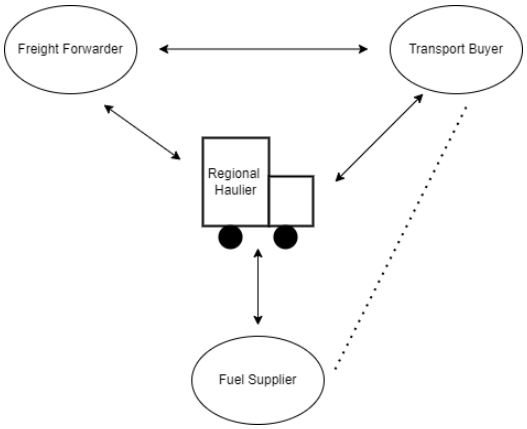

Figure 3 Regional Network Visualized

3.2. National Network

National Network (Figure 4) reflects a simplified national logistics network in Sweden focusing on the core logistics functions such as transportation, handling of goods, some warehousing and necessary management for these functions. As stated previously, Freight Forwarder is the same actor as that of Regional Network, however now showing its relation to the National Haulier.

Transportation of goods in Sweden comes with challenges tied to its geography and how the population is spread across the country. Sweden is a country of 10,5 million people across a land area of 410 000 km² (Statistikmyndigheten 2022b). More than half of this land is either forest or used for farming activities (Statistikmyndigheten 2023). Roughly half of the country's population reside centered around its three largest cities: Stockholm, Gothenburg, and Malmö. All three of these cities are in the southernmost portion of the country leaving the remaining population spread out across a large amount of land characterized by forest terrain (Statistikmyndigheten 2022b, 2023). Sweden's GDP may be broken down into 80% from the private sector and 20% public sector. The private sector in Sweden is 70% service-based and 30% goods. According to Statistikmyndigheten (2022a) the top four activities contributing to the GDP from the private sector are mining and production, municipalities, trade and business services. The public sector includes education, health care, police, and any other public entity (Statistikmyndigheten 2022a).

Additionally, there are environmental sustainability goals set by Swedish Parliament places pressure on Swedish businesses to conform and achieve. The overarching goal of Sweden's long term climate policy is to have zero net greenhouse gas emissions by 2045. The policy has multiple milestones to ensure that goals are met. The next milestone outlines that in 2030 GHG emissions should be 63% lower than those in 1990 (Naturvårdsverket 2023).

While Freight Forwarder is the same organization as that in the Regional Network, in the national context it takes on slightly different characteristics. The Freight Forwarder is a large global company managing transportation at the national level using multiple modes such as road and rail for various industry types. The Freight Forwarder also manages international transportation, but in this research the focus remains on domestic transportation across Sweden. National Haulier is owned by the Freight Forwarder and drives nearly exclusively

for the Freight Forwarder. The fleet consists of a total of 700 vehicles running on different fuels both fossil and fossil-free. Currently, there is discussion about which fuel or fuels will best be suited in the future which is reflected in the mixture of vehicles. Estimation of biomethane use was difficult as the best suitable fossil-free fuel is driven dependent on customer demand or route infrastructure so there is no constant or predetermined transport allotted to biomethane alone. In addition to driving on fossil-free fuels, the National Haulier tries to implement other practices that decrease their environmental footprint, like eco-driving training or creating aerodynamic vehicles with removal or addition of objects to streamline the vehicles' motion. These practices are discussed and collaborated further with other hauliers driving for the Freight Forwarder to help ensure that each haulier and the Freight Forwarder reach their environmental sustainability goals. This collaboration of hauliers extends past environmental topics creating an association committed to aiding each other, sharing experiences, failure, and preferred equipment. Even though the National Haulier conducts the largest portion of Freight Forwarder's transport, they state this collaboration and exchange is seen as between partners and that a win for one is a success for all involved parties.

The case study does not include a particular participant acting as a transport buyer, yet the Market is included in Figure 4 as it was mentioned in interviews and has a part in determining the behavior and relationship dynamics of National Network. Market in this network can pertain to another logistical actor, customers, technology providers and developers, political actors, or the society of Swedish consumers at large. The Market may represent many different industries, each with their desires and demands on how transport should be conducted and the level at which environmental concerns should be considered. The ambiguous source of the market and its role is visually displayed in Figure 4. The market in this network should not be thought of as one set actor but rather a compilation of multiple. It could be speculated that most industries in Sweden with road freight may have at one point or currently utilize transportation services from the National Haulier. Possibly, the one connecting factor in this diverse Market is its geographical location in Sweden.

Additionally, there is no Fuel Supplier represented in the National Network. This is due to the Freight Forwarder's statement and commitment to general environmentally conscious transport at the national level. According to the Freight Forwarder, it is difficult to promise national transport on just one fossil-free fuel due to routes and infrastructure variation across the country. Instead, the Freight Forwarder together with the National Haulier determine the best possible fossil-free fuel(s) so that the Freight Forwarder may continue to work towards their environmental goals while satisfying the customers' desires and requirements. The network has competency and knowledge in transport via biomethane, electric vehicles, hydrogen, and cargo bikes.

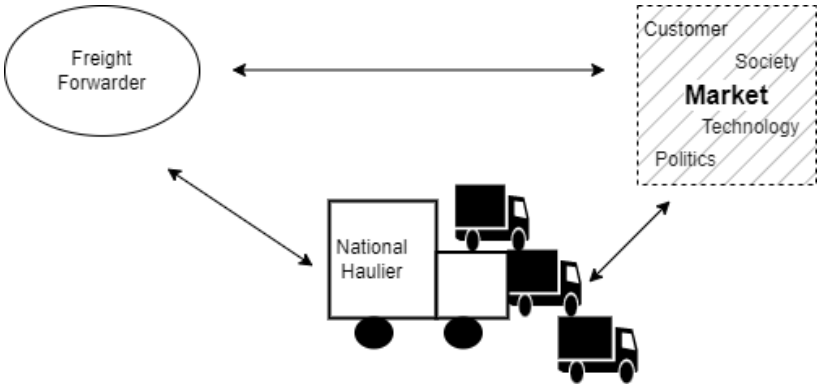

Figure 4 National Network Visualized

3.3. Biomethane in Case Context

Biomethane is one eventual product of an anerobic digestion process. The production process begins with the collection of organic waste. These wastes can originate from multiple different sources depending on the make-up of the society the digestor serves, such as households, agricultural or industry. The waste is digested for a determined period of time based upon multiple factors such as the organic chemistry of the feedstock or desired methane content (Drosg et al. 2015; Sarker et al. 2019). The energy content of a final product is dependent on the methane content (Argalis and Vegere 2021). After which a purification process takes place so that biomethane may be used as vehicle fuel. Remaining product after purification can be returned to the agricultural sector as a biofertilizer thereby closing the food production loop and improving the overall health of the food supply in the community replacing chemical fertilizers (Guilayn 2020).

In recent years, biomethane, its production and use has seen a unique development in the Swedish context. Mostly positive market awareness of biomethane gives a boost for stakeholders to invest in biomethane and politicians to pursue furtherment of biomethane (Winquist et al. 2019).There are 140 digestors in Sweden with the majority located in the southern part of the country. Additionally, there are 190 public tanking stations and 60 private stations across Sweden promoting biomethane as a vehicle fuel (Biogasmarknadsutredningen 2019). In addition to providing energy security and increase in local job creation and economies, biomethane could reduce the greenhouse gas emission of road transport in Sweden by 25% (Johansson 2013; Olsson and Fallde 2015). One criticism in Sweden around biomethane production is the source of feedstock and if investing into anerobic digestors and biomethane will harm Swedish forests and biological diversity (Naturskyddsföreningen 2021).

According to Ottosson et al. (2020) and Naturskyddsföreningen (2021) politicians should be at the forefront setting guidelines, standards and creating general interest through various incentives for anaerobic digestors and their byproducts (Winquist et al. 2019). However, the transportation industry may be the most difficult to steer politically thus forcing politicians to become creative when attempting to bring environmentally sustainable change to the transport industry (Huttunen, Kivimaa, and Virkamäki 2014). According to Gustafsson and Anderberg

(2021) there are so many actors involved between the transportation industry and implementation of fossil-free fuels like biomethane that finding a solution can easily become another's problem shifting responsibility making the process ineffective. Tax subsidies issued by the Swedish government aided greatly with the implementation and further development of biomethane in the country (Biogasmarknadsutredningen 2019). Between 2015 and 2019, there was nearly a doubled use of biomethane and its other by-products yet only a 5% production increase proving that there is a market willing in invest in biomethane in Sweden (Biogasmarknadsutredningen 2019; Ottosson, Magnusson, and Andersson 2020). Previously it was the lack of profitability or the slow return rate on investment that caused stakeholders to be hesitant to invest in biomethane (Winquist et al. 2019). Due to the subsidies from the Swedish government, a biomethane digestor and plant was economically profitable after 7 years compared to the predicted 5 to 20 years (Argalis and Vegere 2021; Olsson and Fallde 2015; Stelling 2014). Like any other fuel production, regular maintenance should be completed on the anerobic digestor and complimenting infrastructure (ie storage tanks, pipelines) as to ensure safety and quality of the production and product (Gittelson et al. 2022).

Indeed if Sweden plans to reach their 2030 energy goals, then an investment in biofuels, their production and infrastructure is required (Karlsson, Kjellsdotter Ivert, and Brunner 2021). However, the future of tax subsidies is in jeopardy. In the end of 2022, the EU Commission did not validate the Swedish government's continued plan to provide tax subsidies to organizations using biogas. Different actors are now working to find a solution that appeases the EU Commission, Swedish government and organizations that have built their operations around biomethane (Wallentin 2023).

Biomethane has had a large economic and societal impact on the focal region for the case study in Paper 2. Motivation to begin an investment in biomethane production was due to the air quality of the region, organic waste from one of Sweden's largest slaughterhouses and a desire from the regional public transport to become more competitive. With the region being largely agricultural with access to forest and bodies of water including the Baltic Sea, biomethane production emerged as a viable solution (Ersson, Ammenberg, and Eklund 2013). The biomethane producer for the region is publicly owned by one of the municipalities and operates as their waste management and energy provider among other roles. In 2012, the initiative to collect household waste began as a reaction to the Swedish government's goal that by the end of 2020 40% of the country's food waste should be biologically treated. The goal has since been updated that 75% of food waste should be biologically treated by 2023. Estimates show that using between 22.5% -30% of the county's arable land for biomethane production would not be a threat to the food security in the county despite contradicting opinions. Biomethane currently generates about 500Gwh/year that is used as transport fuel in the county (Ersson, Ammenberg, and Eklund 2013).

Conditions for biomethane and biomethane production in Sweden allows for a unique context to study biomethane as a vehicle fuel, however these circumstances prove it difficult to generalize into other contexts yet remains important in understanding the entirety of this research.

4. Frame of Reference

The following section will outline the Frame of Reference so that the reader is given knowledge and insight on previous literature that pertains to this kappa. There are three components to the frame of reference: Logistics Actors & Green Logistics Practices (GLP), Value Creation and Symbiotic Relationships. These three components result in the presentation of a theoretical model that will be utilized to guide the researcher through analysis and discussion of the licentiate thesis answering the posed research questions and fulfilling the purpose. Literature discussing the logistic actors, their roles and GLPs will aid the researcher in answering RQ1. Whereas the researcher gains insight and understanding for answering RQ2 from both the sections in this frame of reference discussing the logistics actors and value creation.

4.1. Logistics Actors & Green Logistics Practices

Like a biosphere, a logistical network is complicated involving multiple actors working together to ensure an effective flow of materials and information is established (Christopher 1998). The general characteristics of a logistical network include exchange of information, learning capabilities, certain infrastructural points like warehouses or distribution centers, integration of actors and services and a focus on the customer (Rossi et al. 2013; Simchi-Levi et al. 2008). Each actor in the network contributes with their own strengths, resources, and competencies to push the network towards becoming more environmentally sustainable (ALICE 2019). This could be to the benefit of the individual actor, the entire network or both.

Employment of freight forwarders to coordinate and handle logistics operations on behalf an organization allows the organization to focus on development of core competencies rather than stretching investment (Simchi-Levi et al. 2008). Utilization of freight forwarders also may provide lower costs without diminishing quality provision to the transport buyer's customers as freight forwarders may coordinate shipments between their clients so that trucks run as full shipments as possible (Premkumar, Gopinath, and Mateen 2021). However, this typically limits the amount of customization in service available to the transport buyer depending upon the client range of the Freight Forwarder (A. H. Bask 2001). This trend of limited service offering is changing as transport buyers in recent years have begun to demand more environmentally sustainable options (Premkumar, Gopinath, and Mateen 2021).

Transport buyers are the actors who have goods to be transported and work with a freight forwarder to complete the transport within certain demands depending on the product or nature of the shipment. Transport buyers typically search for efficiency and manners that can mark their own competitive advantage when deciding upon a freight forwarder (Ballantyne, Lindholm, and Whiteing 2013). Yet in recent years, the environmental commitment of the freight forwarder is increasingly becoming more important in the choice making of the transport buyer (Premkumar, Gopinath, and Mateen 2021). Alignment in information sharing and GLP expectations of the freight forwarder and transport buyer has become important in order to provide and meet the expectations of the transport buyer's customers (Huge-Brodin, Sweeney, and Evangelista 2020). According to ALICE (2019), transport buyers and freight forwarders have the chance to lead the way forward in fossil-free fuel transition but this alignment will prove pivotal to success of the transition.

The haulier is the actor in a logistics network with the task of physically completing any transport. From the literature review conducted by Premkumar, Gopinath and Mateen (2021),

the freight forwarder's influence in haulier choice is confirmed. The decisions of the freight forwarder may eventually affect the haulier and its operations concerning mode choice or pricing model.

GLPs may be categorized and defined in many ways. Taking inspiration from Castelein, van Duin and Geerlings (2019) and Evangelista (2014), the GLPs will presented in this kappa as outlined in Osman et al (2022) (Paper 1). In Osman *et al.* (2022), the categories were derived based upon function or participating actor(s) of the GLPs. Thus, the four GLP categories are as follows: Business Strategy, Logistics System, Social, and Energy & Emissions. All practices within these categories benefit in creating a more environmentally sustainable business operations either at the actor level or across the network, however practices found in the Energy & Emissions category were noted to be the most aggressive towards emission reduction and establishing a more environmental manner of conducting business. Through these four categories, the remainder of this section divulges into the manner in which various logistics actors have and may contribute to these practices from previous research.

Business Strategy GLPs

Many of the GLPs found in this category do not have their roots in logistics, rather they originate from traditional business practices but have received a green revamp in the last few years. This background allows various logistics actors to implement portions of these practices.

The DNA of any business regardless of the industry is their competencies and ability to stand apart from their competition. Development of internal competencies and collaboration experiences oriented towards being more environmentally conscious may result in the organization's shifting focus towards importance in sustainability (Sallnäs and Huge-Brodin 2018). Prices set for goods and services could send signals to their consumers. One of which could be that the logistics actor prices their services in a manner that also shows their interest to aid partnering actors become more green in the process (Kumar et al. 2017). Finally, workplace culture with an emphasis in environmental sustainability where employees feel empowered usually result in green practice adoption (Rodrigues and Kumar 2019).

Following the trend of moving towards overall greener practices, models and tools once used by niche groups or with a different purpose are seeing resurgence in organizations seeking to become more environmentally sustainable. One trend with growing popularity across industries is the circular economy and sharing economy; adoption of such a mindset in business models may provide the organization with multiple benefits such as customer satisfaction, less waste and ability to develop further competencies (Khandelwal 2020). Utilization of Logistics Performance Indices (LPI) aid in the identification of both strengths and weaknesses in an organization which depending on the organization's goal may show how going forward organizations can take real action to reach any business or sustainability goal (Anser et al. 2020). Additionally, integration of logistics actors may increase value for all stakeholders while providing more avenues to become more sustainable by exchanging ideas and resources (Mehmann and Teuteberg 2016).

Logistics System GLPs

In this category, practices are presented that may create a holistically more productive logistics system and reduce its environmental impact in the process. Actors that typically utilize these practices are those most closely interacting with transportation and vehicles itself,

such as hauliers, energy suppliers and freight forwarders. However, some of these practices cannot be steered by the logistics actors themselves but by the governing body responsible.

The practices which may be driven by hauliers, freight forwarders or any actor that makes decisions about the transportation mode and vehicle center around finding the most effective solution for the actors and the climate. This efficient and smart use of resources is outlined as one of the five solution areas in the ALICE (2019) report. These GLPs require little to no investment or change to the current logistics operations rather requiring more creative and flexible solutions. Employing multi-modal transport or optimizing shipments and routes may decrease the carbon emission impact from freight transport in the short term (ALICE 2019; Demir et al. 2019; Zhu et al. 2014). Success in offering these types of services could be determined by the alignment and strength of relationship between the transport buyer and freight forwarder (ALICE 2019; Huge-Brodin, Sweeney, and Evangelista 2020).

Research has looked into the choice of driving longer heavier vehicles may reduce climate impact through decreasing number of trips (Rodrigues et al. 2015). The method of truck platooning may increase energy efficiency in vehicles (Paddeu et al. 2020; Pająk and Cyplik 2020). Introduction of dry ports in an intermodal system may increase efficiency of both the transport and energy use (Awad-Núñez et al. 2015; Demir et al. 2019; Eng-Larsson and Kohn 2012). Drawing and driving an optimized route or pooling orders horizontally across a network may increase deliveries using minimal fuel use thereby resulting in more satisfied customers (Tiwari et al. 2021; Zhu et al. 2014). Similarly, reverse logistics and centralization of logistics may increase service quality without sacrificing cost (Lopes Ferri et al. 2015; Yuchi et al. 2019).

The GLPs falling under this category which may be out of reach to achieve by the logistics actors alone pertains to the infrastructure serving the network. Depending on the political structure, the infrastructure (roads, railways, harbors, tanking stations, bridges, etc) may land under the legislation of a national or municipal government and will be dealt with accordingly. Additionally, tanking stations and their appropriate maintenance could be steered by a government body, the energy supplier or, in some cases, by the logistics actor. In the end, general modernization of the infrastructure ensuring that it serves the community and participating logistics networks well and effectively may allow for more environmentally sustainable freight transport (Kayikci 2021).

Social GLPs

The logistics actors typically have very little direct impact to the influence of social GLP adoption; however, this does affect their operations, budget and decision-making process. Critic towards social GLPs addresses the entirety of the climate crisis such as emission levels or exploitation of resources leaving organizations to make action plans themselves rather than social GLPs providing specific action points (Stelling 2014).

In general, research has shown that there is a reluctancy to adopt policies and there is a lack of policy addressing freight transport specifically (Jaller, Otero-Palencia, and Yie-Pinedo 2019; Stelling 2014). This combined leaves actors in the freight transport industry wandering without real guidance in how to achieve the policy goals placed before them.

Taxation is usually an included action within a passed policy and has the ability to be a useful tool in nudging organizations towards a more environmentally focused mindset. However, in

research taxation is usually not separated from their policy package so little research has been done on taxation solely. Nevertheless, there has been research on the alignment of taxes across the supply chain so that entire network feels equal pressure in becoming environmentally sustainable rather than the majority resting on the shoulders of a few actors (Henkow and Norrman 2011).

Energy & Emissions GLPs

This category includes the practices that may be the most aggressive and proactive in bringing organizations towards reducing their environmental impact and reaching goals placed by the organization or policies enforced from governing bodies. Logistics actors have the ability to implement at least one of these practices despite their placement or role in the network (ALICE 2019).

Certain practices are more informative rather than concrete solutions. Many organizations across industries have started to write and distribute their climate action plans or reports on carbon emissions (Kalenoja, Kallionpää, and Rantala 2011). Both of which provide benefit to the community and certain cases themselves, but usually there is a lack of action resulting from these reports raising critic (Vasiliauskas, Zinkevičiute, and Šimonyte 2013).

Advances in technology have produced various mode specific solutions to either use less fuel or emit less carbon. In road freight, low carbon emitting road vehicles are available and in commission (Dioha and Kumar 2020). As urban areas continue to grow, the emphasis on road transport within city limits has become important through choosing green modes of transport like electric vehicles or cargo bikes (Athena, Seraphim, and Vandelslander 2014).

Finally, the implementation of fossil-free fuel sources may be seen as the most progressive and aggressive GLP in terms of GHG reduction. Transition to a fossil-free fuel is an investment for logistics actors and society as both will subsequently benefit (Karlsson, Kjellsdotter Ivert, and Brunner 2021). A wide variety of fossil-free fuels exists available for use and according to research a green future will include many different fuels best suited for the purpose, industry, mode, or region (Johansson 2013). Some of the fossil-free fuels used in Sweden include HVO, biogas and different manners of electrification (Karlsson, Kjellsdotter Ivert, and Brunner 2021).

4.2. Value Creation

This section will begin by presenting a general background of value creation including its uses and criticism of some schools of thought. There will be a presentation of both Goods Dominant Logic and Service Dominant Logic, where in which argument will be made that Service Dominant Logic may be best suited for value co-creation in a logistics context.

An offering to consumers should have at its core two vital factors: value and price (Isaksson and Huge-Brodin 2013). Glimpses of these factors may be exposed in a logistics network by which GLPs are implemented and motives behind their implementation. Through one of the lenses that value may be evaluated or created, researchers may be able to understand how GLPs could become valuable service offerings in a logistics network.

Traditionally, value in a business context has been taught from the organization perspective rather than including the customers or other stakeholders in the process. In some circles, this continues to be the case. Value provision to the consumer is one of the pillars of traditional marketing thought (Grönroos 2017). From the perspective of a focal organization, Porter's

Value Chain is broken down into two activity types – primary and support activities. Leaving criticism for the lack of interaction between the organization and its customers through its one-sided value creation (Christopher 1998). This perception of benefits reflects educated guesses from the organizations of what they believe their customers may find valuable. However in Service Dominant Logic (SDL), all stakeholders acknowledge the importance of value co-creation and take an active role (Meredith and Shafer 2020).

Vargo and Lusch (2016) argue that Goods Dominant Logic (GDL) is a base of SDL thus leading to better understanding of SDL and co-creation of value. GDL places value in the good through production. Typically value in GDL centered around perceived worth for price and utility (Lusch, Vargo, and Brien 2007). This model left little room for consumer feedback and eventual improvement of the product which led to the eventual marketing shift from GDL to SDL. This shift could be attributed to general globalization after World War II and the more recent rise of the internet where service and consumer engagement proved a contributing factor to gaining competitive advantage (Pires, Stanton, and Rita 2006; Webster 1993).

SDL provides a concrete framework in which involved actors in a service offering should interact with transparency, long-term relationship mindset, recognition of other actors as important contributors and monitoring of services (Hall et al. 2022; Vargo and Lusch 2016). Logistics is a service lending itself well to the SDL mindset of how knowledge and skills from one organization could bring benefit to another (Vargo and Lusch 2014; Vargo, Maglio, and Archpru 2008). In SDL, value does not exist until the service is consumed leading to quandaries of when exactly service within logistics is consumed. The answer could be drawn from the thought that in SDL goods would not exist apart from the service (Lusch, Vargo, and Brien 2007).

Value propositions are characteristics or actions that those involved with value co-creation deem worthy for further developing the service. Value propositions can be either operand (physical) or operant (human, organizational, informational, non-tangible) (Edvardsson, Tronvoll, and Gruber 2011). The value propositions are determined by the actors involved and the nature of the transaction, which would vary depending on the good's characteristics (Vargo, Maglio, and Archpru 2008). Often, in the logistics context value propositions are operant. For example, a warehouse and its' clients may use value propositions such as time efficiency or employee health to spur creation of value whereas a production line and its' customers may emphasize cost reduction or quality of finished goods.

SDL allows consumers and stakeholders to actively participate in the creation of value through what Vargo et al. (2008) deem a 'mutually beneficial relationship' through value co-creation (Vargo, Maglio, and Archpru 2008, 146). Value co-creation allows the involved organizations to adapt and survive situations in which they cannot control, such as changing market trends, political shifts or the climate crisis, as they depend upon one another to actively improve service offerings over time not just in a one-time transaction (Vargo, Maglio, and Archpru 2008). Value co-creation has the possibility to occur during day-to-day mundane activities (Ngoc et al. 2017; Vargo and Lusch 2008). The process of co-creating value can be aided by the recognition of expectations from the different actors or technology and new knowledge transfer to other employees (Ngoc et al. 2017). Actors operating with a SDL mindset place worth of the development of all actors included in co-creation processes

as positive development of one actor benefits all involved actors (Hall et al. 2022). Equally as important in the process is the recognition of propositions that do not create value or hinder organizations from successfully co-creating value (Rossi et al. 2013). The points after co-creation in which the involved actors reflect and regroup before embarking on the next round of co-creation can address these propositions and if value was in fact created in a sort of evaluation loop. These points can be deliberate and conscious actions taken by the actors in the form of a meeting or extension of a contract or they can be unconscious decisions in which the actors simultaneously decide to continue participating in co-creation. Yazdanparast, Manuj and Swartz (2010) state that by participating in such an evaluation loop of value may lead to stronger relationships between the actors. Thus, these stronger relationships in turn allow the actors to develop competitive advantages connected to the value propositions.

SDL has the ability to benefit the participating organizations and their stakeholder in the long-term through the development and improvement of core competencies and becoming more service and relationally-centered which can strengthen and unify a network (Taghizadeh and Rahman 2022; Vargo and Lusch 2008). This relationship mindset may aid logistics managers in creating a competitive advantage and providing their customers with high quality service. The aim of value co-creation is that the service offering and thereby the relationship between the two actors improves, becomes stronger, furthering value creation however there is the ability to destroy value where there is misalignment, mistrust or disregard among the actors (Grönroos 2017). The conditions and repercussions of this value degradation have not been researched at length but understanding previous mistakes may avoid future value degradation from occurring.

Value propositions should lead not only to co-creation of value, but also sustainable competitive development of the organizations involved. There are many different propositions in which organizations may co-create value, but there are a few considered important when co-creating value in a logistical context. The root of these propositions is the strength of existing relationships or the ability to form strong relationships (Touboulic and Walker 2015). Building and maintaining a relationship may be established on what Jazairy, Lenhardt and Haartman (2017) deem soft skills: communication, trust and culture. Communication and improvement upon identified weak communication skills may be an enabler for improvement of a service through value co-creation while establishing trust between the actors (Jazairy, Lenhardt, and Haartman 2017). Culture contributes to co-creation of value by providing a groundwork and common starting point for comprehension of the network's surroundings (geographically, societal, political, etc.) (Gammelgaard, Andersen, and Figueroa 2017). This common goal may lead to actors feeling and perceiving support from one another thus continuing forward in providing the best possible service. An actor's workplace culture, moral standards and organizational vision may affect co-creation propositions such as risk tolerance, organizational motives and competitive desires (Singh, Rastiogi, and Aggarwal 2015). According to Lusch, Vargo and Brien (2007), workplaces that empower and encourage its employees to partake in the value co-creation may experience that such employees are large sources of innovation and knowledge possibly becoming competitive advantages. In remaining competitive as a firm, it could be disadvantageous for organizations to continue to offer the same service instead of actively moving forward to develop competencies through adoption of technology or other innovation (Lusch, Vargo, and Brien 2007). Risk tolerance and willingness to integrate innovation may create a competitive advantage for the actors, but to be done properly stable relationships and communication channels are vital (Kustrak

Korper, Holmlid, and Patrício 2022; Mavi and Mavi 2022; Rossi et al. 2013). Misalignments could prove disastrous if the relationship lacks Jazairy, Lenhardt and Haartman's (2017) soft skills.

The idea of value co-creation within logistics is gaining popularity as its dynamic strategies prove beneficial to logistics managers (Vargo and Lusch 2017). Logistics managers today have three major challenges to overcome: balance between value and cost, identification of services desired, and keeping customers satisfied despite constant change in requirements and desires (Yazdanparast, Manuj, and Swartz 2010). The static one-sided value proposition of traditional logistics management does no longer keep pace with the evolutionary competitiveness of logistics experienced today. The older mindset of Goods Service Logic in logistics organizations and practices determining value on behalf of the customers through providing effective, efficient and differentiated services has become outdated (Langley and Holcomb 1992; Lusch, Vargo, and Brien 2007). The co-creation, trust and interaction between actors as suggested through SDL may aid both individual logistics organizations and their respective networks with the competitive advantage demanded as logistics becomes more important to all levels of the economy (Langley and Holcomb 1992; Matthies et al. 2016; Vargo and Lusch 2017; Yazdanparast, Manuj, and Swartz 2010).

4.3. Symbiotic Relationships

Somewhat parallel to the traditional logistics and marketing mindset, the biological sciences have also focused on individuals or in the terms of symbiotic relationships, partners, rather than as a part of an entire ecosystem (Relman 2008). German botanist, Heinrich Anton de Bary, was the first known scientist in the 1800s to use the term symbiosis when describing relationships between two species: "living together of two dissimilar organisms, usually in intimate association and usually to the benefit of at least one of them" (Relman 2008, 721). This relationship may be temporary or permanent depending on the nature of the relationship (Nordon and Charles 2002). While there are many forms symbiotic relationships may take, there are three majorly recognized relationships: mutualisms, commensalism, and parasitism. Mutualism is where both organisms benefit. Commensalism occurs when one organism benefits, yet the other is neither harmed nor benefited. Finally, parasitism is when one organism benefits on the behalf of another (Leung et al. 2008; Paracer 2000). These relationships are visualized in Table 7.

Symbiotic Relationship	Actor 1	Actor 2
Mutualism	+	+
Commensalism	+	0
Parasitism	+	-

Table 7 Visualization of Symbiotic Relationships

While this is the basic breakdown and explanation of symbiotic relationships, there is a possibility that the nature of an existing symbiotic relationship may change either to a different form of symbiotic relationship or shift in benefiting organism (Nordon and Charles 2002). Removal or death of an organism may spur a ripple effect of change not only the symbiotic relationship it partook in but also at the community level (Secord 2002). Every ecosystem has keystone species which are species that have a large and disproportionate effect on the ecosystem in comparison to its biomass. They typically promote vital activities for life to continue such as nutrient cycling and energy transfers. Even if a keystone species is

not active in a symbiotic relationship, its presence and role should be acknowledge when investigating a symbiotic relationship (Zook 2002).

Mutualism is most likely to succeed in the long-run when two 'honest' organisms are involved genuinely attempting to bring equal benefit to both organisms (Leung et al. 2008). Commensalism is difficult to defend as the researcher needs to quantify and document the absence of benefit and harm. It is easier to recognize positive or negative effects on an organism involved in a symbiotic relationship (Secord 2002).

As previously discussed, symbiotic relationships were believed to have developed as a manner of survival not just for one species but for multiple (Cianco 2016). In recent years, the idea of industrial symbiosis has borrowed certain aspects of symbiosis and symbiotic relationships to create a harmonious industrial network where resources optimization mirror that seen in nature (Jacobsen 2006; Martin 2013). While the terms are similar, the goals and objects analyzed differ. This research explores relationships between actors including any propositions that may affect that relationship. Whereas, in industrial symbiosis research, resource use or the relationship is the focus.

Vargo and Lusch (2016) use the term service ecosystem to describe the forum in which SDL may be utilized on a broader scale which has led to research using this term and idea to attempt to understand phenomena that occur in the natural world (Matthies et al. 2016; Vargo and Lusch 2016, 2017). Service ecosystem is defined as "an ecological function or process that is considered useful to humans" (Matthies et al. 2016, 51). A fundamental principle in service ecosystem is that no organism acts in isolation and it is best to analyze the ecosystem network holistically (Matthies et al. 2016). The research completed in this licentiate occurs in the non-natural world and prioritizes benefit or usefulness amongst humans. Arguably, the growing importance and implementation of logistics practices that benefit or minimize harm to the natural environment may allow for future cross-disciplinary research to occur. Ideas, definitions, and inspiration can be taken from both the industrial ecosystem and service ecosystem fields to help bridge the gap and visualize the use of symbiosis in a logistic network context.

The use of keystone species and symbiotic relationships will be used in the analysis as a metaphor. The hope of its use is to provide inspiration to look at a problem from a different angle and mindset rather than replication of the biological meaning of keystone species and symbiotic relationships into a logistics context. Additionally, the use of the metaphor builds upon Yoon, Moon and Lee's (2022) proposition that the two worlds have the ability to be used together.

4.4. Presenting a Theoretical Model

Based upon the previous sections in the Frame of Reference, a framework enabling combination of SDL and symbiotic relationships emerges. As described in the Methods, the use of symbiotic relationships in this kappa are as a metaphor and source of inspiration hopefully allowing for a fuller comprehension of the phenomenon.

As biospheres do not directly correlate to a logistics network, the original use of symbiotic relationships will need to be altered to become suitable for the logistics context. Outwardly logistics actors and species may seem synonymous, but they are not. Species encompass a much larger group with potentially larger benefits or consequences for the biosphere when

their role or existence is changed. Due to short-term contracts found in many logistics networks, actors are constantly changing and turning over without equivalent repercussions (Arshinder, Kanda, and Deshmukh 2008).

Yet there are many similarities that allow for the use of this metaphor between logistics and biology to be viable. Logistics actors are constantly evaluating progress and co-creation of value just as organisms actively keep the symbiotic relationship in check through various measures or what is called value propositions in SDL. As actors are beginning to be more progressive in their GLP implementation, introduction of these new practices in logistics networks are a good opportunity to utilize SDL so that the network may find the best manner a GLP would function and create value for involved actors.

Even though the actors participate in value creation, like in nature, one actor may receive more value or 'benefit' or could steer the value creation in their favor. This could be in part due to their role in the logistics network or the individual worth placed on a particular value proposition. Prior to entering a relationship where SDL is used, the actors each enter the value creation process with their resources, competencies, and motives. 'Honest' mutualistic organisms or logistics actors invest willingly in a partnership believing that all involved desire to achieve value, profit or another factor of success for all actors (Adner 2017; Matthies et al. 2016). Actors have the ability to be both co-creators and co-destroyers of value, therefore, if one actor perceives there is an imbalance of gained benefit or general misalignment there is a possibility that the nature of the partnership will change (Adner 2017; Grönroos 2017; Matthies et al. 2016). The theoretical model presented in Figure 5 visualizes these dynamics.

The theoretical model in Figure 5 also sets out to visually represent the two research questions of the licentiate thesis. The first research question being *What is the role of the logistics actors when involved in the implementation of biomethane?* is represented by the circles labeled actor which includes the different components discussed in the Frame of Reference, like motive and competencies, which may influence their role in the logistics network and GLP implementation.

The second research question – *How do the relationships of these logistics actors contribute to the value creation for implementing biomethane in freight transport solutions?* – takes visual form through the value proposition offered by each actor. Together the actors undergo an evaluation loop based on the proposed value proposition per SDL. Through this evaluation loop, the aim is that the value proposition will develop so that both involved actors may receive value. As the development of value creation through the proposed value proposition progresses, hopefully the GLP implemented will ultimately provide value for both involved actors and become a competitive advantage.

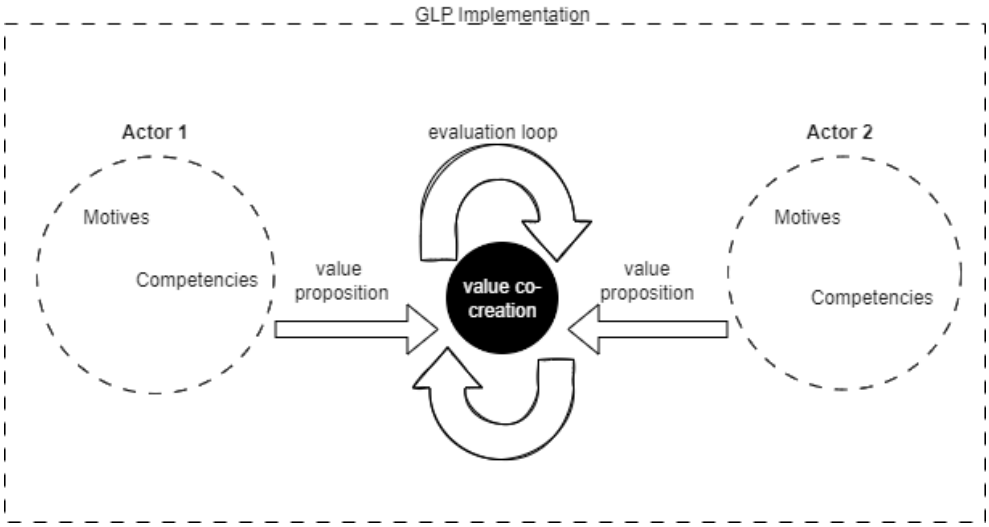

Figure 5 Theoretical Model Inspired by (Ehrenthal, Gruen, and Hofstetter 2021)

It is impossible to have full control at all times over the value co-creation process therefore there is room for unknown and uncertainties to occur (Vargo, Maglio, and Archpru 2008). As in nature, an ecosystem or symbiotic relationship is under constant threat from other organisms despite their perceived preparedness (Zook 2002). Just as the organisms best able to adapt to changing environments in nature would be predicted with best ability to survive according to Darwin, SDL may act as an evolutionary predictor of survival in logistic organizations undergoing new circumstances such as the implementation of biomethane (Vargo and Lusch 2017).

In the Discussion, an adaption of Table 7 which visualizes the symbiotic relationships as defined by biologists will be used to visualize the co-creation of value ongoing between logistics actors depicting how each value proposition is experienced in biomethane implementation.

5. Appended Papers

The following section includes a summary of the three papers appended in this licentiate thesis. In addition to the summary of each paper, the paper's contribution to thesis and author's contribution is explained.

5.1. Paper 1 – Exploring green logistics practices in freight transport and logistics: a study of biomethane use in Sweden

Mary Catherine Osman, Maria Huge-Brodin, Jonas Ammenberg & Jenny Karlsson (2022). *Exploring green logistics practices in freight transport and logistics: a study of biomethane use in Sweden*, International Journal of Logistics Research and Applications, DOI: 10.1080/13675567.2022.2100332

Summary of Paper 1

This paper is a systematic literature review with several complementary interviews. The goal of the paper is twofold: (1) to study the literature written about Green Logistics Practices (GLPs) in the logistics literature with the hope of understanding the position transitioning to fossil-free fuels take and (2) to understand biomethane's role as a GLP.

A systematic literature review was conducted and from the inclusion and exclusion criteria a total of 162 articles were included in the review. Analysis of the articles allowed the researchers to categorize their findings based upon actors, drivers and GLP categories. Three major actors in the introduction of GLPs were found: supply chain actors, governmental actors and general stakeholders. The decision of using 'supply chain' to describe the actors was with the intent to include all actors involved in the process from raw material production to last mile as the literature search included a wide range of actors. Whereas in this licentiate thesis the focus is on the actors completing the transport thus called logistics actors. Each of these actors had different perceptions and aims when implementing GLPs. Drivers of implementing GLPs range from shifts in customer trends to economic gains. These various drivers are reflected from the point of view of the actor implementing these practices and their role in the network.

However, the largest result from the analysis may be the categorization of GLPs into 4 different categories: Business Strategy, Logistics System, Social and Energy & Emissions. The final GLP category, Energy & Emissions GLP is the most effective in aiding organizations to become overall more environmentally sustainable. Multiple interviews were conducted to help in understanding just how fossil-free fuels, as a GLP, are perceived and complement existing literature. Biomethane was chosen as the focal fossil-free fuel alternative. Certain trends were found among the actors interviewed. The focus of low-cost service has been replaced with providing quality, price-appropriate service to the market. In the context studied, the actors were able to provide transport via biomethane at a relatively similar price due to the fixed fuel price set by the Fuel Supplier. While green transport is becoming more sought after, the specific demands for how an organization implements greener transport solutions are vague. However, one actor interviewed requested specifically that transport be completed via biomethane due to their positive previous experience with biomethane fueling their industrial machinery breaking against norm. All actors found that

government regulations were weak and some of the actors themselves had gone beyond the regulations of their own accord.

The actors also were interviewed on other GLPs they implement. All actors had their own competencies or business model which eventually led to a more environmentally sustainable organization. The Logistics Systems GLPs among the actors varied mainly depending on the role and size of the actor. All actors stated that the policies in place did not necessarily encourage organizations to implement environmentally sustainable practices. Few actors called for harder, more progressive regulations. Finally, multiple actors expressed their positive feedback and experience towards biomethane and believe that it will be a good future solution in long-haul trucking.

Contribution to Thesis
Through the systematic literature review, the researcher is able to gain better understanding of the general roles logistics actors take in GLP implementation as well as what has been researched about different GLPs (RQ1). The interview study is able to give specific insight into logistics actors' experience with biomethane implementation (RQ1).

Author's Contribution to Paper 1
Mary Catherine Osman conducted the literature review, large part of the literature analysis, steered the conduction of interviews and their analysis writing the majority of the first draft of the journal article while responding with Maria Huge-Brodin to the reviewers' comments. Maria Huge-Brodin contributed to the analysis of the literature and interviews additionally in editing and overall structure of the paper. Jonas Ammenberg provided insight into biomethane production and industry while providing feedback for the paper across its various stages. Jenny Karlsson aided in feedback and structure of the paper.

5.2. Paper 2 – Actors' Drivers and Barriers when Implementing Biomethane: An Embedded Case Study

Mary Catherine Osman, Maria Huge-Brodin & Linea Kjellsdotter Ivert (2022). *Actors' Drivers and Barriers when Implementing Biomethane: An Embedded Case Study.* Manuscript developed from a conference paper presented at NOFOMA 2022 at University of Iceland: Reykjavik, Iceland. Will be submitted to a journal.

Summary of Paper 2
This is an embedded case-study of one network comprising of four actors. The goal of this study was to begin to understand the drivers and barriers of the different actors when they switch to biomethane. From literature seven different dimensions were identified that could appear as either drivers or barriers: technology, customer, management, costs, relationships, society, and politics. Surprisingly, there were few barriers found in the case study and overwhelmingly there were from most actors a strong driving perception of all the dimensions. All actors perceived the Political dimension as both a driver and barrier, as while there are regulations and governmental support for biomethane use, actors view these goals as easily attainable thereby discouraging organizations to pursue more environmentally sustainable practices.

While in literature it is common to split drivers and barriers, the researchers found that certain dimensions were built upon and were reliant upon one another. One such stark example of

this interconnection is seen in the Costs dimension – cost of investment, service pricing – and many of the drivers and barriers around costs can be dependent on the strength of the relationship between the actors.

Contribution to Thesis
A closer look at logistics actors' drivers and barriers in biomethane implementation provides the researcher with a better image of the actors' role (RQ1) and what they perceive valuable in biomethane use (RQ1 & RQ2). As it was concluded that these drivers and barriers were interrelated, an understanding of the network dynamic and identifying propositions for value creation could be drawn from the paper (RQ2).

Author's Contribution to Paper 2
All three authors were active in conducting the interviews, analysis and writing composition of the paper. Mary Catherine Osman took on the tasks of transcribing the interviews, reading, and composing the literature framework as well as over seeing that the final product read as one cohesive work. In addition to previously named tasks, Maria Huge-Brodin wrote the discussion section and whose models were later adapted for the paper; Linea Kjellsdotter Ivert contributed to various parts of the paper including the methodology, results, introduction, and conclusion.

5.3. Paper 3 – Business Practices for Transition to Biomethane for Freight

Mary Catherine Osman, Linea Kjellsdotter Ivert & Maria Huge-Brodin (2022). *Business Practices for Transition to Biomethane for Freight*. Presented at LRN 2022 Conference at Aston University: Birmingham, UK.

Summary of Paper 3
Besides making a profit, an organization's main goal is to provide a service and or product of value to its stakeholders. The difficulty is in determining what the stakeholders find valuable. In Service Dominant Logic (SDL), the different actors may work together in value co-creation to ensure that the offering brings value to all parties. Various business practices can be involved value co-creation eventually bringing forth an offering such as biomethane as a transport fuel. These business practices may further become competencies for one or multiple of the involved parties.

Pertaining to new transport services, certain business practices stick out as eventual points of co-creation and therefore investigated further in this research including collaboration, pricing, workplace culture and offering of new services. In attempts to fulfill the purpose of this paper, *to describe business practices of a freight forwarder when providing value to its stakeholder by offering transport fueled by biomethane,* a case study was conducted. The two networks included a total of five logistics actors.

Collaboration plays a large role in value creation of biomethane transport solutions. Actors that have knowledge or experience with biomethane transport solutions motivate and drive their fellow actors forward in implementation of biomethane. Pricing as a business practice differs depending on the role of the actor, possibly reflecting perceived value of the offering of biomethane. Organizations interviewed with positive encouragement towards being sustainable or increasing sustainability awareness were seen to be more keen or open to testing and implementing green solutions such as biomethane transport solutions proving that workplace culture as an influential business practice.

Due to the innovative and creative-thinking workplace cultures of some of the actors included in the study, the interest in new service offerings and their implementation gains greater support. Another indicator of value co-creation through new service offering is the size of the organization. Larger organizations were more willing to test new service offerings as they did not view the implementation as risky with a large organization to fallback if failure should occur. A general statement from all actors interviewed remarked on how little the average customer understood is involved in green transport solutions and biomethane in general. Customers want green transport solutions but do not understand the time, effort, investment that is required in terms of technology, infrastructure, and costs. Biomethane nor any other green transport solution is an overnight fix and much needs to be done in terms of education and acceptance before green transport solutions are implemented on a wide scale.

Of the business practices investigated in this paper, workplace culture and collaboration seem to be the most interlinked. Further research and development of the conference paper will hopefully aid in understanding how business practices contribute to value co-creation not just for biomethane transport solutions but for a wider range of GLPs.

Contribution to Thesis
Paper 3 gives the researcher further insight into the relationships and dynamics of a biomethane-driven logistics network and some of the value propositions for co-creation (RQ2).

Author's Contribution to Paper 3
All authors contributed to the conduction of interviews, model choice, research design and analysis. Mary Catherine Osman synthesized the literature and wrote the literature overview as well as portions of the results and discussion. Linea Kjellsdotter Ivert contributed by writing portions of the results and discussion, conclusions, and future research. Maria Huge-Brodin took the task of writing the research design and general overseeing of the paper's progress.

6. Discussion

This section will present and discuss the analysis structured in relation to the two research questions. The analysis will use the presented symbiotic relationships found in nature as an aid to describe and answer the research questions. Logistics actors seeking to become more sustainable could be seen as a biosphere in which these relationships may occur and form pertaining to biomethane implementation.

6.1. Identifying and Describing the Species- Answering RQ1

The starting point for understanding a biosphere and its innerworkings is to identify individual species and their purpose within the biosphere. Therefore, in parallel to biological studies and how the roles of different species may affect a biosphere's functions, identification of logistics actors will be done to answer RQ1: *What is the role of the logistics actors when involved in the implementation of biomethane?*

This identification and mapping of individual species may also aid in the logistics context when a new practice or service, such as biomethane use, is introduced. An important species in any biosphere is the keystone species. The keystone species has an important role of holding the biosphere together and functioning as designed. The absence of the keystone species would be perilous for the remaining species and would lead to eventual collapse of the biosphere if not replaced (Mills, Soule, and Doal 1993). However, differing from the biological definition of keystone species, the identified keystone species from the two case networks indicate the actor that takes on a large burden in the implementation of biomethane. Removal of this actor or change in its role may alter the network's ability to complete biomethane-fueled transport in the short-term until the network has gathered the resources and competencies replacing whatever was lost. This short-term recuperation period is reflective of that seen in nature in similar circumstances.

As seen in both Paper 1 & 2, the specific characteristics of actors, their perceptions, a logistics network and therein it the roles of its actors determine what drives or bars relationships and eventually value creation (Oberhofer and Dieplinger 2014). The two networks studied differ as to size, reach, number of participating actors and profit margins therefore will be analyzed as two separate operating networks thus one keystone species is identified for each.

Species Included in Regional Network

The Regional Network comprises of the Freight Forwarder, Transport Buyer, Fuel Supplier and Regional Haulier. The Freight Forwarder is represented in both networks but differences in roles are seen. The Freight Forwarder has support due to its size but works uniquely on a regional level. This is exemplified through the collaboration with the Fuel Supplier to provide the regional actors with a unique solution fulfilling their requirements and requests. Thereby resonating with a finding in Paper 2 and the importance of a society recognizing and even applauding the progressive environmental actions taken by a local organization.

The Transport Buyer may be seen as a catalyst to the network implementing biomethane reflecting findings from Dahlgren and Ammenberg (2022). Employees at all levels of the Transport Buyer are encouraged to engage in and suggest ideas that may bring the organization closer to its goals. As seen in Paper 2, stimulated and included employees are more likely to actively participate in collaboration which could translate into the eventual creation of value also supporting the findings of Palmi *et al.* (2023). This innovative mindset

and focus of finding creative green solutions may have spilled over to the enthusiasm of the other actors. Previous success and experience with biomethane and the trusting relationship with the Fuel Supplier pushed the Regional Network to begin deployment of biomethane-fueled trucks as per the request of the Transport Buyer. While the Transport Buyer requested biomethane, the Regional Haulier took on most of the risks in investment of biomethane-fueled trucks and adjusting pricing to continue to deploy full or nearly full truckloads.

The Fuel Supplier is only present and included in the Regional Network. GLP research typically alludes or includes a governmental actor, however rarely a fuel supplier and none found to date where the fuel supplier acts as both fuel supplier and government representative (Havenga and Simpson 2018; Paddeu et al. 2020). While not considered a logistics actor as it does not partake in logistics activities, through the interviews conducted in Study 1, one may conclude that the Fuel Supplier has earned a role in as an actor in a fossil-free logistics network and should be included as its actions and motives affect the whole network. Through the interviews conducted for Paper 1, the Fuel Supplier's commitment to biomethane not only as a vehicle fuel but as a sustainable solution for multiple municipal issues became apparent. The Fuel Supplier had the ability to provide biomethane at a stable price and production which could have helped in building trust and stable relationship of businesses, industries, and private citizens in the region. This trust amongst organizations is more difficult to replace yet not impossible (Meqdadi, Johnsen, and Johnsen 2017).

One misconception of keystone species is that they must be the largest and most powerful species in a biosphere, but this is not always true. Some biologists identify keystones species as the species that has disproportionate power over a biosphere compared with its size (Zook 2002). In the Regional Network, the Regional Haulier is identified as its keystone species. While connected and, at times, dictated by the other actors, the absence of the Regional Haulier could cause disruptions to the business models and biomethane implementation of the remaining actors. The long-standing, semi-dependent relationship with the other Regional Network actors and regional commitment of the Regional Haulier is crucial to the provision of biomethane-fueled transport in the network. Without this relationship, it would be difficult for the Transport Buyer to continue completing transport on biomethane. This finding is a reflection of the importance of a coordinated environmental ambition as discussed in (Sallnäs, 2016). Additionally supporting Dahlgren and Ammenberg (2022)'s finding that transport buyers usually are more proactive in environmental sustainability goals leaving the contracted hauliers to follow suit. While the transport buyer is more proactive than the haulier in sustainability initiatives, the freight forwarder typically has more guiding force in the network concerning the implementation of GLP (Huge-Brodin, Sweeney, and Evangelista 2020). This exposes the importance of differentiation in understanding the viewpoint from which one assesses an actor's role and motivation.

From the analysis of the Regional Network stemming from the actors' relationship with the identified keystone species, Regional Haulier, one could surmise that Regional Haulier's status as keystone species is not based upon the actions of the Regional Haulier. Rather, Regional Haulier's role in the network, expectations and importance deeming it difficult to replace has been placed upon it by the other actors in the network, namely the Freight Forwarder and Transport Buyer. The Freight Forwarder has the motivation to bring high satisfaction levels to its clients through quality service. Thus, in combination of the Transport Buyer's specific request for biomethane-fueled transport and the Freight Forwarder's strive

for quality, the network's vitality was pushed down onto the Regional Haulier as a result. Findings from this research challenge Vargo, Maglio and Archpru's (2008) statement that value co-creation is a result of mutualistic relationships. This questions one of the findings in Paper 2 stating that actors with clear drive for environmental change or 'green champions' pushes the network to implement GLPs. Ironically, the Regional Haulier's passivity towards environmental goals but commitment to relationships in the network aids in its keystone species status.

Keystone species as experienced in a logistics network differs from that in a biosphere. Removal of a keystone species in a biosphere could mean impending destruction of the entire biosphere. The logistics network is not as dramatic. Removal of a keystone species in a logistics network may cause initial problems due to the loss of competencies of the removed actor. After the initial disruption, the network will eventually recover either through a myriad of various possible actions, such as personal development of lost competencies or replacement of the removed actor. Speculations to how this transition would occur may depend on the strength of the relationships and resilience of the network (Chen and Miller-hooks 2012; Miller-Hooks, Zhang, and Faturechi 2012).

Species Included in National Network

The actors in National Network include the Freight Forwarder, National Haulier and the Market. The Market represents several actors in the National Network which from Paper 1 could be included as Actors from supply chain or Actors from general stakeholder groups. These actors do not specify their transport to be completed with biomethane, rather reflect the moving trend towards environmental sustainability and active choice of carbon reducing practices. This trend according to the National Haulier and Freight Forwarder cannot be ignored as GLPs are nearly homogenously expected thus an active force in the eventual value creation. One can see a positive trend between number of stakeholders involved in a GLP and willingness to test innovative solutions such as biomethane or electric vehicles (Cebrat, Karagiannidis, and Papadopoulos 2008; Crawford et al. 2016; F. Zhao et al. 2019). Like the Transport Buyer in the Regional Network, one may classify the Market as the catalyst for the National Network to begin investigating greener fuels. Implementation of GLPs may reduce costs or boost competitive advantage. This drive forces networks to begin to consider green practices as the norm even if such practices go beyond minimum requirements outlined by governmental legislation, as Paper 1 suggests.

The National Haulier is owned by the Freight Forwarder and has little power to diverge from conditions and quality standards of the Freight Forwarder. This dependency and ownership also entail that the disappearance of the Freight Forwarder also means the disappearance of the National Haulier. The collaboration of hauliers contracted by the Freight Forwarder are included as involved species in the network. This collaboration aids and enables the National Haulier to develop and provide the Market with better service offerings. However, none of the hauliers participating in this collaboration other than the National Haulier are included in the data collection so assumptions will be made that all behave and relate as the National Haulier.

In the National Network, the Freight Forwarder is seen as its keystone species. Due to the sheer volume and reach of the transportation managed by the Freight Forwarder in the National Network; its resources, competencies, size, and number of dependent actors cause it to be irreplaceable. The size of the Freight Forwarder and commitment to quality allows it set

standards without little opposition from its hauliers which considering the typical role of a freight forwarder in logistics networks is expected behavior as described in Sallnäs and Huge-Brodin (2018). However, in comparison to the regional network, the Freight Forwarder cannot promise transport completed on a certain fossil-free fuel. Therefore, there is not a fuel supplier present in the National Network while multiple fuel suppliers were alluded to in the interviews.

6.2. Species Interaction – Answering RQ2

Using the previously identified keystone species as the anchoring actor in the analysis, the relationship and interaction of the two networks based upon the value propositions will be explored. The value propositions revealed from the interviews and results from various points during the licentiate thesis, particularly those in Paper 3, were communication, innovation, determination for success and perceived support. Thus, these value propositions will be utilized in the analysis determining the symbiotic relationship between logistics actors. These four identified value propositions will be used to build an analysis like that of biological symbiotic relationships and leading to answer: *RQ2. How do the relationships of these logistics actors contribute to the value creation for implementing biomethane in freight transport solutions?*

The value propositions have their origins either in literature or the findings from Papers 2 or 3. References to these connections will be made throughout the discussion.

As seen in Paper 3, the value propositions may become intertwined and dependent upon one another in value co-creation. This occurrence is also experienced in certain interactions in the Regional & National networks. Communication as described by Hall *et al.*(2022) may build ground for positive feedback and collaboration between actors thus producing a good forum in which value co-creation may occur. Throughout the relationships to be discussed, it is seen that the presence of communication as a value proposition and from which benefiting actor may foreshadow the remaining value propositions and to whom their presence benefits. Actors involved with innovation as a value proposition in value creation and any forthcoming of new possible service offerings may inherently develop a competitive advantage individually and as a network as stated in Taghizadeh and Rahman (2022).

Several sources mention the importance of communication is seen as a value proposition as good communication allows for growth in other areas. Communication allows for a relationship to be formed giving way to eventual collaboration (Hall et al. 2022; Jazairy, Lenhardt, and Haartman 2017; Yazdanparast, Manuj, and Swartz 2010). Innovation, referring both to any physical technical developments but also to an innovative spirit, may also be seen as a value proposition driving co-creation of value between organizations. Innovation may be co-created to address certain issues affecting the network, such as climate crisis or COVID restrictions (Mavi and Mavi 2022). Inclusion in innovation may also encourage organizations to take ownership of the problem at hand (Rossi et al. 2013). A common goal and determination for success of a service may originate from a financial desire to profit or from a personal motivation to collectively work towards a common goal (Lusch, Vargo, and Brien 2007). Perceived support between the other actors in the networks may actively contribute to the network's transition to GLPs thus its presence as a value proposition is solidified (ALICE 2019).

The descriptive aid and comparison of the biological symbiotic relationships is used as a tool to strengthen the analysis and discussion. Visualization of biological symbiotic relationships are used to visualize benefit (+), harm (-) or no effect (0) within each factor of value creation experienced by each actor.

Interaction between Actors in the Regional Network

An influence affecting multiple interactions and possible value creations across the Regional Network was the general success and ease the actors experienced when first implementing biomethane and in its continued use (Paper 2). This positive experience may elevate any on-going value creation or lessen the seriousness of possible value destruction thus deserves to be mentioned prior to the discussion of the relationships in the Regional Network.

The relationship and co-creation process of the Regional Haulier and Freight Forwarder is characterized by the Freight Forwarder benefiting and being more dominant in value creation than the Regional Haulier in almost all areas (see Table 8). This could be due to the role each of the actors possesses in the network. The two actors do communicate however it seems as if the Freight Forwarder has the upper hand in almost all interactions guiding or directing the Regional Haulier (0/+). However, the Regional Haulier does not seem harmed by this behavior, and this could be due to the size difference of the organizations as well as their logistical roles in the network (Martinsen and Huge-Brodin 2014).

In terms of innovation, this relationship does not particularly allow for innovative development, but both are open to introducing innovative practices and solutions into their service offerings (0/0). This signaling of willingness and ability to change routines opens possibility for both actors to benefit from the co-creation process as discussed in (Dehling, Edvardsson, and Tronvoll 2022).

The Regional Haulier has not stated any direct climate goal motivating it to pursue environmentally sustainable solutions with their clients, however the Freight Forwarder has published their commitment towards reduction of GHG (0/+). These commitments increase their desire to ensure the Transport Buyer is satisfied with the service and that it reflects positively regarding their climate goals aligning with drivers of GLP implementation described in Paper 1. Finally, both actors perceive that they receive sufficient support not just from one another but from society and politicians (+/+).

This commensalism relationship between the Regional Haulier & Freight Forwarder creates value in biomethane implementation where the Freight Forwarder is the main beneficiary. The size and role of the Freight Forwarder allows for the value to be created that benefits itself through satisfaction of the Transport Buyer and the Regional Haulier could be just seen as a method to achieve this satisfaction.

	Regional Haulier	Freight Forwarder
Communication	0	+
Innovation	0	0
Determination for Success	0	+
Perceived Support	+	+

Table 8 Symbiotic Analysis of Relationship between Regional Haulier & Freight Forwarder

The relationship and any ongoing co-creation of value between the Regional Haulier and Fuel Supplier may be the weakest from the Regional Network (see Table 9). They have little direct

communication with each other besides any potential problems with the biomethane infrastructure (0/0). Between the nature of the relationship and the position of these actors in the network, the role of technology in innovation is a driver in value co-creation mainly benefiting Fuel Supplier reflecting findings in Paper 2 (0/+). This organizational motive of the Fuel Supplier spills over into their determination to see biomethane in freight transport succeed (0/+). Once again, both actors perceive support from politicians and the public (+/+). Building upon Mutter's (2019) findings, this support could reflect the regionality of the network and its bound up identity and pride in biomethane production.

A commensalism relationship could be used to describe that of the Regional Haulier and Fuel Supplier. In this relationship, the Regional Haulier allows for value creation for the Fuel Supplier just by driving biomethane-fueled vehicles allowing the Fuel Supplier to further develop technology, competencies and as a source of motivation without Regional Haulier making any real effort towards value creation.

As previously stated, it may be difficult to be certain of a commensalism relationship in nature (Secord 2002). Some biologists state the irony of the commensalism relationship in which some actions of the benefiting species (ie eating scraps or sharing a root system) could be interpreted as destructive or parasitic depending on the context and motive (Mathis and Bronstein 2020). Similar experiences can be seen in this research. The regional context, long-standing trust between actors and joint motivation of biomethane implementation seem to create a viable atmosphere for commensalistic relationships to occur and positively affect value creation.

	Regional Haulier	Fuel Supplier
Communication	0	0
Innovation	0	+
Determination for Success	0	+
Perceived Support	+	+

Table 9 Symbiotic Analysis of Relationship between Regional Haulier & Fuel Supplier

The relationship between the Regional Haulier and Transport Buyer could be interpreted as slightly parasitic in which the Transport Buyer is the benefiting actor (see Table 10). The communication occurring between these two actors is not on the same level as the communication between the Transport Buyer and Freight Forwarder. Communication between the Regional Haulier and Transport Buyer is typically restricted to more routine or delivery focused communication possibly hindering co-creation of value and positive growth of the relationship (0/0) (Hall et al. 2022; Jazairy, Lenhardt, and Haartman 2017).

However, due to the current role status of the Regional Haulier and Transport Buyer, it does not seem likely that communication would become a value proposition for either actor. Technology and innovation brought into the operations of the Regional Haulier is due to the desire and request of the Transport Buyer. The Transport Buyer can tip the scales with the rate at which the Regional Haulier adopts innovation as the Transport Buyer is the Regional Haulier's largest client. This relationship pushes the Regional Haulier to feel like they should attempt to please the Transport Buyer as much as possible even if they are taking on most of the risks. As seen in Paper 3, the size of Transport Buyer allows them to take risks without large worry over the possible consequences (-/+).

The Transport Buyer has stated a clear determination to be more environmentally cautious in all their operations even encouraging employees to partake and contribute to the realization of the goals of the organization (Paper 2) (0/+). This active participation through empowerment of employees to bring about positive environmental change in their workplace and society is also supported in Palmi *et al.* (2023). However, the Regional Haulier does not have the same drive, leaving it to allow the Transport Buyer to lead the way. This misalignment of goals and motivation may cause problems in co-creation of value or resource use, unless the actors take proactive steps to understand the other's reasoning as discussed in (Dehling, Edvardsson, and Tronvoll 2022).

The Transport Buyer's positive previous experience and regional support for biomethane combined with various sources of support perceived for the Regional Haulier has led to an overall positive co-creation loop between the Regional Haulier and Transport Buyer (+/+). The regional collaboration aligns with Hall *et al.* (2022) and Paper 3 showing that the Regional Haulier's willingness and possibly eagerness to adapt to benefit the Transport Buyer eventually benefits the overall network.

The word parasitism holds a bad connotation. However, this parasitic relationship may suggest it is necessary to achieve successful implementation of biomethane. Similarly as seen in nature, certain parasites deplete the host just enough so that parasite itself may live and in some occurrences the host may not even realize it is parasitically infested (Benesh and Kalbe 2016). As biomethane-driven transport is currently outside the norm of the GLPs offered, a parasitic relationship with a motivated benefiting actor may convince a network to implement biomethane with little to no notice of harm.

	Regional Haulier	Transport Buyer
Communication	0	0
Innovation	-	+
Determination for Success	0	+
Perceived Support	+	+

Table 10 Symbiotic Analysis of Relationship between Regional Haulier & Transport Buyer

One relationship presented in Figure 2, the Regional Network, which has yet to be discussed as it falls outside the scope of the analysis centered around the keystone species is that between the Freight Forwarder and Transport Buyer. As stated previously, Freight Forwarder prides itself on providing its customers with high quality service and meeting their needs rather than having the lowest price. The Transport Buyer desired to have their transport driven on biomethane and the network, in some manner steered by the Freight Forwarder, was able to find a functional solution through co-creation. The two organizations are similar in structure which aids in strengthening the relationship. They are both the localized counterpart to a multi-national business, allowing them to feel support and emboldened to take risks. Additionally, both these organizations have ambitious environmentally sustainable goals motivating the Freight Forwarder and Transport Buyer to find and implement GLPs that work within their branches. Pertaining biomethane implementation, a coordinated dependency could be seen as described in (Sallnäs 2016). Through their stable relationship, they have been able to find a solution which depends on their continued work partnership.

Interactions between Actors in the National Network

The analysis of the relationships between the actors included in the National Network follows the same structure as that in the Regional Network.

The relationship between the Freight Forwarder and the National Haulier could be similar to an offspring relationship (Table 11). The National Haulier is independent of the Freight Forwarder's ownership and governance yet shares a name with the Freight Forwarder and handles most of the transport on behalf of the Freight Forwarder. This relationship allows both to a certain extent to make their own decisions taking on any consequences that may arise, yet in reality the two seldomly split from each other. This shared organizational culture may contribute to their ability to co-create value (Jazairy, Lenhardt, and Haartman 2017). The two have good communication which brings forth value and continuously builds upon their strong relationship (+/+). This dialogue not only brings value to the Freight Forwarder and National Haulier, but also to the other hauliers belonging to the collaborative network. These hauliers benefit by understanding what brings the Freight Forwarder value thus being able to continuously provide service up to the standards of the Freight Forwarder.

Per the findings in Paper 3, this haulier collaboration network also plays a role in using innovation as a co-creator of value. Freight Forwarder prides itself on bringing quality to its customers and satisfying any of their personal requests. Through the haulier collaboration the National Haulier can bring innovative solutions to the customers simultaneously providing quality service per the standards of the Freight Forwarder (+/+).

Both the National Haulier and Freight Forwarder have set rigorous climate goals and their dedication to service quality provides good determination for biomethane to succeed (+/+).

The size and support of the two organizations allow them to take risks without major repercussions. This in combination with the perceived support from the government allow for further value to be co-created (+/+) (Chan et al. 1997).

	Freight Forwarder	National Haulier
Communication	+	+
Innovation	+	+
Determination for Success	+	+
Perceived Support	+	+

Table 11 Symbiotic Analysis of Relationship between Freight Forwarder & National Haulier

A full analysis cannot be made of the relationship between Freight Forwarder and Market. Data was not collected from the Market, only allusions and predictions were given from the National Haulier and Freight Forwarder. Thus, an analysis of co-creation of value may not properly be divulged.

Paper 2 suggests two factors that could lead to value creation, but more data should be collected to say for certain. One point that could lead to value co-creation or co-destruction is the Market demanding greater offering of GLPs yet not understanding or willing to pay the appropriate price for these solutions (Emmett and Sood 2010). Additionally, the perceived support may waver depending on the stance of an actor representing the Market and their understanding of or ability to fulfill regulations. If the Market deems these regulations either too difficult or too easy to fulfill, then motivation for provision or implementation of GLPs may suffer (Walker, Di Sisto, and McBain 2008).

Further Discussion on Interaction

One difference in the nature of relationship of the Freight Forwarder between the two networks is seen in relation to the breadth and vantage point the Freight Forwarder takes on in the networks. At the time of data collection, the Freight Forwarder acting in the Regional Network believed that biomethane is the best fossil-free fuel available to long haul trucking. However, in the National Network, the Freight Forwarder sees biomethane as a 'landing point' bringing the freight industry into the next era of fossil-free fuel but that electric vehicles is the solution best suit for long haul trucking in the long run. A logistics network either regional or national has the ability to metamorphic allowing for change and variation over time depending on the circumstances (Simchi-Levi et al. 2008). The discord of the Freight Forwarder on the National and Regional levels displays this complexity.

The level of operation, national vs regional, of the network seems to affect the viewpoints of value in fossil-free fuel driven transport. The Regional Network has more direct communication with the public and their desires therefore possibly influence by the strong political and economic connection the region and its industries have with biomethane (Mutter, 2019).

Co-creation of value occurs in biological relationships just as it does in the relationships between two logistical actors. Freight transport completed with biomethane is a service offering and has experienced co-creation of value resulting in relationships resembling symbiotic relationships in the biological context. The balance of power between the actors and the motivating force of the relationship will determine the nature of the relationship and whether it takes on mutualistic, communalism or parasitic traits. In the biological context, co-creation and co-destruction of value may be determined by propositions such as ability to absorb nutrition or reproduce. However, the logistical context seen from the two networks studied reveal that co-creation of value is done through communication, innovation, determination for the practice's success and perceived support. The general structure of logistics networks and their behaviors differ from the structure and behavior of networks in industrial symbiosis as described by Adner (2017) which are built either by affiliation or activity where logistics networks typically fulfill both.

While this was not experienced in the analyzed cases due to the actor's individual or collective motive and commitment to environmental sustainability, a possible point for value destruction may originate from the perceived support value proposition yet eventually effecting all other value propositions. As revealed in Paper 2, if the actors determine that organizational goals or governmental regulations are not clearly written, vague or not challenging enough this could leave the actors unmotivated to meet and exceed prescribed goals as stated in Walker, Di Sisto and McBain (2008) and Lin and Ho (2011). One suggested reason for this not occurring in the analysis is the deliberate chosen scope of the analysis to focus on logistics actions and context.

7. Conclusions & Future Research

The conclusions and contributions of this licentiate thesis are built upon the three papers and the analysis undergone in the kappa. All three papers in full are included following the References. Therefore, the conclusions presented in this section will focus on answering the research questions posed in the Introduction. Additionally, the contributions and the limitations of both the included papers and kappa will be presented in this section. Concluding this kappa, the researcher includes reflection upon the use of symbiotic relationships as a metaphor and suggestions for future research.

7.1. Answering the RQs

As in nature, the logistics actors have an ability to adjust the network to whatever problem arises. The implementation of fossil-free fuels is no different. Through value co-creation, like in symbiotic relationships, a certain natural order is established according to each of the actor's roles so that value is attempted to be created across the involved actors. This participation of value co-creation both for individual actors and entire networks may allow for strengthening of relationships amongst actors and development of ability to actively compete in a market demanding independence from fossil fuels. Summary of the findings for each research question are presented to answer the purpose: *understanding value creation and implementation of biomethane in freight transport from the point of view of the logistical actors.*

In RQ1, the included logistics actors were still functioning in their traditional roles, however certain attributes of their traditional roles proved exaggerated when implementing biomethane. The Freight Forwarder coordinated transport both in the National and Regional Networks as per the actor requesting transport. Here the size of the Freight Forwarder seemed to take on different forms depending on the network. In the Regional Network, the Freight Forwarder could be seen more as a mediator listening to the requests of the different involved actors ultimately making a decision for the best of the entire network. While in the National Network, Freight Forwarder together with the National Haulier seem to be focused on the end-goal of providing quality green service for their customers but not necessarily making room for customization of service. This difference could be due to number of the involved actors represented in the Market. A different result could have come forth if there was a specific actor representing the market or a comparable actor representing the Market in the National Network.

In the National Network, the transport was requested by the Market who encompasses several different actors while in the Regional Network it was the Transport Buyer. The hauliers (Regional & National) both completed the transport on behalf of the Freight Forwarder per the respective requesting actor's demands. In both networks, it could be suggested that implementation of biomethane was motivated by the Market and Transport Buyer's demands.

Another striking difference in roles between the hauliers is due to actor attributes and network composition. These two factors combined may determine the risk allowance of the haulier. The National Haulier is a multi-national organization owned by the National Haulier with a fleet of 700. This seemed to give credibility to increasing influence in dictating how their fleet would integrate biomethane into their service offering. Additionally, National Haulier is willing to take on risk due to the support of the Freight Forwarder and assurance that failure would not lead to irreparable economic harm. On the other hand, the Regional Haulier is

independently owned with a fleet of 39 trucks rooted in and serving the region for 40 years. This leads to the Regional Haulier not having the same fallback cushion therefore being less willing to take risks. This may contribute to its passive role in the Regional Network. The passivity of the Regional Haulier does not diminish its importance in the network, rather may establish its importance per its keystone species status. With the flexibility and ability to bend to the demands of the Transport Buyer pushing the entire network towards implementation of biomethane. This again could be due to the characteristic differences between the National and Regional Networks, but also the organizational structure of the two hauliers.

The importance of a fuel supplier to a logistics network was uncovered and should not be overlooked when analyzing green logistics networks. This role of a fuel supplier may only grow in importance as networks move towards implementation of fossil-free fuels. As stated in McKinnon (2018), implementation of fossil-free fuels come with different challenges across a network. Thus, building a steady, collaborative relationship between the logistics actors and the fuel supplier may allow for easier transition to fossil-free fuels. The roles of the logistics actors did not change. The importance and stability of their competencies and organizational environmental sustainability initiatives aid their relationships. These relationships are not only beneficial with other logistics network actors but also in the implementation of biomethane and other GLPs they intend to implement.

In RQ2, the stability of relationships between included logistics actors allowed these actors to create value through various value propositions: communication, innovation, determination for success and perceived support. An interesting observation in communication as a value proposition was revealed. The relationship analysis where there was one benefiting actor in communication, this typically foreshadowed the same actor benefiting from many of the other value propositions. This finding leads to development of the idea that value propositions are interrelated in value co-creation as suggested in Paper 3. Despite the actor leading the communication, an overall trend showed that communication led to value co-creation as the actors were able to align to some extent and plan for a common goal.

The degree to which innovation was experienced as a value proposition depended upon the roles of the actors. Actors working directly with the technology involved like the hauliers or Fuel Supplier seemed to have stronger experiences either in creating or destroying value. Relationships where both actors had similar environmental motivations or goals, like between Freight Forwarder and National Haulier, experienced more value creation due to determination for success. One value proposition possibly neglected previously is the factor of perceived support. All actors felt and perceived that they have support – financially, politically and or relationally – to actively participate in the adoption of biogas.

When determining the relationships of the logistics network, it is important to understand the context in which the network operates. As discussed earlier, the role of the Freight Forwarder shifted slightly between the Regional and National Network and therein it how it related to the other actors in the network. In the Regional Network, the relationship between the Regional Haulier and Freight Forwarder gives way for the Freight Forwarder to be the more dominant and benefiting actor in creation of value. Notably this is done without harm to the Regional Haulier and their relationship rather it seems to allow for strengthening of the relationship and further success in biomethane implementation. On the other hand, in the National Network conclusions could be drawn that the Freight Forwarder is the domineering logistics actor due

to its size and ownership of the National Haulier. Proper conclusions are unable to be drawn on the state of the relationship between the Freight Forwarder and the Market. From literature, it could be posed that certain actors represented by the Market may have more influence than others in value creation of biomethane as a service offering (Huge-Brodin, Sweeney, and Evangelista 2020).

By understanding this contextual difference – regional vs national, land vs city, etc. – and its impact on logistics actors' relationships may aid in implementing fossil-free fuels. This contextual difference may also lead to a deeper understanding of a fuel supplier's role and importance in a network. Particularly those, like the Fuel Supplier in the Regional Network, who have ties to the municipality and a commitment to local initiatives and growth.

7.2. Contributions & Limitations

The aim of this licentiate thesis is to bring contribution to the academic world as well as the practical contribution for the freight transport industry. However, this licentiate thesis did have limitations which should be addressed.

Contributions to Research

All three papers include a fuel supplier as an actor in a fossil-free logistics network. Through this inclusion in the papers, the findings are more accurately able to begin to address and understand the complexities of the logistics functions of a logistics networks running on a fossil-free fuel. Research that excludes a fuel supplier may not capture the phenomenon fully as the paper findings show that collaboration with the fuel supplier may lead to transition success. The papers contributed to the logistics research of biomethane use in transport which in turn has contributed to logistics research around the use of a specific fossil-free fuel. Previous research has mainly suggested or pointed towards the importance of fossil-free fuels in freight transport (Ellram and Murfield 2017; Pålsson and Johansson 2016). This research moves forward in green logistics research by looking specifically into biomethane and how a logistics network fueled by biomethane could operate.

General research around biomethane is beginning to appear in logistics journals, however much of the current research in freight transport centers around electricity, for example: Liu *et al.*, (2023)'s research about electric vehicle queing to charge and Mousavi *et al.* (2023)'s research on proper charging station construction. Additionally, this research contributes to green logistics as a whole aiding in the furtherment of research on how GLP implementation affects a network and actors behavior plays a part in the whole like (A. Bask et al. 2018; Laguir, Stekelorum, and El Baz 2021).

This licentiate thesis has a threefold contribution to research. It furthers the research of biomethane-use in the logistics context presenting it as a viable fossil fuel alterative for freight transport opening the possibility for further research. Building upon Vargo and Lusch (2017), this research continues to investigate the use of Service Dominant Logic and value co-creation in the logistics and environmentally sustainable contexts. The combination of logistics and biology presented in the work is a furtherment of Yoon, Moon and Lee (2022). Like biology and its research subjects, logistics is a dynamic and metaphoric entity allowing for further combination of the two fields.

Contributions to Practices

The managerial contributions from the included papers are two-fold. In Paper 1, the complexities of implementing various GLPs are exposed and acknowledged particularly the challenges in fossil-free fuel adoption. Acknowledgement of these challenges and complexities can allow the logistics network to move forward together in finding an implementation method that allows all actors to partake according to their competencies and role in the network. Secondly, Paper 3 solidifies the importance that society has on the manner the organizations operate. Society may therefore act as a value creator or destroyer in value co-creation of a GLP such as biomethane. This finding should embolden society to make demands for GLPs knowing the influence they hold.

From this licentiate thesis, the practical contributions include presenting a manner for logistics actors to utilize to identify their role and propositions to guide value creation. This tool and understanding of SDL and value co-creation may be utilized in the implementation of any GLP a logistics network is hoping to implement. Through SDL, logistics actors may be able to avoid misalignment or guide the actors in realignment. Similarly, to its academic contribution, this licentiate thesis also highlights biomethane in its practical use, implementation and possible management of challenges that arise. Through presentation of a successful implementation of biomethane, it may inspire other logistics networks seeking to implement a fossil-free fuel that fossil-free freight transport may not be as difficult as perceived.

Limitations

The research also has its limitations and should be recognized to give a full picture of the research. This research was completed in the Swedish context therefore the Swedish culture and geography as well as the unique regional emphasis on biomethane impacts the results of the studies. The actors included in the case provided the researchers with a successful implementation of biomethane to study which had been established for some time prior to data collection. Actors just beginning to implement biomethane or with a not as positive experience should change the results.

The analysis also comes with limitations and therefore should be discussed. The definition and scope of networks in this research may be seen as a limitation. A different definition or inclusion of actors may have led to a different analysis and results. Due to the analysis and involved actors, certain value propositions were revealed. It is possible that with more data, a different analysis method, different actors or definition of network, the value propositions and the results may have been different.

Value and its creation in this research are limited to the value between businesses. This focus on co-creation of value between businesses (B2B) is due to the involved actors and the aim of the research. Other value propositions may have occurred if a more societal or B2C approach had been taken. Admittingly, neither the societal nor B2C value of fossil-free fuels should be overlooked. However, due to the limitations of this research, insights into such value co-creation fall outside the scope and therefore no conclusions may be drawn. Additional limitation of co-creation of value could be seen in the choice of using Service Dominant Logic to steer the analysis. Another result and conclusion may have resulted if another school of value creation had been utilized, such as Porter's Value Chain.

7.3. Reflections on Use of Symbiotic Relationships

Drawing inspiration from biology and symbiotic relationships came with many challenges, but also many joys. Setting a boundary of the extent to which logistics and symbiotic relationships mixed was the first challenge. The researcher needed to take care that the focus stayed on logistics and the thesis did not turn into a drawn-out metaphor. Additionally, the researcher needed to be aware of clarifying where the two worlds differed not to cause confusion. However, the integration of symbiotic relationships quickly became a source of motivation for the researcher. Not only was the researcher able to dig deeper into two subjects – animal life and logistics- that she has great interest in but was able to merge the two. After realizing that there was potential for symbiotic relationships to be used in a logistics context, the researcher took it upon herself with joy so that all would be able to also see the connection. There is possibility for further use and combining of biology and logistics as suggested by Yoon, Moon and Lee (2022).

No matter how thorough a metaphor, regard and consideration should be taken to ensure that there is a clear line of similarity simultaneously a separation between the fields proves to be challenge. One such example from the kappa is the differentiation that needed to be made between species and actors. On the surface the two seemed interchangeable and equivalent. Yet, during the analysis period it became apparent that they are not interchangeable nor equivalent. A species in an ecosystem has much larger span, consequence and benefit depending on its actions where it literally could mean the difference between death and survival for the ecosystem. Compared with a logistics actor who may momentarily experience an equivalent action-based consequence or benefit, the logistics network will eventually adjust or replace the logistics actor without major long-term damage to the network.

7.4. Future Research

From this licentiate thesis, it is apparent that research about fossil-free fuel freight transport is just in its beginning phase. Looking forward, the importance of relationships and value co-creation in fossil-free fuel use and implementation is apparent and should be researched more. Upon further research, the value propositions used in this thesis could be strengthened or challenged. Therefore, broader data collection including different cultural and geographic representations could increase understanding of the phenomenon of fossil-free fuels in freight transport. Including a variety of fossil-free fuels would allow researchers to see how the different alternatives compare against each other. This could possibly allow for a deeper understanding of any effects on the relationships of the logistics actors. Thus, aiding the freight transport industry advance towards independence from fossil fuels.

This licentiate thesis revealed two interesting findings about value propositions and value co-creation in logistics networks. The first is the influence communication may have on a network's creation of value. While communication has been researched at lengths in other fields, there is possibility for further understanding communication's weight as a value proposition in green logistics further building upon (Sallnäs and Björklund 2020). Further research of how a network may achieve a level of communication so that value creation may occur benefiting actors in implementing of GLPs would build upon research like that of Bask *et al.* (2018) and Jazairy, von Haartman and Björklund (2021).

Secondly, further development of how perceived support creates or destroys value could enable development of well-positioned policy and legislation to drive forward the transition to

fossil-free fuels rather than hinder. Continuation of research by broadening the actors included could build upon the initial empirical observations gathered in this licentiate thesis. Including a broader range of actors may allow for a deeper understanding of trust and power in a logistics network thus the inner workings of the transition to fossil-free fuels.

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Papers

The papers associated with this thesis have been removed for copyright reasons. For more details about these see:

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Appendix A

This Appendix contains the interview guide that was used to guide the interviews throughout the licentiate thesis. Not all questions were posed during every interview depending on the actor interviewed and the phase of understanding and position in knowledge and theory collected by the researchers during their abductive approach.

All interviews were conducted in Swedish and transcribed. Certain quotes were translated into English to bring into the papers or conference presentations.

Interview Guide

How do customer demands affect your business activities and offerings?

Påverkar kundernas kräv hur ni planerar och utvecklar som företag?

How do your customers perceive sustainability in business? Do they demand it?

Hur inser kunder en hållbar affärspartner/val? Kräver dem sånt?

Does your organization conduct business with international companies? How? What? Who (if can disclose)?

Jobbar ni med internationella företag? Hur så? Vem/Vilka om man får säga?

How has technology impacted business activities? Pros/cons?

Påverkar technologi hur ni gör affärer? Fördelar? nackdelar?

Do you see a connection between technological growth and promotion of sustainable business practices?

Finns det koppling mellan tekniskutveckling och hållbart trender i affärer enligt dig?

What kind of actors/players outside the organization impacts how you conduct business? How so? What roles do they take on? How much power do they have?

Finns det ytter aktörer som I nåt sätt påverkar hur ni gör affärer? Hur så? Vilka roller tar dem? Hur mycket kraft har dem i din samverksamhet?

What are the pros/cons of having these actors involved?

Finns det för-och nackdelar med att involvera dessa aktörer?

Do the actors outside your organization have financial interest? How so?

Har yttre aktörer ekonomiska intressen i företaget? Hur så?

What are some of the GLPs you implement? Why? How? What were the motives to using these GLPs?

Vilka GLP avänder ni? Varför? Hur? Vilka motiv hade ni att använda dem?

How do you include customers when developing new services?

Hur inkluderar ni era kunder när ni utvecklar nya tjänster?

In your own words, what are your company's competencies? Are there any that you would like to add to your business? Which ones? Why?

Enligt dig vad är företagets kompetenser? Finns det kompetenser ni skulle vilja utveckla hos er? Vilka? Varför? Varför har ni inte utvecklat dem tidigare?

Do you use any particular business models or tools to provide customers with the best service? More sustainable service?

Har ni några affärsmodeller att hjälpa er ge kunden bästa tjänst? Mer hållbar tjänst?

Is there anything you believe would create a smoother, more effective supply chain? From your perspective and knowledge?

Enligt dig finns det någonting som kan hjälpa er skapa mer effektiv försörjningskjeda?

Could operations be optimized?

Finns det möjlighet att optimera samverkan? Hur så? Har ni ett förslag av hur man kan optimera det? Har ni funderat över att skapa samarbete som hjälper att optimera samverkan (ie Crowdshipping eller Horizontal collaborations)?

Are there any policies/taxes in place that affect your operations and business? How so? Do you think they are effective?

Finns det några politik eller skatter som påverkar er samverkan eller affär?

Why biogas and not another source of clean energy?

Varför valde ni att byta till biogas? Funderat ni om en annan 'grön' bränsle?

How does your choice of biogas affect the supply chain? Or does it? Did you have to make any changes when implementing biogas?

Påverkar val av biogas din affär? Hur? Behövde ni att ändra något innan ni kunde byta till biogas?

How does choice of biogas affect the mode? Does biogas limit you to certain modes?

Hur påverkar biogas transport val? Känner ni begränsad till vissa transport metoder?

What are some of the GLPs you implement? Why? How? What were the motives to using these GLPs?

Vilka GLP använder ni? Varför? Hur? Vilka motiv hade ni att använda dem?

How do you include customers when developing new services?

Hur inkluderar ni era kunder när ni utvecklar nya tjänster?

In your own words, what are your company's competencies? Are there any that you would like to add to your business? Which ones? Why?

Enligt dig vad är företagets kompetenser? Finns det kompetenser ni skulle vilja utveckla hos er? Vilka? Varför? Varför har ni inte utvecklat dem tidigare?

What types of modes do you use? Why? Pros/cons? How? Would you change anything about them?

Vilken/Vilka transport methoder använder ni? Varför? Hur? Vad har de för för-och nackdelar? Skulle ni vilja ändra någonting om utvalda transport methoder?

Have you considered integrating an intermodal system? Why? Why not?

Funderat ni över om ni skulle implementera intermodal transport? Varför? Varför inte?

Can you see room for logistical improvement in your mode choice? How?

Enligt dig kan ni förbättra transport i ett logistik sätt? Hur?

Is there room for sustainable improvement in your mode choice? How?

Enligt dig kan ni förbättra transport i ett hållbart sätt? Hur?

FACULTY OF SCIENCE AND ENGINEERING

Linköping Studies in Science and Technology, Licentiate Thesis No. 1965, 2023
Department of Management and Engineering

Linköping University
SE-581 83 Linköping, Sweden

www.liu.se

DEPARTMENT OF TRAFFIC ANALYSIS AND LOGISTICS

Swedish National Road and Transport Research Institute (VTI)

SE-581 95 Linköping, Sweden

www.vti.se

LINKÖPING UNIVERSITY

vti