Master's degree thesis

LOG950 Logistics

Managerial opinions on implementing a Supply-Demand hub in an industrial cluster; a qualitative case study of Raufoss Industrial park

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Preface

First of all, we'd like to thank Øyvind Hansebråten at Raufoss Næringspark and Rune Karlsen at Multisped for giving us the opportunity to write our thesis about the logistics center. Writing this thesis on behalf of them has allowed us easy access to the companies inside the industrial park, and their help in connecting us to the correct companies was invaluable.

We sincerely thank every company we visited and interviewed for their participation, willingness to share information, openness and generally positive attitude towards us as researchers. The time and access granted to us was a crucial part of completing the thesis.

Special thanks to Jan Nesset for the tour of the Raufoss historical center, the CD-ROMs and the book about Raufoss Ammunisjonsfabrikker. It was greatly appreciated.

Additionally, we would like to thank our supervisor, Asmund Olstad for guidance in completing the thesis. The contribution he made in helping us editing and structuring the thesis was of great value.

We want to thank our families for their support during our education. It is with gratitude we finish our education with this thesis, it would not be possible without them.

Last, but not least we would like to thank Molde University College, for two and five years of quality education.

Lage Oddvin Sæbø Jordbru

Daniel Mikkelsen

Abstract

The main purpose of this thesis was the uncovering of managerial opinions regarding the establishment of a logistics center in conjunction with Raufoss industrial park. Based on a solid theoretical research we develop a stepwise model of integration, with different levels of service offered for each step. We uncovered the current situation for the companies designated as intended customers, their challenges, needs and found opportunities they can exploit with a successful implementation.

Design/methodology/approach: This thesis employed a qualitative case study research method with a descriptive research design. A series of eight in-depth interviews were conducted, with further data coming from observations and historical data. A model was developed based upon academic research and the answers were compared with the steps in the model. Limitations include a lack of cost focus and anonymizing interviewed companies.

Findings & Discussion: Based on our model, our findings indicate that the complexities of a manufacturing cluster makes the complete integration into a "supply-demand hub in an industrial cluster" (SDHIC) difficult. Due to the stepwise model, we find a suitable level of integration. We uncover general challenges and issues with the current situation and how these issues could affect the decisions of the companies.

We conclude with a recommendation based on our model, for what concept the logistics center should adopt. Finally, we end with managerial implications and suggestions for future research.

Keywords: **Industrial park, industrial cluster, demand hub, supply hub, logistics center, horizontal cooperation, internal transportation, warehouse, customs, consignment, integration model, SDHIC.**

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1 Introduction

1.1 Background for the thesis

The ownership firm of Raufoss Industrial park has a project where they are looking into the possibility of building a logistics center. This would cover the shipping and receiving of goods and raw materials for the firms in the industrial park. This would be a return to a situation similar to what existed in the industrial park earlier in its history. When one company owned everything in the park. At that time, there was one distribution center for the entirety of the industry park, one procurement department and one distribution organizer. Today there are around 50 companies working inside the park with over 2500 employees. The companies in the industrial park maintain an export share of production at approximately 90%.

This proposed logistics center is interesting due to several key aspects:

Firstly, the industrial park is located in Raufoss. Transportation wise, an isolated location, with only one real opportunity for transporting goods to and from the park. It can only be supplied using road transportation. It is located far from the ocean, and the railroad is no longer used for goods transportation.

Secondly, it will be a supply-demand hub for the firms within the park, which means that there will be sharing of warehouse space between many firms. A Supply-demand hub located in the industrial park at Raufoss is, in a Norwegian context, a novel concept, given the current structure of the park.

Third, Supply-demand hubs studies are usually confined to the optimization sphere. We made a specific model for the case at hand, partly based on previous academic research. This is a new concept for the companies, and being introduced to this concept through our thesis yields interesting results.

Fourth, Raufoss industrial park is a light-metal cluster. There may be transferrable results to other industrial clusters, or it could work as a comparative work towards other clusters of similar complexity.

Additionally, one of the authors has worked almost every summer since 2006 for one of the companies in the industrial park, so has extensive knowledge of one company in particular, and general knowledge about the rest of the companies in the industrial park. This has

nurtured a certain interest in the industrial cluster at Raufoss. Information was collected in the summer of 2018 to uncover a possible master thesis from one of the companies in the industrial park. None of the companies had a specific task suitable for a master thesis, but the industrial park itself had the aforementioned project of suitable scale.

1.2 Structure of the thesis

This thesis is structured into ten chapters. Chapter 1 is the introduction of the thesis, with some background, the structure, and the research questions. Chapter 2 contains the limitations of the study and a disclaimer. The 3'rd chapter contains the case description with the history of the industrial park, the business case developed by Multisped and some general challenges to Norwegian industrial companies. Chapter 4 presents the literature review and contains five sections: Centralization vs decentralization, cluster theory, horizontal cooperation, distribution centers, and supply hubs & cluster supply chains. Chapter 5 covers our data and methods. Chapter 6 is the presentation of our model developed based on the contents of chapter four. Chapter 7 presents our findings and discussion, divided into two parts; the model related findings and general findings that describe the current logistics operation in the park. The impact these have, and the implications they have for the final decision making regarding the establishment of the logistics center. Chapter 8 is our conclusion. Chapter 9 are the managerial implication. Finally, Chapter 10 are suggestions for further research.

1.3 Research questions

Here are the main research questions we are going to answer in this thesis:

1. "Uncover what the logistics managers in the industrial park think about the proposed new logistics center."
2. "How does the literature indicate that such a warehouse would impact the firms?"
3. "Uncover if the new situation will benefit all firms as a group or if there are certain firms which will likely benefit more than others."

1.3.1 Case-specific questions

To help solve the research questions; there are some additional case-specific questions. These overlap well with the desire of Raufoss Næringspark and Multisped to have a quality description and understanding of the current logistics situation in the park. Different companies have different structures, customers, suppliers, and challenges. These different characteristics will influence the opinion a company has towards our 7-step logistics center model. With this in mind, certain specific characteristics were interesting:

- Do they have an environmental profile, and is that profile in accordance with current tasks and processes.
- How do the companies look upon Multisped, and the associated owners, and what challenges are associated with non-Multisped transportation.
- Discover what IT and improvement-systems the companies use today, to see if integrating the systems in the new logistics center will be challenging.
- How is the current structure of warehousing, transportation and supply chain management in the industrial park?

2 Limitations of the Study & Disclaimer

This case study is a special geographical case, due to the close geographical proximity of the companies in the industrial park. The park is located far from the main national and international transportation routes. Road transport is the only viable option to access customers and suppliers since the railroad no longer has goods traffic from Raufoss to Oslo. There is already an established horizontal coordination process through Multisped and the common usage of that, making the adaption stage of unified transportation planning easier.

There are no plans for a specific size of the warehouse. The costs for investment, rent, transportation, and maintenance are all unknown. The generation of revenue is not known, and budgets do not exist. Therefore, costs are not the focus of our thesis.

2.1 Disclaimer

Companies and results that can be associated with specific companies are anonymized. In this thesis, we will not do any correlation due to anonymity concerns from the companies. The purpose of the assignment is to uncover information regarding the companies involved and to aggregate the information such that the decision made by the industrial park is as optimal as possible. In the tables we use in the thesis; the labels that represent the companies are different in each table, the position of the companies is scrambled.

3 Case Description

3.1 History

Industry has a long and illustrious history at Raufoss, with the first instance of proper large-scale industry established in 1873 with the foundation of Rødfos Tændstikfabrik producing matchsticks. The early production of matches was dangerous due to flammable production materials and processes, and the factory burned down two times before 1892. When the third fire struck in 1893, the company's owners decided that they had had enough, and they decided to sell what remained of the production facility. This coincided well with a governmental military commission's recommendation from the previous year. It recommended that the Norwegian government establish domestic ammunition production in case of a future war of independence against Sweden. At this point, the Norwegian government was not independent and shared a king and Foreign Service with the Swedish government. As the junior partner in the arrangement with aspirations of independence self-sufficiency in all military aspects were of high importance to the Norwegian government in preparation for any conflict with Sweden. The recommendation was that the production of ammunition be established in a location that was difficult to capture for the swedes. With respect to this Raufoss was ideal, since it is located west of the formidable natural obstacle Mjøsa, Norway's biggest lake. Additionally, there are many natural obstacles, among them Glomma between Raufoss and Sweden. In 1895, the preparation of factory facilities was done, and production machinery was moved from Christiania to Raufoss and small arms ammunition production could begin. When the railroad was connected from Oslo to Gjøvik, going through Raufoss in 1902, this made the logistics easier and the factory's importance continued to grow until 1905. With the peaceful dissolution of the union, there were 500 employees working there, but the demand for ammunition started to decrease with the peaceful resolution to the independence question. This fall in demand continued to up until the start of the first world war, when the government decided that it needed to prepare the

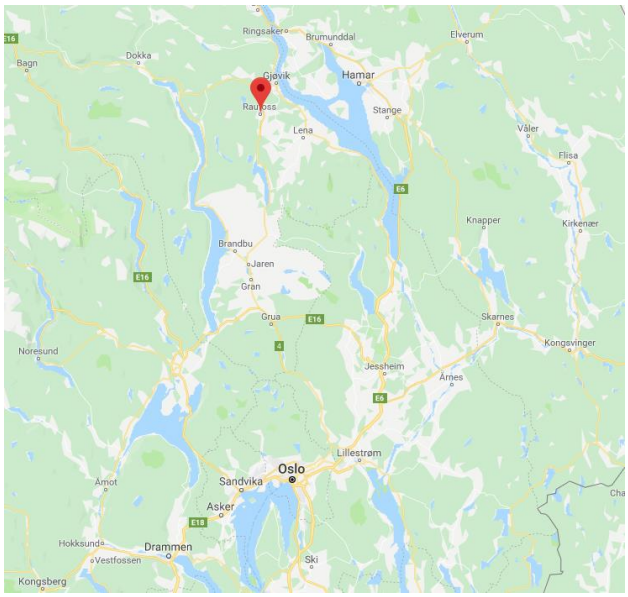


FIGURE 1 – GOOGLE MAPS LOCATION OF RAUFOSS, NORTH OF OSLO

factory for any future involvement in the war. Norway never got involved in the first world war, but the factory satisfied an almost endless demand for ammunition during the war. With the end of world war one, the factory shifted much of its production towards civilian production, but that could not compensate for all the lost ammunition production. As such Raufoss went through hard times during the interwar period.

During World War Two Norway was occupied by the Germans, and Raufoss manufactured ammunition for the German armed forces, with some reluctance on the part of the workers. After world war two, ammunition production was an ever-decreasing part of the whole production, and from 1960 onwards a lot of the production was focused on aluminum parts for the automotive industry and other aluminum products. In 1968 Raufoss Ammunisjonsfabrikk was made into a stockholder company with the government owning all shares. In 1990 it went public on Oslo Stock exchange, still with the government owning all shares until 1995, when the production was separated into two subsidiary companies with the automotive production being one of the two. 40% of the shares in the automotive industry was sold to Norsk Hydro due to the capital intensity involved with the production and the government not wanting to ship the entire bill at that time. The 60% remaining Hydro shares were sold by the government in 1997. The remaining ammunition production was, together with Finnish and Swedish weapon manufacturing companies, merged to form Nammo in 1998. Since the late 90's there has been further diversification and privatization of the production facilities of the industrial park.

3.2 Business case:

The business case below was developed by Multisped AS in coordination with Raufoss Næringspark ANS, it has been translated and is marked in Italics. The underscored part of the "Initial Goals" is where our thesis comes in and will help the interested parties.

3.2.1 Background

Raufoss Næringspark ANS (liable company) is considering the opportunity to establish a logistics center, the purpose of which is to make Raufoss industrial park a more attractive cooperation partner for todays and future tenants. At the same time increasing the internal warehouse capacity of the park, could increase available production space in a situation where the area available for production is limited. In conjunction with this, the proposed center would contain a driver center, to improve the conditions of drivers performing

transportation assignments for the park's customers. This will reinforce the parks social responsibility and facilities towards the goods transport conducted in the industrial park.

The initiators of the project are Raufoss Næringspark ANS with support and competency from Multisped AS, Toten Transport AS, LRN AS and Schenker AS – who are the biggest local transportation and freight-forwarding providers in the industrial park. The building is planned to be erected by Raufoss Næringspark, while the daily operations is planned to be conducted by or in connection with Multisped. This operation is planned to be done in such a way that transparency is maintained, such that the companies using Multisped's already existing services can trust that the warehouse operations are not being subsidized by increased costs for the already existing services.

3.2.2 Vision

The vision is to create a warehouse that delivers resource and cost-efficient logistics solutions to the companies within the industrial park area. It will contain a temperature regulated area and a non-regulated area. Additionally, they want to offer customs and consignment space such that companies can make agreements with their suppliers to their needs and optimize their own supply chain to lower their costs. The warehouse is to be built in a fashion conducive to easy further expansions and is going to serve the industrial parks customers exclusively. The warehouse shall contain:

I. *A transport and freight-forwarding department, and function as new offices for Multisped's current services.*
II. *A driver-center with sanitary facilities for usage by drivers*
III. *An IT-system solution that is fully capable of integration with the IT systems employed in the park*
IV. *An IT-system that allows for 100% control of goods and the location they are currently occupying.*

With the IT-system in mind it is imagined cooperating with SINTEF Raufoss and NTNU Gjøvik to find and design good and innovative systems.

3.2.3 Proposed effects

- *Cover the size and efficiency needs of the tenants in the park*
- *Offer new solutions that will stimulate offshoots*
- *Reduce the need for external warehousing*
- *Increase opening hours to increase flexibility in loading and unloading*

- *Exploit joint operations benefits with regards to cost savings for the tenants*
- *Give every company in the park one mail address for incoming and outgoing goods. Nature of goods and size of shipment determines whether to unload at logistics center or at production company inside the industrial park*
- *Reduce traffic inside the industrial park and in Raufoss city center through internal transport of smaller batches. In addition, the park entry is moved away from residential areas to Skumsjøvegen.*
- *Reduced environmental impact through optimized processes and cooperation.*
- *Reduce the investment needs of the tenants in the park.*
- *Improve mail reception systems*

3.2.4 Revenue sources

The planned sources of revenue are based upon rent per square meter, freight forwarding services, handling services, customs services and warehouse services.

3.2.5 Initial goals

- *Uncover enough quality information from tenants regarding their need for warehouse space, who can inform and permit good operational and investment decisions.*
- *Calculate revenue streams and determine best operation such that the offer given to tenants is the best possible offer.*
- *Summary of the project who can show us the financial foundations for initiation of the project*
- *Contracts such that the warehouse can expect to have 60% of available warehouse space used for the first operational year*

The underscored part of the business case is the focus for this thesis.

3.3 General challenges to Norwegian Industry

When we consider the situation for the firms inside Raufoss Industrial park, we must be aware that approximately 90 percent of their total production is for export. With this in mind, we need to account for them competing against the rest of the world, and that Norway due to high wages are at a structural disadvantage in the total cost structure. The difference compared with the rest of the EEC nations has been decreasing since 2011, but it's still higher than elsewhere (*Wage levels in the industry, 5.3.4*, 2018). This has forced Norwegian companies to use capital-intensive methods of production, which has decreased unit price and

increased the profit margin. Logistics and Supply Chain Management is a part of the greater whole where companies can still gain additional competitive advantage. They need to run and maintain this part of their business with the same shrewdness as they have treated production itself. Due to the geographical location of Raufoss, there are certain limitations that are placed on the firms. Due to most of the production going to foreign markets and the railroad from Raufoss to Oslo no longer carrying goods traffic, everything is sent by truck from Raufoss. Assuming that most transport head south from Raufoss toward Oslo, then further towards Stockholm, Gøteborg and the rest of Europe, all the traffic has to pass through several tollbooths on their journey. On top of that, the road connection to Oslo is less than ideal, and a lot of time and money is wasted on poor traffic flow (Limmesand, 2019). This is an additional cost on top of the costs associated with truck transport, where there are two categories: Time and distance costs (Grønland *et al.*, 2014). The additional fixed costs per journey occur due to tollbooths. In addition, this gives incentives to try to optimize the logistics operations for the companies. Through the EEA agreement, they have access to foreign transporter companies that have lower costs than Norwegian transporters.

4 Literature Review

In this chapter, we will explore the existing literature relevant to our topic. We start with a foundation based on literature concerning centralization versus decentralization, before framing it in a cluster theory setting. Then we will build further with horizontal coordination and distribution centers. Finally, we extend into the aspect of supply hubs in industrial parks and cluster supply chains. All of these topics were important to develop and fully understand our 7-step integration model presented in chapter 6.

4.1 Centralization vs decentralization:

The question of centralization versus decentralization in supply chains and warehousing is vital to the academic discipline of SCM. The central question in centralizing or not is what kind of cost structure we have in the different instances. Inventory management can account for a large part of the total logistics costs in a company. The true cost of holding inventory is according to (Christopher, 2016) divided into

- Cost of capital
- Storage and handling
- Obsolescence

- Damage and deterioration
- Pilferage/shrinkage
- Insurance
- Management costs

The level of these costs all plays a role in the decision-making process that occurs when deciding upon the optimal way of organizing the supply chain and its features. Further the decision regarding the structure of the supply chain and inventory management has impacts beyond the financial. (Baker, 2007) found that inventory was a way of guarding against supply uncertainty, but that it also increased risk-related factors. Thusly inventory management is related to risk management across the supply chain. The warehouse level is for traditional manufacturing businesses used as the demand penetration point in the supply chain. Up until that point the production of goods is forecast driven, while from the warehouse and downstream in the supply chain it is driven by actual demand. Moving the penetration point further up the supply chain is part of the modern supply chain managers job (Christopher, 2016).

Customer satisfaction levels is an important part of logistics, and one of the kpi`s under that umbrella is the availability of goods (Frazelle, 2002). To meet this KPI it is common to use inventory as a means of improving responsiveness to shifting demands. When a company has longer lead times in relation to their suppliers than the lead time of the customers, then we a need for inventory as the inventory supplies the demand until supply can catch up (Baker, 2007). There are however opposing finds to this view:

"*The fact that the impact of inventory on supply chain responsiveness is largely negative is both a rather critical and surprising result. Contrary to the view widely held in theory and practice, the analysis undertaken here reveals that inventory is an important net destroyer of supply chain responsiveness, negatively affecting all of the dimensions of supply chain responsiveness except predictable upward shift in demand, and customer lead time compression"* (Etienne, 2005).

"In most cases, instead of increasing speed of supply chain response, inventory represents dead weight that slows down the response process. In consequence, a firm can only validly rely on inventory as a driver of supply chain responsiveness if that firm competes in market segments that are experiencing large predictable and unpredictable upward shifts in demand and customer lead time." (Etienne, 2005)

These findings appear to be in concurrence with the thinking behind the LEAN concept, in so far that inventory is one of the wastes that needs to be reduced to improve the performance of the firm.

Pedersen, Zachariassen and Arlbjørn (2012) found that the literature available on centralization versus decentralization did not account for smaller and medium sized companies. Their findings illustrate that there is a difference in how companies act, based on the size, and that this creates different challenges when compared with the larger companies, where empirical studies have been carried out before.

"*This case study showed that SMEs (small and medium sized enterprises) and large companies have different approaches to warehousing, and the reason for this lie in:*

- *SMEs generally have scarcity in competences and fewer resources;*
- *SMEs have fewer advantages of economies of scale in a centralized setting; and*
- *Management resources to carry through a centralization project are limited in SMEs."*

It is unclear at this time what classifications we could put on the different firms within the industrial park and the implications of the varying sizes we can find within the park.

4.2 Cluster theory:

An early work that still rings true is Chinitz (1961), where he wrote that; the development of regions is dictated by their industrial structures, and those structures are generated by two factors. The first factor is related to when the industries are established and elevate to a large enough size to create cluster economies. This is also why it is so important to achieve an industrial innovation and why establishment formation in regional economic development is so important (Eberts and Stone, 1992) The second factor is the location of the region`s industries in the product cycle. This can also be a partly function of strategy.

Development and new strategies will always appear and evolve in a region.

"*Regions in advanced economies develop in a consistent pattern, and at their root is the interplay among cluster economies, risk-adjusted rates of return, firm strategies and market forces that seek to equalize interregional factor price differentials"* (Hill and Brennan, 2000). They further define an industrial cluster as a:

"*geographical concentration of competitive firms or establishments in the same industry that either have close buy-sell relationships with other industries in the region, use*

common technologies, or share specialized labor pool that provides firms with a competitive advantage over the same industry in other places".

This definition consist of four parts, where the first part, the geographical part, have to be present, and combined with at least one of the three other parts to be considered an industrial cluster (Hill and Brennan, 2000).

Morosini (2004) defines an industrial cluster as

"*A socioeconomic entity characterized by a social community of people and a population of economic agents localized in close proximity in a specific geographic region".*

This are based on the rules of Marshall (1961), and why firms choose to locate themselves in the same area as competitors, customers and suppliers. He mentions three key aspects and explanations. Firstly, they locate themselves together graphically because of the labor, and quality of the labors. There will be a pool of high skilled labor for the specific needs of the firms, and easy to access. Secondly, firms can achieve economy of scale in developing and using common technologies and capital infrastructure due to the industry specific, non-traded inputs the firms can provide by locating in close, geographic proximity to each other. Third, the firms can collaborate and generate a maximum flow of information and ideas. This provides a pool of shared knowledge that can be turned easily into valuable innovations through close geographical proximity (Marshall, 1961).

Being in an industrial cluster proves to bring many economic advantages (Sheffi, 2012). The companies within the cluster could experience an increase in productivity due to shared resources and availability of suppliers, they would improve the human relationship between them through information sharing, direct communication and understanding. Further, this would improve the trust level among the companies in the cluster (Sheffi, 2012).

To achieve competitive advantages, Porter (1990) suggest having a look at the nature and environment of the firm's natural habitat and nationality. He further explains that;

"firms gain competitive advantage where their home base allows and supports the most rapid accumulation of specialized assets and skills, sometimes due solely to greater commitment" (Porter,1990).

However, to achieve this form of competitive advantage, one must have a look at the four attributes of a nation that shapes the environment that local firms compete in and promote the advantage in. These four attributes are sorted by Porter (1990) in this way;

- Factor conditions
- Demand conditions
- Related and supporting industries
- Firm strategy, structure and rivalry

Factor conditions represent the inputs necessary for an industry. This includes high quality labor, high-tech technologies and natural resources. Demand conditions are the nature of market and if it stimulates change or not. Related and supporting industries refers to the presence or absence of supplier- and related industries that provide firms with the materials necessary to compete in the market. Firm strategy, structure and rivalry refers to the existence of local rivalry that drives firms to differentiation, innovation and investments.

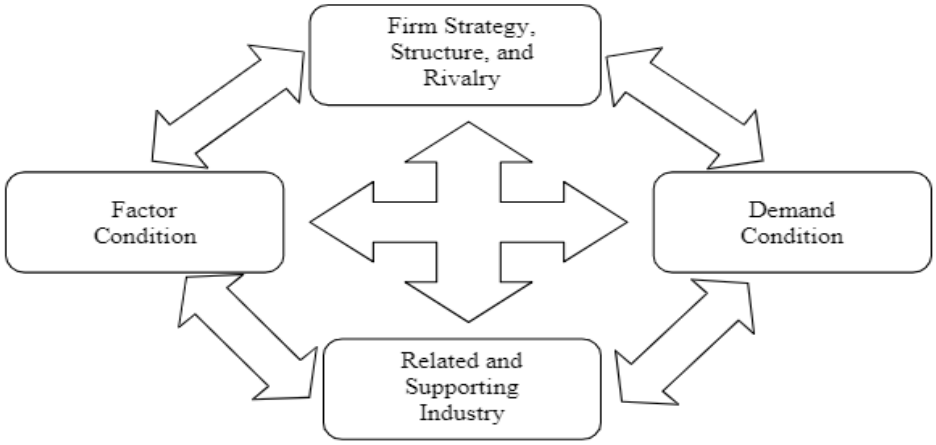


FIGURE 2 - THE DETERMINANTS OF COMPETITIVE ADVANTAGE (PORTER, 1990)

Hill and Brennan (2000) took the model above a step further and connected it with an industrial cluster. The arrows in the middle of the figure above will represent the drivers, or the driver industries in a region. In every industrial cluster, there are at least one driver industry in which the region has its greatest competitive advantage (Hill and Brennan, 2000).

Furthermore, they state that;

"*the reason for the requirement that the driver industry be composed of competitive firms or establishments is that a major source of cluster economies is generated by the forces of competition in product innovation; quality enhancement; the adoption of process innovations; and the encouragement of entrepreneurship to take advantage of perceived market, supply or distribution gaps within the cluster"* (Hill and Brennan, 2000).

If the competition were missing in the cluster, then the region would solely depend on the driver firm(s) market power and supplier network to comprehend the revenue and cost saving sides of the cluster.

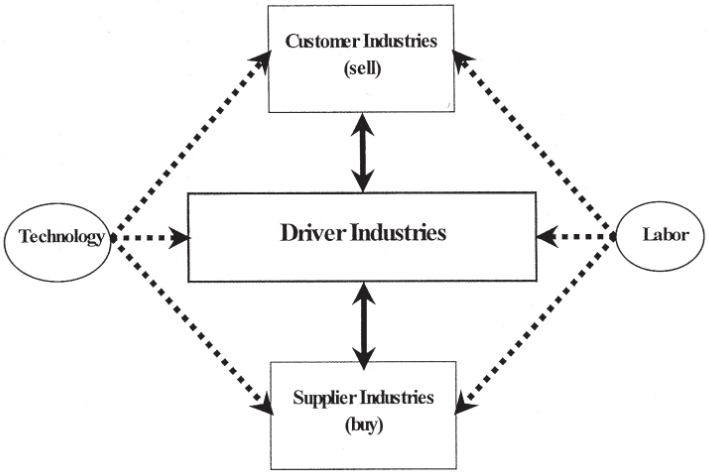


FIGURE 3 - STRUCTURE OF AN INDUSTRIAL CLUSTER (Hill and Brennan, 2000)

The figure above describes the context of an industrial cluster based on linkages between external factors like economy, customers, suppliers and their position relative to that of the same industry nationally.

"*The two types of inter-firm relationships which contribute to the success of clusters can be defined as "vertical" and "horizontal"* (Sheffi, 2010).

Vertical relationship will be the links among the business partners, while horizontal relationship are links among the firms that are at the same stage of production (Sheffi, 2010). The article further comments that firms in a horizontal relationship both compete, and cooperate along dimensions that advantage them, which will be related to the thesis, as Raufoss industry park contains horizontal relationships through Multisped.

"*Given the potential advantages and disadvantages of geographical clustering of firms, it is hard to establish a comprehensive theory on the aggregate (net) effect of geographical clustering on firm growth and the direction and magnitude of the effect of geographical clustering on firm growth may differ across firms and industries. In fact, the*

empirical literature on the effect of geographical clustering on firm growth is scant and, more importantly, shows very diverse and often conflicting findings" (Lee, 2018).

Being a cluster also brings certain advantages to whom being inside the cluster. Sheffi (2010) embody five major advantages; trust, tacit knowledge exchange, collaboration, Research and education and supply base;

- Trust is easier to develop inside a cluster. There are many people with similar backgrounds, languages, religions and customs. By this, it can develop a pattern that lower the transaction costs between firms whether they trade between each other or have a horizontal collaboration between them.
- Tacit knowledge is knowledge that cannot be codified in an E-mail. Knowledge associated with development and operations support direct communication, and face-to-face meeting, either if there are a discussion between competitors, customers or vendors. In a cluster this can be done easier, faster, more effective and less expensive, in a more informal exchange setting between technicians, manufacturers etc. In this way, there is a less change of knowledge spillovers.
- With the concentration of firms in the manufacturing industry, with the same needs and concerns, will easily give a natural rise of joint activities. The firms would be able to lower its costs while raising quality for all firms to a higher new level. They would be able to collaborate in "*lobbying for the provision of infrastructure, regulatory relief, incentives, and other government largesse"* (Sheffi, 2010).
- Research and education. Symbiotic relationships between universities and the industry clusters are comprehensive and an important aspect of the collaboration and knowledge sharing in a cluster. The way industrial clusters provide themselves with labor and have a division inside the park that works with the "new, skilled labor."
- Supply base is based on the fact that clusters attract suppliers who see advantages in locating next to their customers. Chance interactions with customers, the possibility of learning through experience and where the industry is heading to forge strong relationships and collaborations is often important factors how firms locate their businesses.

Ketels, Lindqvist and Sölvell (2006) states that clusters are considerate important for countries' economies. This is due to that the agglomeration of firms' palpable economic benefits in three different dimensions:

- The companies in the cluster achieves a more efficient operational status
- They acquire higher levels of innovation, due to knowledge spill generated by interaction between member firms and competition through constant pressure of doing better.
- Higher level of business formation, due to both cluster itself and suppliers receive the benefits of economy of scale.

Porter (2000) presents that the existence of a cluster signals an opportunity. It brings lower entry barriers, an already existing pool of local potential customers, established relationships, and other firms that have "made it" in the local market.

"*A firm within a cluster often can more rapidly source the new components, services, machinery, and other elements needed to implement innovations, whether in the form of a new product line, a new process, or a new logistical model"* (Porter, 2000).

He also states that a cluster, under certain circumstances, can slow down innovation. By this, Porter (2000) means that a cluster shares a uniform approach to competing and the firms within the cluster has a "group mentality" which often reinforces old behaviors, lower the interest of new ideas, and creates fixed standards that prevents adoption of improvements.

4.3 Horizontal Cooperation

Here follows a chronological review of the available literature for horizontal cooperation. Given the circumstances in the industrial park, we have identified horizontal coordination as a theoretical aspect of this thesis. We base this decision on the fact that Multisped AS, is a horizontal coordination effort made by the distribution companies of Toten Transport AS, LRN transport AS, and Schenker AS. They together purchased the old central transportation office from Raufoss Ammunisjonsfabrikker AS, and established it as a way of continuing to offer the services. Customs clearing and coordinating the transport of items to and from the industrial park as opposed to being in competition with each other over the transport inside the park. Such cooperation between actors performing similar jobs in a supply chain is becoming more common as the pressure on logistics service providers increase.

"Today, the most frequently cited problems of Logistic Service Providers (LSPs) are low capacity utilization, empty haulage, a negative public image and declining profit margins. The main causes for these problems are the stiff competition in global markets, high fixed costs, rising petrol and labor prices, the proliferation of products with shorter life cycles and the increasing expectations of customers" (Verstrepen *et al.*, 2009).

Traditionally when talking of coordination in logistics or supply chain management, the focus is on vertical coordination, with horizontal cooperation not given much focus. Simchi-Levi, Kaminsky and Simchi-Levi (2003), defines supply chain management with focus on a single supply chain:

"the set of approaches utilized to efficiently integrate suppliers, manufacturers, warehouses, and stores so that merchandise is produced and distributed at the right quantities, to the right locations, and at the right time, in order to minimize system wide costs while satisfying service level requirement."

This definition does not exclude horizontal coordination, but its focus is on the vertical aspects of supply chain management. It focuses on avoiding excess or unnecessary logistical costs, or waste. It is worth noting however, that to establish horizontal coordination in a situation where we have a lot of vertical coordination makes the entire situation more complex. As it is not just the transporters who are going to cooperate who decides, there is also the companies involved in the supply chain of one or both of the companies.

Bengtsson and Kock (1999) identifies four different patterns of horizontal cooperation can take on. Co-existence, referring to a relationship that does not include any economic exchanges and they are acting on independent economic goals. Cooperation, where we see tight bonds exist between the companies and they define common goals to pursue. Competition, where the companies take action and react on the others action while competing for the same group of customers and relying on the same suppliers. The last type is Co-opetition, where we have horizontal cooperation between the logistics companies. Goals are jointly set if they cooperate, but not if they do not. Here you can have cooperation between two competing manufacturers on the logistical arena, while at the same time they can compete in other aspect like price and quality of goods. The authors further say that ruling management of companies should not be afraid of applying competition and cooperation at the same time, to achieve the goals set forth for the organization as a whole.

How common is horizontal coordination in transportation and logistics? According to Cruijssen (2006), horizontal cooperation is common in both maritime and air transportation. In maritime shipping so called "*conferences"* is a common practice. It is cooperation between ocean carriers on a specific transport line against collective tariffs and identical service levels. They offer advantages like economies of scale because of the larger volume being shipped and improved customer service. Further they prevent price wars by offering rate stability. As

for aviation they cooperate extensively across companies through the use of so-called alliances. To set it in a Norwegian context SAS is a member of Star Alliance who has a total of 28 members (*Star Alliance*, 2019). This alliance allows for member airlines to share infrastructure, communication initiatives and to co-locate at airports across the world, lowering service costs and allowing for lower prices and improved services for the individual traveler (*About Star Alliance*, 2019). These international alliances make sense for the airlines to participate, as merging and purchasing other airlines is not always an option for airlines. Many airlines are owned by governments and the granting of international traffic rights is often confined to specific airlines. This leaves international horizontal cooperation and coordination as an effective alternative (Cruijssen, 2006).

As for land-based transport there is more limitations on the available scientific literature, but the interest in the field is increasing, and recent production is increasing as compared to earlier years. The first proper article on horizontal integration of logistics came from Caputo and Mininno (1996), where they analysed the usage of horizontal integration of logistical functions in the Italian grocery sector. They suggest many actions and policies, which companies should consider allowing such cooperation to function smoothly. Such actions are among others: standardized pallets and packaging, sharing warehouses and distribution centers, joint route planning and outsourcing elements together. Erdmann (1999) is mentioned by Cruijssen (2006) as having constructed a model to estimate the synergy potential in the German consumer goods industry, we have not been able to verify that based on lacking skill in German. Likewise, Vos *et al.* (2003) who wrote in Dutch, according to Cruijssen (2006) they defines three types of synergy: *Operational synergy, coordination synergy and network synergy.* Where Operational synergy only concerns a single process or activity, coordination synergy if cooperation takes place across several activities and there is harmonization across these activities, and network synergy exists if there is a cooperative restructuring of a complete logistics network by multiple partners.

Henkel and Schwarzkopf were the basis for Bahrami (2002) where he compared three potential situations: First the distribution continues as currently, secondly they do cooperation with the current logistical arrangements, thirdly that they adapt their logistical organizations to the joint demand for both companies. His findings indicate that the second scenario would save Henkel & Schwarzkopf 2.4% of costs, while the third scenario would result in savings of 9.8% of costs.

Cruijssen and Salomon (2004) found that order sharing between transportation companies in the Dutch transportation sector could be expected to lead to a cost saving between 5% and 15%. Furthermore, the results indicated that order sharing is more profitable when many transportation companies participate.

Hageback and Segerstedt (2004) studied the remote municipality Pajala in Northern Sweden, close to the Finnish border. It is sparsely populated with the population spread over a large area with one person per square kilometer approximately. To reverse population decline it is necessary to create work opportunities for people and to accomplish that they need competitive companies. Since most of the companies have their clients in southern Sweden, the transportation routes are long and done in an intermittent fashion such that there is not a truck to each company every day. The findings indicate that there is limited knowledge about the concept of co-distribution, as only 8% of the companies have been thinking of it. At the same time, 43 % of trucks/trailers are not loaded to maximum weight or volume. With this in mind the author's state:

Co-distribution leads to fewer drivers needed and may even cause left-over resources at the conveyers/suppliers. (of transport) *On the other hand, with no co-distribution, low utilization of the trucks, the transportation companies must strive for higher "market" prices for transport to rural areas* (Hageback and Segerstedt, 2004).

Further, the findings indicate that co-distribution may decrease the volume of trips by more than one-third, and at the same time increase frequency of deliveries. Likewise the cost of transport would decrease by one-third and the disadvantages of long-distance transports reduced significantly (Hageback and Segerstedt, 2004).

Cruijssen (2006) surveyed logistical service providers in Flanders in Belgium to uncover their views on challenges and opportunities in implementing horizontal coordination. He references Michon, Duineveld and Groothedde (2003), who showed that joint route planning across Belgium and the Netherlands in the case he was investigating saved 30,8% of distance

travelled, combined with a fill rate of over 95% this resulted in a fleet reduction of 50%.

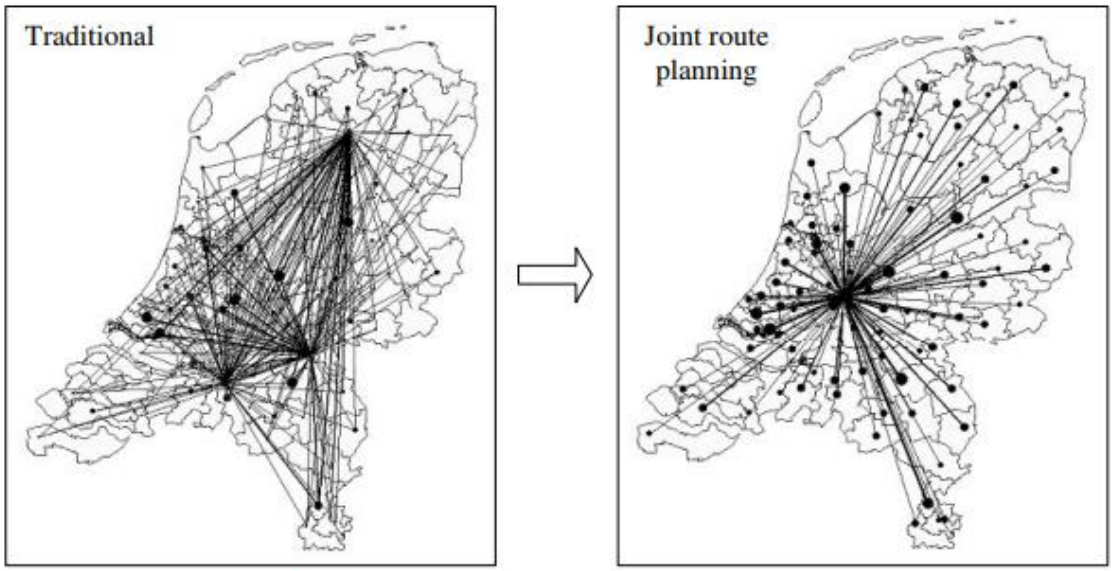


Figure 4-3: Case study: centralisation and joint route planning

FIGURE 4 - (Cruijssen, 2006)

Cruijssen (2006) further conducted a survey of his own, contacting 1537 logistical service providers (LSP) in Flanders and they show that the opportunities associated with horizontal cooperation were *"...widely supported across the Flemish logistics sector."* Further, *"It can be concluded that cooperation on core activities, although it involves the exchange of customer information, is considered to be more desirable than cooperation on non-core activities because of the higher cost savings potential."* And, *"...lead to the conclusion that respondents consider horizontal cooperation to be an interesting possibility for increasing their customer service."* The LSPs expect most issues to occur in relation to bargaining power towards the other partner in the relationship (Cruijssen, 2006). The survey result from the Netherlands showed similar results, however the Flemish LSPs saw more challenges with horizontal cooperation than their dutch counterparts. It is suggested that this is due to cultural differences and that Flemish LSPs would rather learn from first adaptors and experimenters (Cruijssen, 2006).

Frisk *et al.* (2010) studied transportation in the Swedish forest industry and the savings potential seen in that sector from collaborated planning of transport. Their findings indicate a cost savings potential of 5-14%, where five percent is achievable with just better planning in the current organization of firms, while collaboration increases that to fourteen percentages. They highlight how the cost savings could be distributed among the participating firms, and look at a number of sharing mechanisms.

Krajewska *et al.* (2008) looked into collaboration planning in road transport in Germany. Their findings were in accordance with earlier research, that the transporters could save money by collaborating. They suggest using cooperative game theory which has been used in other industries with good effect, such as automotive, retail, and health care.

Verstrepen *et al.* (2009) presents and overview of most of the important motives for LSPs to start horizontal cooperation, both internal and external motives are covered. They find that horizontal cooperation can help companies improve their customer service, better utilization of infrastructure and assets, and serving new geographical regions as well as serving existing regions better. They also describe the life cycle of a horizontal cooperation relationship, where they identify four phases:

1. Strategic positioning
2. Design
3. Implementation
4. Moderation

The results of the paper will according to the authors be stimulating to the cooperative behavior currently observed and that is a useful future development in the sector (Verstrepen *et al.*, 2009).

Schmoltzi and Wallenburg (2011) published a comprehensive overview of motives, structure and performance attributes for horizontal cooperation between LSPs. They based their findings on empirical data from managers of German LSPs and found that 57 percent of them were a member of at least one horizontal cooperative relationship. They found that external market objectives were the largest driver of the initiation of these relationships. Further, the relationships are preferred to be with partners with similar competencies and that the relationships involve strong functional integration. The similar competencies are divided into six dimensions:

1. Contractual scope
2. Organizational scope
3. Functional scope
4. Geographical scope
5. Service scope
6. Resource scope

Contractual scope is to be understood as the formal limits to the cooperation. Organizational scope is the number of collaborating organizations. Functional scope means the activities covered under the cooperation, specifying if it is core activities or not can be a good starting point. Geographical scope is the geographical area covered by the cooperation. Service scope is naturally the services offered by the cooperation, and finally the resource scope referring to the overlaps that exists between the participants of the cooperation.

Observed failure rate for horizontal cooperative relationships were at 19 percent in the study (Schmoltzi and Wallenburg, 2011).

Wang and Kopfer (2013) analyzed and concluded that collaborative transport planning of less-than-truckload freight would benefit all involved parties. Improvement in routing would enable the freight carriers (LSPs) in this scenario to achieve better fill rate and lower costs. They only studied homogenous fleet carriers, but it is according to the authors transferable to heterogeneous fleet carriers.

Further, Verdonck *et al.* (2013)'s article on collaborative logistics from the perspectives of road transportation companies has some very interesting findings. They split the types of collaboration into two types: order sharing and capacity sharing. Order sharing involves sharing or exchanging customer orders to improve their efficiency and profitability. Order sharing can take on many forms:

- Through joint route planning
- Through auction-based mechanisms
- Through bilateral lane exchanges with information sharing and side payments
- Through information secured swapping
- With shipment dispatching policies

Capacity sharing would be the other way of organizing the collaboration put forth by the authors. Where instead of exchanging the order information, they cooperate by sharing the capacity of the vehicle park. Thus, capital investment in terms of buying trucks is spread among the firms involved, and utilization rates kept high. There are two forms of capacity sharing outlined:

- Using mathematical programming
- Using a negotiation protocol

Both types of cooperation are possible and would improve performance for companies involved with road transportation (Verdonck *et al.*, 2013).

Agrell, Lundin and Norrman (2016) explored the varying coordination levels through different types of governance structures in the transportation industry. They identify three types of governance structures:

- No forwarder coordination (direct contracting with shipper)
- Investor owned coordination (price-only contract)
- Carrier cooperative coordination (revenue sharing contract)

They found that cooperative governance can contribute to improved service provisions, reduced service price, improved consumer surplus and improved profit for the carriers. As an example, they used the Swedish trucking industry in conjunction with a Swedish grocery retailer acting as shipper. The different structures' impacts are accounted for and it is found that: "*carrier-cooperative forwarders dominate both regular competition and contract work for investor-owned forwarders for the carriers"* (Agrell, Lundin and Norrman, 2016).

Perez-bernabeu *et al.* (2017) goes into much the same as previous researchers in the field of horizontal coordination do. They analyze the advantages companies can gain by using the strategy, and what challenges are associated with optimization in such instances. They represent an efficient way of reducing costs and promoting environmentally friendly policies. Small sized carriers can achieve greater economies of scale, which would otherwise be outside their reach, thus ensuring their competitiveness in a more and more global transportation market. The biggest challenge they have identified is related to trust issues, as well as the difficulties associated with allocating costs and profits among participating partners. They suggest that due to the complexities associated with the three levels of cooperation: Strategic, tactical and operational; hybrid algorithms should be employed to solve optimization problems in the cooperative relationships. Suggestions are for usage of hybrid algorithms such as: simheuristics and learnheuristics.

Lastly, Verdonck (2017) has an expansive literature review and expands upon Verdonck *et al.* (2013) and adds more types of order sharing in horizontal cooperation. That is to say that the vehicle routing problem is divided further into more properly defined types:

- Order sharing through join route planning:
  - Vehicle routing problem
  - Pickup and delivery problem

- Arc routing problem
- Integer problem

Verstrepen, Krols and Van Breedam (2005) (in dutch) is referred to as distinguishing four key factors in deciding upon a strategical partner:

- Trust & Engagement
- Operational fit
- Strategic fit
- Cultural fit

Trust referring to the conviction that the other partner will refrain from behaving in an opportunistic manner. Operational fit concerns organizational characteristics on a financial and operational level such as company size, structure and the profitability. Strategic fit requires that the strategies of the companies are mutually strengthening and compatible. The final factor is cultural fit, where the corporate cultures of the companies are similar enough to facilitate a stable cooperation.

These factors are compared with the previously mentioned Schmoltzi and Wallenburg (2011). The previously defined "resource scope" is found to be similar to the "operational fit" from Verstrepen, Krols and Van Breedam (2005). With these two articles, and their combined input into partner selection criteria in mind, Verdonck (2017) sets forth five measurable characteristics on alliance performance and conducts a study based on them. The five characteristics are:

1. Number of partners
2. Carrier size
3. Geographical coverage
4. Order time windows
5. Order size

Based on the five characteristics, the author then proceeds to model, calculate and analyze what type of saving and cost allocation that gives the highest benefit to the partners. The results indicate that in terms of **joint savings** for the partners there are four factors to consider. First, the profit grows larger as the number of orders that can be combined increases, such that a larger pool increases the likelihood of finding better-optimized routes. To achieve this, large companies best benefit from finding partners of equal size, while smaller companies should search for larger numbers of equal sized partners. Secondly, the

number of cooperating partners cannot approach infinity, as the marginal benefit of adding an extra member is opposed by the complexity of cooperating with many partners. Thirdly, geographical coverage and/or overlapping customer base seem to be important for the long-term sustainability of the coalition. The larger the service region is, the more likely it is that there are efficiency improvements to be made, and overlap in supply area is large negative driver of average transport distances. Lastly, transporters should try to seek partners for joint route planning which serves orders of different sizes from themselves (Verdonck, 2017).

In addition, when the partners have made a decision regarding what kind of sharing mechanism or allocation technique they are going to use, there are some interesting observations. Regardless of technique, we see that participants who make an effort to follow the joint route plan are rewarded with a higher share of the collaborative saving as opposed to members who do not do their best to participate. On top of that it is worth noting that increasing coalition size from two to five members more than tripled profits, however increasing the number of participants increases the likelihood of a breakdown in cooperation over time (Verdonck, 2017).

In summary, there are significant benefits from sharing orders, but the longevity and total size depend on the participants and their individual characteristics. Partner selection and gain sharing decision being vitally important to be able to gain the benefits (Verdonck, 2017).

In general, the academic literature regarding horizontal cooperation, for land transportation, indicates that there is a significant benefit to all involved parties in participating. The question on how to divide the benefits of the cooperation is debated quite a bit, but a definite best solution is not given, and it depends on the nature of the relationship what the ideal solution is.

4.4 Distribution centers:

There have been many studies over the years about distribution centers. Raufoss Næringspark intends the logistics center to function as a receiving and shipping location for the industrial park. For this reason, we consider the warehouse more a distribution center, rather than a traditional warehouse where storage over long periods is a possibility. This is intended as a high throughput warehouse and fits better with the defining features of a distribution center. Baker (2004) examined the current role of large distribution centers within the U.K., and the extent to which these facilities are aligned to modern supply chain strategies.

"There has been a separation of supply chain theory from warehousing theory, with different books and journal articles addressing each area separately. Even where books do cover both aspects, the different chapters are normally not closely linked" (Baker, 2004).

Since Baker's article covers distribution centers in total, where the limit was set by the size of the distribution centers, there are distribution centers from manufacturing industries covered. However, due to the different goods involved and that the results are not sorted by industry sector, we have trouble finding specific features, if there are any, with manufacturing. It is likely that there will be different challenges due to the different nature of the goods, if we compare with "Food producers". What we however do find in the conclusions of the paper is that the major challenges for the managers of such distribution centers, has been cost control:

"When asked the main challenge that the distribution center operation has faced since opening the most common reply was cost reduction (73% of respondents). In looking ahead over the next three years, the major challenge was viewed however as shorter lead times (64%), while cost reduction reduced to 51% of respondents" (Baker, 2004).

Baker (2004) also notes that the change from "lean" to "agile" in supply chains is something that would pose major challenges to the infrastructure in the supply chains. Since the infrastructure is not adapted to the new system, and that equipment and buildings have very long asset lives.

This covers distribution centers in general, however due to the specific nature of an industrial cluster and the spatial properties thereto we need more specific information. The German automotive industry is an industry closely related to a lot of the production happening within Raufoss industrial cluster. At least two companies have the automotive industry as their most important clientele. In the German automotive industry, supplier-parks have become an increasingly important element of achieving profitability, while maintaining efficiency and control over their supply. In terms of logistical development and implementation in Germany, the automotive industry is important (Pfohl and Buse, 2000).

Supplier parks in general are covered in Morris, Donnelly and Donnelly (2004), while Pfohl and Gareis (2005) compared the concept of a German supplier park with the similar but different concepts of a freight traffic center and a distribution center. The German automotive industry largely maintains a competitive advantage based on differentiation, which entails a high degree of service. What this means for the producers is that they have a very late "freeze" of the final production plan, such that the customer can customize their car very late

up until production start. Because of this, the suppliers have high requirements placed upon them in terms of delivery time and flexibility (Pfohl and Gareis, 2005).

The higher requirements of service and trying to lower costs necessitated that they find savings somewhere in the supply chain. Pfohl and Gareis (2005) discuss two factors discussed to achieve the higher service and lower costs:

"*The structure of the supply network varied by the outsourcing of internal value-added activities to suppliers and by clustering suppliers to a supplier hierarchy.*"

By clustering them together, it is easier to exploit synergetic effects in for example transportation. The supplier park is located close to the car manufacturing plant, between 0 to 10 km away, and there are special transportation systems used for the transport between them.

"The supplier park offers at least shared real estate and buildings, but it may offer other shared goods and services (e.g. shared industrial training, shared canteen, shared maintenance service of equipment, shared transport nodes)" (Pfohl and Gareis, 2005).

Pfohl then further uses the definition of (Stewart and Markham, 1985):

"*The distribution center is a node in the network of the transport-oriented logistics system for the distribution of an industry or trade enterprise or a node in the supply chain from the manufacturer to the retailer or from the retailer to the end-consumer".*

Pfohl makes a differentiation between a central warehouse, and transit terminals. In a central warehouse, inventory is an important aspect, while in a transit terminal, there is no inventory as such, and it is more focused on turnover and further distribution. However, both are covered under the "distribution center" term in their article. Further, the number of cooperative partners in a distribution center is small, because it will often be operated by a third-party logistics provider. Normally it is only one participant, however if there are synergy effects, more companies may be involved. In a logistical park, several distribution centers are co-located (Pfohl and Gareis, 2005).

Howard, Miemczyk and Graves (2006) investigates supplier parks in Europe and if they are imperative to the build-to-order (BTO) production strategy, which has become so prevalent in the car industry, as described by Pfohl and Gareis (2005). They analyze the drivers and barriers to the establishment of supplier parks, and concluded that there is not a single uniform reason in common for all the establishments. It was thought that long supply lines

and long lead times leading to production disruptions, was the chief driver for supplier parks. However, they find that it depends upon many factors; Startup costs and institutional norms appear to be moderating forces influencing the decision, while distance, volume and product mix flexibility are drivers. Higher distances, in this instance longer than 1 km, and a better capability for flexibility gives better capability for BTO. Due to this BTO does not necessitate supplier parks to be built as close as possible to the car manufacturing.

More specifically the distribution center as it is described, and we imagine it working is a co-location of already existing external warehouse capacity, to a location with much higher proximity to the industrial park. This is similar to the question of spatial co-location for transportation companies. It is part of the justification for the establishment of logistical parks, as discussed earlier and the benefits they bring. There are some effects already described that transportation companies can benefit from by co-locating. These are many of the same effects we can see in relation to the establishment of clusters.

Heuvel, Langen, *et al.* (2013b) studied the province of North Brabant with a view to further understand spatial connections regarding logistics establishments. Using the AREC definition of looking at companies' location and concentration with regards to postal numbers, they find that such postal codes attract further logistical establishments. The concentration of logistical companies attracts even more logistical companies, and that these findings are in accordance with evolutionary economic theory. The areas will attract more firms and grow over time. More interesting for our paper is that they find that intermodal terminals of transport are a driver of logistical concentration and that already established logistics companies move to such terminals.

All the above authors are then joined by Broekmeulen in Heuvel, Donselaar, *et al.*, (2013), looking further at location decision and concentration areas with a view at co-locating or not. They created a model to determine the optimal location of a distribution center by considering the possibility of combining transport flows in logistically concentrated areas. The trade-off present at the decision is to weigh the reduced transportation costs versus the extra distance travelled, which primarily depends upon the distance between the concentration area and the customer demand. They find:

"*Numerical experiments based on a square shaped distribution region show that on average it is beneficial to locate in the logistics concentration are, if that area is within a*

distance of 0.15 times the length of the sides of the region from the center of gravity of customer demand" (Heuvel, Langen, *et al.*, 2013b).

Additionally, smaller shipment sizes increases the likelihood of gains from co-locating together with other logistical companies. (Heuvel, Donselaar, *et al.*, 2013)

Heuvel, Donselaar, *et al.* (2013), further proved that co-located logistic establishments might have advantages over non co-located logistics companies. The most important advantage is the better opportunities to exchange transport capacity with other logistics companies. These are relevant for the transporter companies themselves, but also for society as it decreases CO2- and other emissions as well as road congestion. Road congestion was mentioned as a traditional negative driver for co-locating, but the effect was not found to be present. They did however not find any relevant effects of labor pooling for administrative and operational workers, but note that it is possible such effects exists for truck drivers. They note that the effect not found could be related to the population of an area. Co-located companies do not share more information as opposed to non-co located companies, was another finding which goes against what was previously believed to be the case (Heuvel, Langen, *et al.*, 2013a)

Verdonck *et al.* (2016) conducted a case study into the placement of distribution centers across the UK and what effect a coalition between three carrier companies. Based on the case study it is predicted that with a limited number of partners, if chosen carefully, carriers can achieve operational benefit from sharing distribution centers. Smaller number of cooperating firms makes communication easier and is easier on management.

In the fifth chapter of her Ph.D. thesis, Verdonck (2017) expands up the chapters on horizontal cooperation from earlier to include sharing of distribution centers. She looks at the cooperative carrier facility location problem, as a multi-company, two-stage capacitated facility location problem in which multiple sourcing is allowed. The results of the numerical experiments conducted indicate that joint optimization of the location of a distribution center could save almost 25% of costs and reduce the number of kilometers driven. That saving however does heavily depend on the choice of partner in co-locating the distribution center. Complementarity is important and partners who differ in terms of distribution ownership and demand distribution will gain on average 97% more savings as opposed to a coalition of equal partners. The experiments suggests that a limited number of partners, when chosen carefully, can reap the participants' significant benefits.

4.5 Supply Hubs & Cluster Supply Chains

Combining the previous topics of literature review together leads us to have to deal with the concept of Supply Hubs. Barnes *et al.* (2003) define the supply hub as follows:

"*A supply hub is a location generally close to a manufacturer's facility where all or some if its supplies are warehoused with the agreement that the materials will be paid for only when consumed. Supply hub is an innovative strategy employed by especially the electronics industry to achieve cost reduction and improved responsiveness".*

Their paper is a foundational work for the academic research into the strategy of having a supply hub. The variant they put forward is in relation to a single company and how they would use the supply hub in relation to their production. Responsibility for the goods and the ownership of it is in the hands of the different suppliers, while the change of ownership happens when the materials enter the manufacturer's production line, or when the materials exit the hub towards the manufacturer, note however that this can vary according to the authors. In some instances, such conditions specify that there is a "freshness clause" in the contract, such that should materials stay in the hub for too long, then the manufacturer assumes ownership of the materials. This is done to entice the suppliers to agree to the system, despite skepticism due to them suspecting that they'll be owning the inventory for too long (Barnes *et al.*, 2003).

The default position as of the article is that the supply hub is owned and ran by a third-party logistics operator. They are responsible for re-ordering of goods, but there is a backup in the form of an information system, that will automatically order more material should the stocks approach a minimum level. This rarely happen, as the third-party logistics provider (3PL) is normally successful at managing the inventory. Lastly, for this concept of a supply hub to be a success, the flow of information is as vital as the flow of materials. Friction in information will lead to bullwhip effects manifesting in the supply chain (Barnes *et al.*, 2003).

Further linkage between Porter's cluster theory and supply chain management was done by Tom DeWitt, Larry C. Giunipero and Horace L. Melton. They examined the linkages between the theories by looking at the Amish community in Homes County, Ohio, USA. The Amish production of furniture in their insular and self-dependent community creates a unique environment, where there is a large pool of skilled woodworkers, deep relationships exists, and a close-knit social network is already in place. All these factors combine and transfer into the workplace which gives the Amish furniture companies a competitive advantage based on

the relationships, core competencies and close proximity, all in accordance with the cluster theory. The authors find a positive impact on supply chain management practices based on cluster characteristics, and that this case is a good illustration of the linkage between cluster theory analysis and supply chain management (Dewitt, Giunipero and Melton, 2006).

The connection between supply chain management and cluster theory gives ground to a new concept as suggested by Yan and Wang (2008) in their paper "Supply chain management and clusters – a case study on Guangdong automobile clusters". This paper illustrates the linkages between the two concepts and suggests that there are performance benefits to concentrating supply chain participants and building strong inter-firm relations. Relocating firms should analyze other companies in close proximity to their new suggested location, and see if they are moving to a location with cluster characteristics. These clusters can improve the performance of both the firm itself and its supply chain, and for that reason the firms should look to primarily focus on local resources when selecting supply chain partners (Yan and Wang, 2008).

Han (2009) is for the most part in agreement with Yan and Wang (2008) and concludes that clusters can contribute to improving the supply chain due to symbiotic effects and allowing for common development.

The concept of cluster supply chain is further explored and explained by Huang and Xue (2012), however their focus is on small and medium sized enterprises, which makes the findings relevant to some of the companies in our case, but not all of them. The European commission defines small and medium sized enterprises thusly:

TABLE 1 - EU'S SME DEFINITION (*What is an SME?*, 2019)

Company category	**Staff headcount**	**Turnover**	or	**Balance sheet total**
Medium-sized	< 250	≤ € 50 m		≤ € 43 m
Small	< 50	≤ € 10 m		≤ € 10 m
Micro	< 10	≤ € 2 m		≤ € 2 m

Li *et al.* (2008) modeled the effect of having a supply hub with bill of materials, and showed that the supply hub can significantly reduce total cost in the supply chain. This cost saving

effect was stronger nearer to upstream firms. At the same time, a supply chain is less vulnerable to bullwhip effects than a supply chain without a supply hub.

Li *et al.* (2009) further expanded their model to allow for multiple supply hubs, and showed that supply hubs lower the cost of the entire supply chain, despite not reaching the optimal scale in terms of transportation and inventory. The bullwhip lessening effect is maintained from the earlier model and is still present.

Tolossa *et al.* (2013) concludes their review of available literature regarding supply chain management and industrial clusters stating that the research in this area is in its infancy.

A closely related concept which Tolossa *et al.* (2013) did not account for in their review article is the supply hub in an industrial park known by the acronym (SHIP). The United Nations industrial development organization (UNIDO) defines an industrial park in the following way:

"*Industrial parks are planned and developed according to a comprehensive plan with provision for roads, transport and public utilities for the use of enterprises (the physical infrastructure). More sophisticated industrial parks offer a wide range of common facilities and support services, such as consulting, financial services, training, technical guidance, information services, joint research facilities and business support services to satisfy the corporate and technological needs of tenants"* (UNIDO, 2012).

The concept is an extension of the supply hub, and is more advanced, yet more specific. The expansion was conducted by Qiu, Huang and Qu (2010) and involves looking at the same type of supply hub, but seeing it as part of an industrial park, such that more than one company can use the supply hub. In that way, the storage space is available for all companies. The view of the supply hub is also expanded in that it is not just raw materials and components that are kept in the hub, it can also store finished products. SHIP therefore acts as a replacement or substitute for warehousing space for all the companies in the industrial park. This will result in land savings in terms of construction, and manufacturers will save on inventory carrying costs, economies of scale and management costs. This comes about because the manufacturers only rent the space they need themselves, and adjust their demand according to their production, such that space that would be idle, were it tied to a single manufacturer is now available to other manufacturers. As a result, the total backorder costs could be reduced. They only must pay for the place/room/area they rent instead of spending money on equipment, employees and systems for holding inventory. The saved costs could

then be put towards improving core capacities associated with production. It is thought of as a very integrated process, where the warehouse is run by a third-party logistics operator.

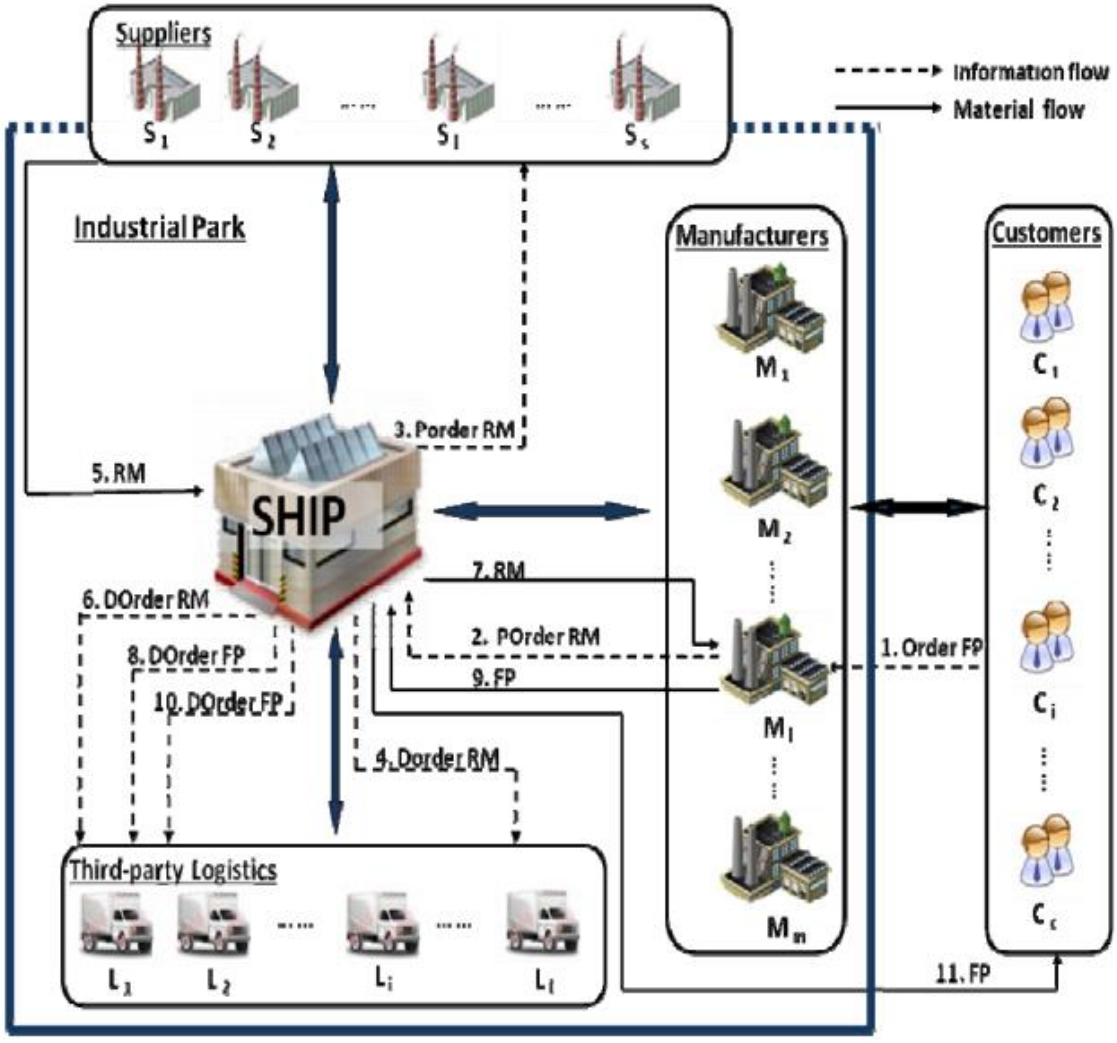


FIGURE 5 - (Qiu, Huang and Qu, 2010)

It is concluded that the supply hub concept is promising for industrial parks to adopt.

Qiu and Huang (2011) looks at the effects of pooling effect that comes from warehouse consolidation under demand uncertainty. The results indicate that there is not always a beneficial effect when seen across the entire supply chain, as it depends on the demand pattern. However, all companies can improve their performance across all demand patterns with SHIP. When the demand patterns seen in the companies are complementary or identically volatile, then there are significant cost savings for the companies.

Qiu and Huang again explores the industrial park model in 2013, this time to explore if the SHIP will help the distribution process in consolidating shipments (Qiu and Huang, 2013). The results show that freight consolidation through the SHIP is possible and that it could

result in better performance for the entire industrial park. The improvements are greater when the number of suppliers and manufacturers increases; in addition, the transportation parameters have a significant influence on the cost levels of the park. Further, larger vehicle capacity and higher fixed transportation costs would mean that the improvement over higher fill rate would be greater. Then finally, higher holding costs on the part of the manufacturers finished goods would lead to higher cost savings, while holding costs of raw materials and varying the fixed production costs did not influence the performance.

The next aspect studied is the adaptions that multiple manufacturers and a SHIP do in terms of storage pricing, replenishment and delivery schedules by Qiu and Huang (2013). The model is expanded such that the SHIP has a competitor outside the industrial park, the public warehouse (PW). They find that dynamic storage pricing instead of constant pricing improves the profit margin for the SHIP, and that this change is affected by costs related to inventory holding and transportation. The level of profit is significantly dependent upon the delivery charge level of the PW and the holding cost of the SHIP, while the delivery charge of the SHIP seems to be less important. The SHIPS profit margin seems to be in opposition to the manufacturers so the management of SHIP should be aware of increasing their charge too much. The demand risk mitigation results are in agreement with (Qiu and Huang, 2011).

The dynamic pricing strategy is further explored by Qiu *et al.* (2015) who through bi-level programming found that it is a viable strategy for the SHIP. They distinguish between smaller and larger companies and find out that the pricing scheme has different impacts on the different companies, dependent upon size. Large-scale manufacturers are not affected by increased delivery charges, while smaller companies are more affected. Above a certain limit however and the SHIPS's profits are going to decrease. A surprising finding is that the SHIP can increase demand for storage space by large manufacturers when setting a high delivery charge when compared with the PW. Moreover, they can increase demand for storage space by small-scale manufacturers by setting their storage rent cost lower than the PW.

The next two steps are happening concurrently in expanding the SHIP model: Firstly, allowing milk-run logistical routes to be used by the SHIP operator or third-party logistical operators. Secondly, a further expansion of the model in terms of complexity, while not taking into account milk-run logistics. Milk-run logistics in the SHIP context start with Qu *et al.* (2014) they describe how by using RFID technology, the companies in the industrial park can integrate their small-batch materials handling into a shared system. They find through their model that information sharing and the frequency of that sharing could be improved by

instituting RFID technology and that RFID greatly reduces the inventory levels of the company, increases vehicle loading rates and the allocation of logistical resources.

Qiu and Huang (2016) found that vehicle capacity does not affect the performance of manufacturers and SHIP when it is sufficiently large. A lower delivery cost will always result in more profit for the SHIP, while giving the manufacturer higher total costs. This is due to manufacturers not adapting their replenishment and delivery timing no matter how the holding cost rate changes, as long as it is significantly low. The most interesting finding is however, that the transportation service with milk-run logistics could lead to benefits for both SHIP and manufacturers; the magnitude is dependent upon supply chain factors. Qu *et al.* (2015) suggests using IoT-technology (Internet of Things) to achieve JIT (Just-in-Time) with a milk-run type process, in an industrial park.

The further expansion on the SHIP model springs from Kayvanfar *et al.* (2016) where the new model is defined as a Supply hub in Industrial Cluster (SHIC). It considers the companies in the industrial cluster to be SME's. The difference in this model from the SHIP as we have seen develop over the last articles is that it has:

1. Capacity constraints
2. Freight consolidation
3. Vehicle capacity
4. Backlogged demand
5. Supplier's capacity

"Freight consolidation is more realistic when different vehicle types are considered, not just a single or homogenous type. The vehicle capacity is important in practice, which was ignored in Qiu and Huang, since it is assumed to be sufficient enough for any delivery. The demand is allowed to be backlogged, since in reality the customers' demands might be better economically backlogged (with respect to the balance between backorders and holding costs). Each supplier has a limited capacity for supplying the raw materials. Besides the above mentioned differences, the 3PL is also assigned with a larger scope of responsibilities to collaborate with manufacturers, where it can balance the backorder and holding costs of inventories at SHIC" (Kayvanfar *et al.*, 2016).

The advantages gathered from this organization is in line with what we have seen earlier, but bears repeating:

1. Land utilization through integration of previous manufacturer warehousing

2. Information sharing, both vertically and horizontally
3. Cheaper shipping consignments through freight consolidation
4. Reduction of capital investments into storage space for the SMEs because of the SHIC's storage capacity
5. Just-in-Time purchasing is possible due to the frequent deliveries from the SHIC to the manufacturers.

With these opportunities in mind, the point of the model is to minimize total logistics costs. The results of the modelling are that the proposed model of SHIC is superior to the classic way of organizing an industrial cluster, where there is no central warehouse, and no freight consolidation in the cluster. The same scenario is solved with other mathematical means in Kayvanfar *et al.* (2017). They expand the name to include demand such that the proposed model is a SDHIC (supply-demand hub in industrial cluster). They use a stochastic approach, but come to similar conclusions:

"*Based on the results, some managerial insights can be gained: (1) by increasing the holding cost of materials and the holding cost of products, the performance of the proposed model is enhanced compared to the classic model; (2) land utilization is at its maximum level when the SDHIC is employed, i.e. the higher the holding cost, the greater the total logistics costs that can be saved; and (3) among the four versions of the BD algorithm developed for the problem at hand, the proposed BA-VI-MC has the best outcome"* (Kayvanfar *et al.*, 2017).

Finally, the newest addition to literature with regards to the specific circumstances we are looking into in our case, comes from "A practical supply-demand hub in industrial clusters: a new perspective" by Kayvanfar *et al.* (2018). It builds on the two previous articles, and seeks to minimize total costs, but adds a *"linear relaxation-based heuristic"* to make the computation go easier. In addition, the models are ran with data from a real life cluster situation and then the results are analyzed with regard to sensitivity. The results indicate that the total costs decrease from the start with the implementation of SDHIC, up until a certain point where the demand for increasing capacity is lacking and increasing the storage space simply increases fixed costs. In agreement with earlier articles and other models, the results indicate that establishing the SDHIC and merging the storage capacity of the industrial members can lead to cost savings. There is a positive effect from collaboration between the 3PL and the SMEs. The required communications can be seen as an optimization of communications in the supply chain, and that merging the planning of supply and demand

goods through the supply chain in a centralized manner can lead to benefits for the entire supply chain. The case study numbers ran in the article suggests that for that specific instance an optimal warehouse capacity for the SDHIC was 44,000 m^3. Transaction costs are taken into account and is diminishing SDHIC as an option; however, the effect is smaller than the positive effects, thus leading the SDHIC to be a positive addition.

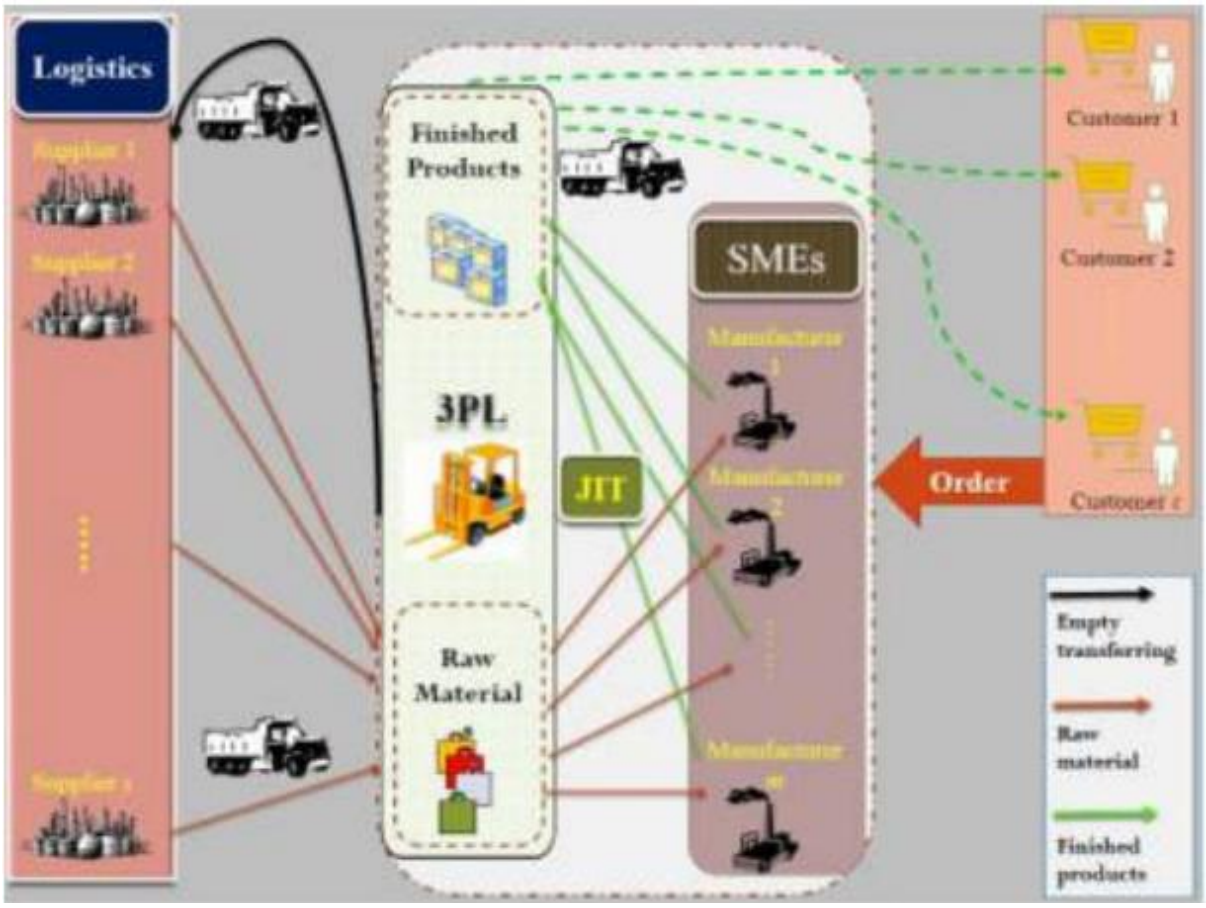


FIGURE 6 - KAYVANFAR ET AL. (2018) - FIGURE 1A

What we can gleam from this fusion of industrial clusters and supply chain management is that there is a limited supply of articles exploring the possibility of merging the two disciplines. Academic articles do however indicate that there are possible advantages to exploit by the building of the new logistics center in Raufoss Industrial Park.

5 Data and Methods

This chapter clarifies which research design, data gathering methods and the quality of research we employed in our thesis.

5.1 Research Design

Following the method set forth in Cresswell (2013), we should first analyze our paradigmatic view of the research. Firstly, our philosophical assumptions with their implication for practice

- Ontological
- Epistemological
- Axiological
- Methodological

The ontological issue relates to the nature of reality and its characteristics.

"When researchers conduct qualitative research they are embracing the idea of multiple realities. Different researchers embrace different realities, and so do the individuals being studied and the readers of a qualitative study" (Cresswell, 2013).

The researchers conducting a qualitative study want to find out about these different realities and report on them, embracing the evidence in multiple forms from the different actors and individuals covered by the study.

Concerning epistemological assumptions, the conduction of a qualitative study must attempt to come as close as possible to the actors or individuals being studied. This means that the evidence assembled is based on the individual's views of their subjective experience of their reality.

Axiological assumptions mean that the values the researchers hold will influence the work they put into a study, but that qualitative researchers make their values known.

"In a qualitative study, the inquirers admit the value-laden nature of the study and actively report their values and biases as well as the value-laden nature of information gathered from the field. We say that they "position themselves" in a study" (Cresswell, 2013).

Methodologically is perhaps the most known difference between a quantitative and qualitative study or research. In qualitative studies, there is an inductive logic, such that the data comes first and informs the theory and the researcher's perspective. It is emerging and is

shaped by the experience of the researcher in collecting and analyzing the data (Cresswell, 2013).

Marshall and Rossman uses the example of a doctoral student from Malawi when discussing cultural differences between the researcher and the subjects in a research perspective (Marshall and Rossmann, 2006). Potentially, this could be a tripwire for our thesis, since the differences in culture between a traditional industrial cluster and the culture in academia can be significant (Maeda, 2019). This illustrates the difference between the two cultures in the United States, probably there is a similar chasm between Norwegian industry and Norwegian academia. Since one of the researchers have experience working in this specific industrial cluster, hopefully this can be a softening factor, allowing for smooth work and cooperation between the companies and the researchers.

Our master thesis will be an applied, deductive, qualitative and descriptive case study thesis.

We have a current and a future uncertain situation that we will be descriptive about, based on a deductive process of evaluating plausible effects by changing from one situation to the other for the different actors impacted.

It will be a qualitative process due to the nature of the research. The future hypothetical situation has no empirical data to give us, thus we can do no quantitative research on it. With this in mind, we need to try to uncover the plausible things that are going to happen in the future scenario. To accomplish this we will use the qualitative method of interviewing personnel affected by the change and what plausible effects they see. The combined answers from the interviews will potentially give us some form of aggregated groups within the sample size and their opinions on the new system. This naturally follows a relativistic ontological approach, where reality exists only as we perceive it, and in this instance, reality only exists, as our interview subjects perceive it. What they perceive is of benefit and what challenges exist is of utmost importance with regard to our research. This leads to an interpreted relation to the real world, as every interview subject has their own reality they perceive and could be very different to the other subjects, as it is socially constructed.

5.2 Data

5.2.1 Participants

Our interview subjects will be the logistics managers of the major companies in the industrial park, as identified by Multisped. They were identified as the proper subjects based upon their

participation in the “Operativt Forum” or operational forum, a working forum composed of representatives from the major companies in the park. They discuss operational issues of the industrial park, such as snow clearing, and the sharing of those costs, and the sharing of costs because of older pollution and contamination. In one instance, the person who were in this forum determined that another in the company was more fitting for the interview.

5.2.2 Observation

“Observation entails the systematic noting and recording of events, behaviors and artifacts (objects) in the social setting chosen for study” (Marshall and Rossmann, 2006, p 98).

We intend to spend some time during our thesis observing current practice for the varying situations that can be influenced by the change in situation. Observing the material flow for the companies today is of interest in determining if, or how the situation will change if the logistics center is built. Likely, the material flow will change for the companies, and this could have many effects that partially can be predicted based on a clear understanding of the current situation. Thus, observing the current situation is of importance to determining future effects.

5.2.3 In-Depth interviewing

We would like to hold the interviews in an informal conversational way, to allow the interview subject to share their knowledge of the situation as they see it. Having them share their own thoughts, structured by their own mind and in their structure and framing, should allow us to uncover information that can be hidden if the interview is more structured.

“The participant’s perspective on the phenomenon of interest should unfold as the participant views it (the emic perspective), not as the researcher views it (the etic perspective)”(Marshall and Rossmann, 2006, p 101).

There will however need to be some systematization in the interview process as we have planned to interview many subjects, which could lead to very disparaging interview answers, not covering the information we need, or there is too much unrelated information in each interview making them long and hard to work with.

“The most important aspect of the interviewer’s approach is conveying the attitude that the participant’s views are valuable and useful”(Marshall and Rossmann, 2006, p101).

Interviews have particular strengths and weaknesses inherited in the method. They yield data in quantity quickly. When more than one person is interviewed, the information becomes more varied, trading depth for breadth (Marshall and Rossmann, 2006, p101). It's also possible for the interviewer to immediately clarify and contextualize the content to the interviewer if there is some form of ambiguity in either the question posed, or the answer given. Give and take is reasonable and expected in the setting.

As for limitations and weaknesses they include, but are not limited to, the following points in no particular order. Every interview involves a lot of personal interaction and this brings some challenges to the table. Cooperation is essential, but the interviewee may be uncomfortable sharing or unable to share the information the interviewer is trying to ascertain. In extreme cases, this could mean the entire interview is a waste of time and can be scrapped entirely. Further, the questions could be asked in such a manner that the answers you, as the interviewer, get are very short, often in the form of a simple yes or no. This is not helpful in an interview setting, where we often would want a flow, and a continuous conversation to allow the interview subject to fully express themselves. A situation where the questions are answered in a yes/no fashion can lead to awkwardness and a want for the interview to be over as soon as possible for both sides of the interview. The reason for questions being answered in such a way could be down to:

- The phrasing of a question by the interviewer.
- Lack of knowledge on behalf of the subject to be able to answer.
- The interviewer showing clear sign of not understanding the related case
- Any other non-related situation effecting any of the involved parties like personal mood at the time.

In such cases however, there is hopefully something that can be learned from the process and better prepare the interviewer for a similar situation in the future. Becoming a better interviewer can be achieved by studying the theory; however, it also requires you to learn from experience as with anything else in life.

5.2.4 Background information, context and documents

We are going to gather background information on the industrial park and the involved parties in the specific situation we are studying. Factual knowledge about the situation that is going to be studied is important to know how things used to be, and how the culture of the situation can influence the rest of the work.

"*Historical context is almost always of interest, but so are cultural and physical contexts. Other contexts often of interests are the social, economic political, ethical and aesthetic"* (Stake, 2008, p127).

If the culture in a given location is skeptical of change and innovation, then a large change to the way business is done can be seen with hostility. If researchers are then not aware of that cultural hostility, it can be difficult to get access to and gather the necessary information for the given project. If the information gathering involves interviews, the researcher could be surprised by the openly hostile attitude, and thus receive poor information leading to a generally poor project. Contextualizing the research question and any hypothesis with the regards to the specific case we are faced with is also important. If we do not contextualize it, we can reach wrong conclusions or make recommendations that conflict with the actual situation. Both background and context can often be determined through the analysis of written material, as well as other forms of material.

"Probably the greatest strength of content analysis is that it is unobtrusive and nonreactive: It can be conducted without disturbing the setting in any way"(Marshall and Rossmann, 2006, p108).

There is however a potential weakness that the analysis rests on the inferential reasoning of the researcher. That is to say that all analysis of this type is done by the researcher interpreting the materials and the conclusion of the individual parts of the whole could be different if there were another researcher doing the analysis. To negate this problem Marshall and Rossmann, 2006 says that:

"Care should be taken, therefore, in displaying the logic of the interpretation used in inferring the meaning from the artifacts"(Marshall and Rossmann, 2006, p108).

5.2.5 Translation

We will be conducting the interviews with the logistics managers from the different companies in Norwegian. The reason we want to do this is that we are confident that we will get longer and more fulfilling answers if done in the native language of the managers. Compare this with everyone involved having to translate everything they are going to say into English. If someone has a less than fluent grasp of English, then we can expect them to use simpler language and they will then have issues explaining complex situations and systems involved with production and logistics for their specific company. We can also assume that they are not a uniform group with relation to English knowledge and will therefore have

some variance, which would then lead to the content of each interview varying a lot making comparisons of content, meaning and intention difficult.

"Clearly the issues associated with translating from one language into another are much more complex than transcribing because they involve more subtle issues of connotation and meaning" (Marshall and Rossmann, 2006, p111).

We believe therefore that there is a benefit of conducting the interviews in Norwegian to have a better grasp of the intentions of the answers. The comparison between the different answers can also be done in Norwegian, and then we can translate the aggregated data and conclusions from the interviews into English.

5.3 Methods

5.3.1 Case study

Gerring (2007) operates with the following definitions for case study:

"Case connotes a spatially delimited phenomenon (a unit) observed at a single point in time or over some period of time. It compromises the type of phenomenon that an inference attempts to explain" (Gerring, 2007).

"A case study may be understood as the intensive study of a single case where the purpose of the study is – at least in part – to shed light on a larger class of cases (a population)" (Gerring, 2007).

Our thesis is a qualitative case study, which has certain implications for how to interpret our conclusions and their wider implication. The case study has suffered from a slightly controversial reputation, as can be seen by looking at early writing on the subject. Primarily it has been attacked for being a qualitative method, and the strengths and weaknesses that entails. Miles (1979) attacked qualitative data as "an attractive nuisance". Initially admitting that there are many reasons why qualitative data collection methods are alluring, by mentioning many reasons, (some of which are quoted below):

"*..they are rich, full, earthly, holistic, "real"; their face validity seems unimpeachable; they preserve chronological flow where that is important, and suffer minimally from retrospective distortion; and they, in principle, offer a far more precise way to assess causality in organizational affairs than arcane efforts like cross-lagged correlations (after all, intensive fieldwork contains dozens of "waves" of data collection, not just two or three)"* (Miles, 1979).

Then he moves on to the weaknesses and problems of qualitative data:

"*Collecting and analyzing the data is a highly labor-intensive operation, often generating much stress, even for top-quality research staff. Qualitative fieldwork is traditionally demanding even for the lone fieldworker, accountable only to the data and his or her discipline; when several fieldworkers' effort must be coordinated, as is more and more typically the case, much energy is required to make data systematically "comparable."* (Miles, 1979)

His criticism is validated by Yin (1981) who agrees that there are problems associated with qualitative studies. Miles' main problems, Yin summarizes as the following:

(a) Within-case analysis was "essentially intuitive, primitive and unmanageable"

(b) Cross-case analysis was "even less well formulated than within-case analysis"

(c) Respondents objected to case study results much more frequently than to survey results, either threatening the research team with legal suit or attempting to rewrite history in order to appear more favorably in the case study

In conclusion, Miles states that, without renewed efforts at methodological inquiry, "qualitative research on organizations cannot be expected to transcend story-telling" (Yin, 1981).

Yin responds to the criticism by pointing out that, case studies can be both qualitative and quantitative, and that qualitative studies do not have to be ethnographic studies or participant-observation. Further, a case study is more representative of a research strategy, which has the distinguishing characteristics of trying to examine:

"*A contemporary phenomenon in its real life context, especially when the boundaries between phenomenon and context are not clearly evident"* (Yin, 1981).

Further, he responds to most of the criticism put forward by Miles and tries to show that case studies can be conducted systematically. Yin does however agree that there is a need for further improvement in case study research. which is evident by the work done by Yin (1994), Miles and Huberman (1994), Stake (1995), Yin (2008) and Yin (2018).

Another defense of Case studies of note is Flyvbjerg (2006), who clarified the five misunderstandings regarding case studies;

1. *General, theoretical knowledge is more valuable that concrete case knowledge*

2. *One cannot generalize on the basis of an individual case; therefore, the case study cannot contribute to scientific development*
3. *The case study is most useful for generating hypothesis; that is, in the first stage of total research process, while other methods are more suitable for hypothesis testing and theory building.*
4. *The case study contains bias toward verification, that is, a tendency to confirm the researcher`s preconceived notions.*
5. *It is often difficult to summarize and develop general propositions and theories on the basis of specific case studies* (Flyvbjerg, 2006).

5.4 Quality of research

Yin (1994) cites Kidder and Judd (1986, p26-29)'s four criteria for judging the quality of research designs:

5.4.1 Construct validity

> *"Establishing correct operational measures for the concepts being studied."*

According to Yin (1994) this is an especially problematic area for case study research. Our thesis focuses on the opinion of managers towards certain concepts we have developed as part of our model. To account for these issues, described by Yin; we use multiple sources of evidence, not just interviews, but also observation, background information, text documents and a focused interview group. These sources together puts our thesis on a solid foundation in terms of construct validity.

5.4.2 Internal validity

"(for explanatory or causal studies only, and not for descriptive or exploratory studies): establishing a causal relationship, whereby certain conditions are shown to lead to other conditions, as distinguished from spurious relationships"

As our thesis is a descriptive case study, this is not applicable.

5.4.3 External validity

Establishing the domain to which a study's findings can be generalized

Our thesis has several elements making the generalization of our findings a bit challenging; firstly, it is a special geographical case where there are no alternative modes of transportation. Secondly, it concerns an industrial park located in Norway with the implications that has for

the applicability to other cases in terms of costs, culture and attitudes. Thirdly, one of the researchers has intimate knowledge about working inside the industrial park, while the other has no experience, such that the combined view is complex and is able to see the case from many angles. The interview process will have higher validity due to that combined perspective. Fourthly, the generalization will likely be very specific to instances where there are industrial parks or industrial clusters in very close geographical proximity. Given certain similarities, we should be able to generalize to other cases based on this thesis, indicating good external validity.

5.4.4 Reliability

Demonstrating that the operations of a study – such as the data collection procedures can be repeated, with the same results

Our thesis' reliability is lowered by several factors. Firstly, the previous operational knowledge about the industrial activity of the industrial park will influence how the interviews are conducted. Previous knowledge makes it harder for a researcher to conduct the same study and get the same results, when it comes to the interview process. Additionally, due to the number of interviews, and their length of at least an hour apiece, transcribing the interviews become a massive task. However, if the number of interviews had been decreased, the utility of the assignment would be lowered for Raufoss Næringspark and Multisped. Comparing these viewpoints against each other we elected to maintain the number of interview subjects, and not to transcribe the interviews. This lowers the reliability, as retracing our steps beyond the interview guide becomes more difficult; however, we decided that the increased validity and utility would be of sufficient value to justify that choice. Additionally, the interview guide reflects that there is a certain amount of previous knowledge on behalf of the researchers, such that we have not written the questions explicitly beforehand. Therefore, the interview guide is dependent upon the researcher conducting the interview.

6 “7-Step” Scale of Integration Model

Based on the theoretical research that we have done; we decided to develop a scale of integration model, illustrating what form, the logistics center could take. We choose to modulate this scale like a staircase. You need the first step to take the next, and this gave the best visual interpretation of the model and made it easier to understand the theory. From the non-committed regular warehouse in close proximity to the customers, with all the benefits that has, to the very integrated concept of a SDHIC as described by Kayvanfar *et al.* (2018). With this scale in mind, we have more precise objectives for what we must try to uncover in the interviews. The third research question will be part of this process, as we suspect that there are differences between what the different companies could potentially get out of the logistics center.

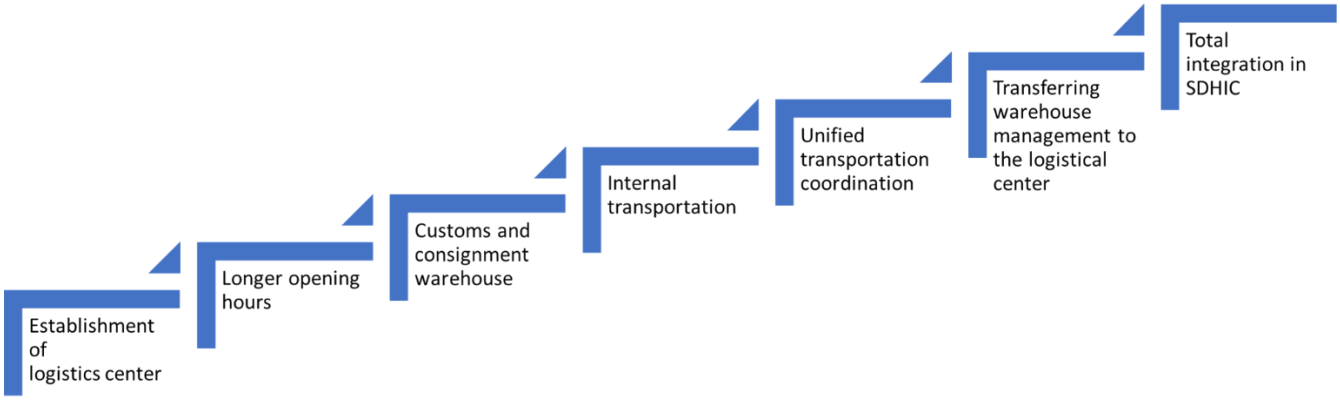


FIGURE 7 - SCALE OF INTEGRATION MODEL (OWN MODEL) (SEE APPENDIX 2 FOR LARGER SIZE)

6.1 Step 1: Establishment of logistics center

The logistics center is established as a regular warehouse facility, which will compete with other warehouses in proximity to Raufoss. This is the barebones solution to the issue of a lack of warehouse space in the general area. In this step, there are no advanced concepts in the warehouse nor any company-specific adaptions. It is purely a simple warehouse intended for the reception and shipping of goods to and from the companies in the industrial park. This means that the running of the warehouse is done the old-fashioned way, and there is no computer integration towards the potential customers, for example. It is just an expansion of “stupid” warehouse space. The park would still own the warehouse and run by or in association with Multisped as described in the business case.

LRN and Toten Transport does not see this warehouse as a direct competitor. They are confident there will be enough demand for warehousing and transportation even if the logistics center is built. Besides, both companies have ownership interests in Multisped.

6.2 Step 2: Longer opening hours

To achieve longer opening hours, there must be established a new logistics center beforehand. The industrial park currently allows for entry by trucks in regular opening hours: 07.00 to 16.00. The companies that run their production 24 hours a day may have exceptions that allow for loading and unloading of goods outside these hours, but these are exceptions. With the expanded logistics center opening hours, all companies can allow for both pickup and delivery outside production hours. This extension of opening hours is unrealistic to achieve while all the different companies run their own warehouses. The costs per company would be substantial; however, when centralizing this capacity, there are economies of scale. The increased opening hours would allow for greater flexibility in both shipping and receiving goods, meaning that the transporters would be less dependent upon arriving in a time interval. With this flexibility, likely comes a better usage and exploitation of drivers' time, such that their costs are lowered for the transportation companies. With this lowering of costs, the feasibility of running transportation companies increases. Over time, this feasibility and better flexibility should increase the competitiveness of local transporters, and make them capable of offering lower rates, thus decreasing the transportation costs of the production companies in the industrial park.

6.3 Step 3: Customs and consignment warehouse

This may very well be one of the more interesting aspects of the whole project. A number of companies in the industrial park are struggling with their capital-binding situation. They currently have excessive inventory levels, and are looking for ways of reducing the capital tied in inventory (Karlsen, 2019). The capital-binding situation is sub-optimal due to the fact that the closest customs warehouse available to the firms, is located in Oslo. This means that running supplies through customs takes time. They declare larger batches, for example, a weeks' input for production at a time, which increases the capital tied in inventory. The capital is tied in inventory, but does not add value to the company. Declaring large batches is necessary to allow for greater efficiency in transportation. With the establishment of a customs warehouse at the new logistics center, the point of ownership transfer could be moved to Raufoss. Thus, decreasing the capital tied in inventory and increasing throughput of

goods. This scenario is an interesting development for certain firms within the park. However, some may not find much benefit in this, such that it is interesting to see which firms will be positive towards this step.

The companies that do not import raw materials could see a benefit with the consignment warehouse. Allowing their suppliers to have a consignment stock of materials for production could allow them greater JIT-adaption and lower the capital tied in inventory. Additionally, it would open up new possibilities in transportation management and planning. This allows for a cost decrease through either greater one-time pick-ups, or smaller pick-ups with higher frequency. If the fill rate of the transporters is increased through this, then the costs would go down, and they could offer lower fares.

It is unlikely that there would be any interest in a consignment warehouse for goods produced in the industrial park. Most of the companies involved in the park produce goods for orders. Utilizing the Make-to-Order (MTO) manufacturing process, there is no need to maintain such a stock (Kolisch, 2001, p.12). Those companies that produce to consignment stock today, have the consignment stock close to their customers, and moving that to Raufoss, is unrealistic.

6.4 Step 4: Internal transportation

This concept is partially implemented in the industrial park. This system is similar to the system laid out by Qu *et al.* (2014). Two companies are running their own internal transportation today. One of these also employs an external contractor. Both companies are responsible for conducting transportation between several buildings with specialized transportation equipment based on the production of that company. Currently, it is composed of tractors with special trolleys fit to the needs of that company, while the other uses forklifts for their internal transportation. This system can be of vital importance to learn how to conduct such a logistical system on a larger scale, with more companies, with different needs.

We think some companies in the industrial park will participate in this step when combined with other steps, while others see this as an absolute necessity regardless of the step in the model chosen.

One clear point is that the current adaption is not scalable to the future needs for the companies in total, and changes have to be made. Equipment, communication, and other systems would need upgrades depending upon the companies involved. To run an automatic replenishment order system, based upon usage and forecasted demand should be the goal of

this step. In addition, automated pick-up systems for finished goods going to the logistics center is also a desirable part of this step.

6.5 Step 5: Unified transportation coordination

The next model step is for the companies to commit to use Multisped as the single transportation planner. This means that all transport to and from the industrial park is done through Multisped. With this increased responsibility, the theoretical foundation for this thesis indicates that there are benefits to the transporters. Due to them having a higher fill rate and less distance covered without a load (see 4.3 Horizontal cooperation). This lowers the cost of transportation, and will in turn allow them to offer lower rates and better service to their customers. These symbiotic relationships should make continued business operations in and around Raufoss easier. Partially this is due to the geographical location of Raufoss, which is far away from alternative transportation means. A mutually beneficial relationship will in the long run have a positive impact on everyone involved.

6.6 Step 6: Transferring warehouse management to the logistics center

Step 6 implies that the logistics center deals with the organization of the warehouse and the levels of inventory held for the production of the companies in the industrial park. They deal with re-order points, safety stock levels, and delivery planning for materials based on the manufacturing firms' production plans. Today the companies themselves are responsible for re-ordering, how much safety stock they need, and forecasts. Giving away this responsibility to the logistics center is according to the academic research; better at enabling JIT-production, weaken the bullwhip effect for the companies involved and allowing for data system integration with the positive synergetic effects. These synergetic effects are generally found in terms of transportation planning. The logistics center will primarily deal with standardized items or goods that are used regularly. Irregularly used goods, needs ordering in accordance with the production plan for each individual company, and this is not something the logistics center can handle on their own in this step.

When building upon earlier steps, this should further improve efficiency in transportation, allowing further decreases in costs. This decrease comes from a higher frequency of consolidation in incoming and outgoing transportation. For this step of the model to function correctly, it requires a substantial amount of IT-integration, and due to this, uncovering what kinds of IT systems that are in place in the park is essential.

6.7 Step 7: Total integration in SDHIC

In this step, everything to do with logistics planning beyond production plans is transferred to the logistics center. All logistic tasks except for the strategic level choice of supplier and the contract negotiations are in the hands of the logistics center. This is partially based upon the SDHIC from Kayvanfar *et al.* (2018), which is covered in chapter section 4.5 in the literature review. In the article a textile industrial cluster in an undisclosed location, has already implemented a system of similar scale. The authors are looking at the system, developing applicable models, and calculating optimum warehouse space for servicing the cluster. We include this step in the model, but realize that the complexity in running a manufacturing cluster is likely larger than a textile cluster. There are probably higher numbers of articles used and produced by the companies, so it is not directly transferable to our situation. However, we would like to find out what attitude the managers have towards this concept and then see if it is plausible now, or in the future.

7 Findings & Discussion

Due to the nature of the findings, we have split them into two categories. The first is findings directly related to the 7-step model and the opinions of the companies in relation to that.

Since the focus is on our model, we want that to be presented and discussed first.

The second part is general findings that are important to uncover for Raufoss Næringspark and Multisped. Some general findings would fit under certain steps in our model but are referenced in the model findings for the sake of readability. To properly explain and discuss those findings without overshadowing the model findings, they are in the general findings section.

Based on the general findings and our model findings, Raufoss Næringspark and Multisped can make the best possible decision based upon quality information regarding the need for a logistics center.

7.1 Model related findings and discussion

Following is our model related findings. For each step in the model, we will summarize the opinions of the companies, their explanation for that opinion and then we will discuss the findings of that step.

TABLE 2 - SIMPLIFIED RESULTS OF INTERVIEWS. (OWN TABLE) (SEE APPENDIX 3 FOR LARGER VERSION)

View on the new logistics center								
	40	41	42	43	44	45	46	47
Establishment of logistics center	M	Y	N	Y	M	Y	Y	M
Longer opening hours	M	Y	Y	Y	Y	Y	Y	M
Customs and consignment warehouse	M	M	N	Y	Y	Y	Y	M
Internal transportation	M	Y	Y	Y	Y	M	Y	M
Unified transportation coordination	Y	N	Y	M	Y	Y	Y	N
Transferring warehouse management to the logistics center	N	Y	N	Y	Y	M	M	M
Supply demand hub in industrial cluster - SDHIC	N	M	N	M	M	M	N	N

Blue squares denotes “Yes” and indicate a positive answer to the question, with the cost question being prerequisite to the answer. If the costs of the solution is too high, then the companies would be unlikely to participate, meaning that there needs to be a cost analysis done before the completion of the logistics center.

White squares denotes “Maybe” and indicates a neutral attitude to the question, such that they would need more information to decide. We use the term neutral when discussing the model for linguistic purposes.

Red squares denotes “No” and indicates a negative answer to the question.

We transform Table 2 into numerical values:

$$Yes = Y = 1$$
$$Maybe = M = 2$$
$$No = N = 3$$

We get the following table:

TABLE 3 - NUMERICAL RESULTS OF INTERVIEWS WITH AVERAGE. (OWN TABLE) (APPENDIX 4 FOR LARGER VERSION)

View on the new logistical center									
	40	41	42	43	44	45	46	47	Average
Establishment of logistical center	2	1	3	1	2	1	1	2	1,625
Longer opening hours	2	1	1	1	1	1	1	2	1,25
Customs and consignment warehouse	2	2	3	1	1	1	1	2	1,625
Internal transportation	2	1	1	1	1	2	1	2	1,375
Unified transportation coordination	1	3	1	2	1	1	1	3	1,625
Transferring warehouse management to the logistical center	3	1	3	1	1	2	2	2	1,875
Supply demand hub in industrial cluster - SDHIC	3	2	3	2	2	2	3	3	2,5

As we can see in table 3, an affirmative answer is given as one; therefore, in this table, a lower value is better. Since the neutral position is two, then an average answer below two means the overall opinion on this step is still positive. We, therefore, characterize two as the

cut-off point for viable solutions. We can see that all steps up to and including Step 6 are viable solutions. While Step 7 falls outside our cut-off point and is not a viable solution.

We will now discuss the findings in greater detail:

7.1.1 Step 1: Establishment of logistics center

In the case of the simple warehouse logistics center, the attitude towards using it was positive in general. Four out of the eight companies indicated that they were interested in using it, even if it is just a simple warehouse. Most companies indicated that cost is a limiting factor. Four companies, however, stated that almost regardless of costs, they would use the warehouse. This is due to the very high demand they have for storage space. The three companies that were more neutral towards participating in this first step were so based on different factors. One indicated no need for the extra space and saw no gain for them in moving existing space to the logistics center. The second has an already well-functioning external storage function with IT integration. For this reason, the first step in our model is too simple for them to participate in. They require a more adaptable and complex solution to participate, and they are positive to more complex steps. The third neutral were unsure if they had anything to gain from participating. The negative answer is from a company with a low volume, high-value production with good warehouse capacity, and a functioning solution for their current needs.

Starting from step 1, it is clear that this would alleviate specific issues for the companies in the park. Those who struggle with pressured warehouse capacity would appreciate the extra available space. Additionally, it will allow all the companies in the industrial park to have the same mailing address, which is not the case today. Currently, the companies do not have the same address, and this has caused some issues. Partly it is due to difficulties with receiving post and packages, and it involves several companies having multiple locations in the park. It would be simpler if all had the same address, and no shipments were sent to the wrong place.

However, due to the simple nature of the solution, the companies that do not have pressured storage capacity are less likely to benefit from this solution, especially when costs are considered. It would be possible for the companies using external warehouses, to transfer that capacity to the logistics center. However, given the current situation of transportation between the external warehouses and the industrial park, it is a less convincing argument. This attitude will likely change when the transportation costs increase due to the blocked main road through Raufoss city center (See section 7.2.2 External Warehouse).

Further, the simple warehouse solution can be helpful with regard to reducing logistical complexity. By reducing the distance between the factory and the warehouse, a physical check of goods would be easier. However, it does not help solve the issues of double handling, which will still exist with the new logistics center. The difference lies in the distance traveled by the goods in transit. Further, the road network inside the park currently is overloaded when the number of vehicles is high, especially in the winter. (See section 7.2.4 Health and Safety) Alleviation of this can be achieved by having the trucks deal with a single point of delivery, and the logistics center handles the internal transportation. In terms of health and safety, the increased number of vehicles in the park increases the chance of accidents, as traffic through an industrial area is less orderly and clear than on regular roads. In terms of security, it would also help, as it would prevent truck drivers from going where they are not supposed to in the park. Regardless of intention, this is a safety threat. It can be seen as a threat in terms of industrial espionage, or it can just be in terms of driving in a restricted area.

7.1.2 Step 2: Longer opening hours

All of the companies agree that longer opening hours is positive, in that every company could see the usefulness of that in the organization of transportation. Even the company that was negative towards step 1 could see the advantage of being able to use the warehouse for individual shipments. Moreover, all of them were very positive to it being a reception area, such that the working pressure on their warehouse operators during the day would be smaller. There was also a positive attitude towards step 2, lowering the total number of warehouse operators in the park, a possible cost saving for the individual companies, and the industrial park in total.

In general, the companies are well adapted to the opening hours currently implemented; however, for some of them, there are issues. One of the companies has two zones of finished goods, with one zone operated around the clock, while the other is only open from 07.00 to 15.00. Due to the longer opening hours at one of the zones, they have operators available, and they allow trucks to load from both zones during the night. That is better than having vehicles wait until the following day. On the other hand, due to the personnel regularly working in one zone and not the other, loading at night takes longer time. Operators are not familiar with where things are located in the area they do not regularly work in. The company does not have a fully functional warehouse management system (WMS), so they cannot use that to find the goods they need. It was also noted that there is no proper system for first-in-first-out

(FIFO), which is a guiding principle for that company. Their warehouse is only functional due to skilled operators remembering what items were first produced, and where they are located. If the operator does not know, they have to check every label, which is very time-consuming.

FIGURE 8 - OPENING HOURS FOR THE COMPANIES IN THE INDUSTRIAL PARK – 0,5 DENOTES THAT SHIPPING AND RECEIVING CAN BE ARRANGED, BUT IT IS UNCOMMON AND EXPENSIVE (OWN FIGURE) (APPENDIX 5 FOR TABLE VIEW)

As we can see from figure 9, core opening hours are from 07.00 to 16.00, but there is no standardization, making pick-up coordination for transporters and Multisped more difficult. The second step for our model is for the logistics center to maintain longer opening hours, for receiving and sending goods from the industrial park. This would help with the already mentioned issues associated with the shorter opening hours. The accumulation of trucks that arrive after hours and through the night leads to increased workload for the logistics operators. Allowing them to pool resources in the logistics center and having longer opening hours, enabling them to deal with trucks as they arrive, making the accumulation overnight smaller. It is important to note, however, that this in itself is no guarantee of cost savings. The total expenditures on longer opening hours for the logistics center must be compared with the current costs of today's situation.

7.1.3 Step 3: Customs and consignment warehouse

As we can see from table 3, one company was negative to use the customs and consignment step of our model. The type of materials they use in their production are of low volume and value. This means that they have no need for a consignment stock concept, and they already have a system for customs warehousing with a local transporter. They see no need to change from their current customs warehousing system to the one proposed in connection with this step. Their opinion is a cost question, and with a cost-saving opportunity in the future; they could see their attitude change. The three companies that are neutral to the idea have different reasons. The first company does not import their raw materials. The overwhelming majority of their input in production comes from Norwegian suppliers. Thus, they do not need a customs warehouse. While a consignment warehouse could be useful, there is no tradition for using such in their industrial sector. The second neutral company saw the advantage of having a customs and consignment warehouse nearby. However, they already have a customs warehouse that they are mandated to use by their corporate owner. This makes participation dependent upon their owner agreeing. The third company was neutral due to manufacturing in a different industrial sector. Due to this, it was unclear if having raw materials part of this concept would benefit them. The last four companies were very positive. For one company, this was of vital importance as their capital binding is very high, and they see this step as a way of reducing it. The four positive companies in volume and value constitute a large part of the manufacturing in the industrial park.

In general, all companies could confirm that capital binding is something they are trying to minimize. Due to the differences in the level of capital binding, this step of the model would be of varying benefit to the different companies. However, all companies have the possibility of some savings when it comes to using such a facility. It allows for JIT production to a higher degree than what is currently possible. There are customs storage facilities in Oslo today, but the issue is that it is part of the harbor area. This means the goods need to be kept in containers in an allocated space. The cost of the customs storage is then; the rent of containers and the area occupied. This is expensive and is a cost driver for the companies who elect to use this solution. With a customs warehouse in the industrial park, as suggested by our model, the goods can be removed from the containers, and stored in a regular warehousing fashion up until they are needed. It is thus saving on direct storage costs compared with the current situation. It also allows for lower capital binding with smaller batch sizes compared with the current situation (See section 6.3).

A consignment warehouse would work similarly for goods not going through a customs process. For companies that purchase goods from Norwegian companies, it is possible to maintain a level of stock at the warehouse. Refill done as needed by the supplier, without involving the production company. This brings benefits to the companies in the industrial park in regards to purchasing, and moves some of the responsibilities to their suppliers. The biggest issue with Step 3 of the model is the uneven distribution of benefits. Certain companies will reduce their capital binding substantially, while others will see little benefit. It is important to note that, the companies that can gain the most benefits, together contribute a large amount of the total transportation and production volume.

7.1.4 Step 4: Internal transportation

For our fourth step in our model, the interview subjects agreed that if the logistics center is constructed, then an internal transportation route or system should be part of that solution. The internal transportation step is, in their opinion, vital for it to be competitive with already existing solutions. There are three groups of interest in this step:

1. Those who are positive to step 4 of our model
2. Those who use internal transportation today
3. Those who are neutral to step 4 of our model

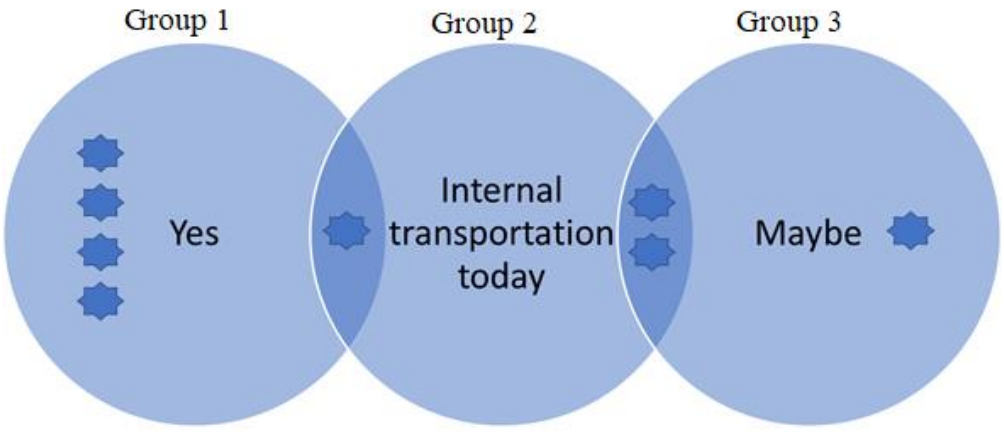


FIGURE 9 - INTERNAL TRANSPORTATION GROUPS - STARS REPRESENTS COMPANIES (OWN FIGURE)

The Venn-diagram in figure 9 is an illustration of the three groups we identified. Three companies employ internal transportation inside the industrial park. The transportation equipment used by the companies is specially adapted to the needs of that company and does not suit other companies' requirements. Two of these companies are neutral towards a standard internal transportation system, as they see their own needs as unique. The first company needs to maintain its internal transportation, regardless of participation. The second company was dependent upon costs. Their current internal transportation system is not going to be operational for much longer. They are merging production facilities and will not need it. To participate in our model's internal transportation is therefore entirely dependent upon costs. The third company of group 2, the positive company, sees benefits in exchanging their equipment for equipment more universally adapted to the needs of all companies.

The neutral company with no internal transportation is dependent upon participation in previous steps. They are company 47 in table 2 and are generally neutral to most of the steps in the model. Their involvement in earlier steps would guide their opinion on this step in the model. If they choose not to participate earlier in the model, then this would rule them out. With earlier participation, it becomes a question of cost.

The positive companies all see the benefits of this step in the model. Three companies see it as an advantageous step to participate in when combined with the previous "Step 3: custom and consignment warehouse", but it is not seen as a necessity. The remaining two companies saw it as a necessity to have internal transportation should the previous step be implemented. This means that for them, there is no option of implementing only one of these two steps.

Making the transport of goods back and forth from the logistics center a smooth and seamless process is the goal of this step. Raw materials would flow to the production companies automatically depending upon the need of the individual company. The finished goods would automatically be picked up based upon the production of the companies. There used to be a manual system for this when the entire industrial park was owned and operated by a single company. That system was not ideal due to a lack of automation and friction in planning and organizing. With technological advancements, the coordination of such a transportation system becomes easier, through the automatic generation of demand for transport back and forth based on IT-systems and sensors. The companies that have internal transportation today will have valuable insight into running such a system and can help in the design of our proposed step. With the addition of more companies, locations, and actors, the need for simplification of communications will be great. This concept could help lower the complexity

and planning for the production companies in the park. On the other hand, the issue with this step of the model is the investment and implementation costs. This will entail a large amount of IT system integration, which will be organizationally challenging and time-consuming. Additionally, we would imagine that it is a semi-automatic or automatic system, and this requires a comprehensive test phase. However, if the customs and consignment concept is chosen, and the internal transportation system is not implemented, it is likely going be a sub-optimal situation. Therefore, the internal transportation system is a natural combination with the previous step of the model.

7.1.5 Step 5: Unified transportation coordination

Unifying all transportation planning into Multisped is our fifth step. Two companies answered negatively towards using Multisped more or committing to use Multisped for all their transport. The first has its own transportation office, doing the same job as Multisped does, with customs clearing and transportation coordination. They have no plans of closing this office and therefore see no need for this step. The second company has it as a priority, to get as much as possible of their transport over on FCA terms to the park, and Ex-works out of the park (ICC, 2010). They are not interested in working with transportation and find FCA and Ex-works incoterms as their best options. However, they said it is impossible to get everything in those terms, and will use Multisped for whatever they must control.

One single company sees this step neutrally. This is due to the final decision being out of their control. They have some influence, but the majority of transportation to and from them is planned by their corporate headquarters in a European country. Therefore, they cannot commit to step 5. However, they said that they see the positive sides to Multisped, and agree that more transport going through Multisped would bring benefits.

The last five companies were positive in committing to use Multisped for all the transportation they control. Some of them have a guiding principle of using Multisped whenever possible. Almost all companies have some FCA and Ex-works transportation, but they all could see the potential benefits in channeling as much transportation as possible through Multisped, to decrease cost price and gain economy of scale advantages. Additionally, the view on the services Multisped offer and the benefits of them are elaborated in section 7.2.4 Health and Safety.

This step in our model will, over time, give the transporters lower costs and allow them to compete better against low-cost foreign companies. This would also allow them to offer

better rates to the companies in the park, due to an increase in the number of trucks with a high fill rate and bigger chances of finding return goods. The issues we saw with the use of FCA and Ex-works transportation, as we present in 7.2.5, will be alleviated. When dealing with Multisped, the production companies would not tolerate the pickup time speculation seen with foreign transporters. Due to the size difference between the large multi-national corporations and the companies in the industrial park, the power relation dynamic is skewed. Raufoss is a small part of the customer base for the international transporters. For Multisped and their transporters, however, they are a large customer. Multisped uses transporters who adhere to their way of doing business; this way as described appears to adhere very well with the Triple Bottom Line concept. This means they use transporters who pay a living wage, have as environmentally friendly vehicles as possible (Euro VI), and use the tires demanded by the climate rather than governmental regulations, as we will describe later in 7.2.4. The issue with this step, is that benefits are proportional to the number of companies that participates, if few are willing to use Multisped, the benefits are smaller. It is easy to exit the system, to start using foreign transporters again, and it is unlikely that Multisped will be competitive based purely on cost. Their primary competitive advantage is the service level, which can be improved with the system.

7.1.6 Step 6: Transferring warehouse management to the Logistics Center

Referencing table 3 we can see that three companies are positive to the idea. They said it is interesting and that they could see potential benefits. Having the logistics center deal with many of the standardized goods would save time and money. Further, they also commented that there would likely be benefits to letting the logistics center deal with certain common consumable items, such as packaging, service agreements for forklifts and raw materials. The positive companies said that over time, this is what must happen in the industrial park. They did specify that the commitment is dependent upon existing and functioning infrastructure and IT systems. It would allow further specialization for the companies in the park towards production and focusing logistical specialization into one company. One of the positive companies has a sub-optimal warehouse management system currently (See 7.2.8). If they could enter into the concept and the system functions better than their current system, then they are very positive to this step. The three companies together are representative of a large part of the total transportation and production volume of the industrial park.

Two companies were outright negative towards the concept, the first because they feel they are well adapted logistically to their production requirements. Giving away control was not

interesting. The second company was negative due to safety concerns concerning the nature of their products, and the special requirements put on storage and transportation.

The neutral companies were unsure about how the concept would affect their own companies. Their final decision will be dependent upon access to more information, and the potential costs they could save through participation.

There are several benefits to this step, as it would lessen the administrative burden of the companies. Allowing this organizational change will depend heavily on the successful integration of IT systems between the logistics center and the production companies. With this integration, however, it would combine with the unified transportation planning, and allow for cross-company transportation pickups, both to and from the industrial park to a higher degree than with previous steps only. This would mean that the likelihood of full trucks increases, leading to lower costs over time. Additionally, since the same company does the planning of order frequency, quantity, and transportation, it is probable that there are synergetic effects. This could mean that the average time between pickups or quantity per pickup could decrease, or increase depending on the goods and the total cost involved with the transportation. Whatever gives the lowest cost would be the preferred option. Overall, this would provide the companies with lower logistics costs, and increase their competitiveness. The negative aspects of this step are related to the investment and implementation of this system. The time and money needed for the proper integration into this system are likely substantial. Getting companies to commit to this idea can also be a challenge, as they are giving away some inventory control for the prospect of lower costs. The mutual trust required for this implementation and operation is substantial.

7.1.7 Step 7: Supply Demand Hub in Industrial Cluster – SDHIC

Our expectation towards the realistic view of this step was that it would be difficult for companies to accept handing over this much responsibility. For four of the companies that suspicion turned out to be correct, and they were negative. The first company saw issues with this due to safety and security measures related to their goods being dangerous and documents being classified. The other three were negative due to being part of a larger corporation, and the responsibilities and tasks of the SDHIC would conflict with corporate processes and functions. The last four were neutral but remained skeptical of this step. It was seen as an ideal solution, in theory. They were open to this step being a future development of the logistics center; however, as an initial option, it was unlikely that they would participate.

There are opportunities associated with the adoption of the final stage in our model and a complete integration of ordering and transportation planning. It would act based upon the production plans as set forward by the companies involved, through a complete IT system integration. The theory indicates that it is going to be help restrict bullwhip effects in inventory levels; however, for most of the companies in the industrial park, this is not an issue. Most of the products produced in the park are, produced from raw materials to finished goods, and there are no extended supply chains. This means that bullwhip effects are not an issue. Since this is not the case for the industrial park this means that there is no benefit to that specific instance, it does however allow for further specialization towards core competencies for the companies. We concur with the logistics managers that it is an unrealistic solution currently. The complexity and the amount of integration it requires would be extremely challenging. We think it might be a good idea for less complex clusters, as has been described by Kayvanfar *et al.* (2018).

7.2 General findings and discussion

As said in the introduction to this chapter, this section will summarize and discuss the general findings. Some of them support the model related findings, but are in this section for readability sake. They are all interesting findings for Raufoss Næringspark and Multisped, and are linked to the research questions from 1.3 and the case-specific questions from section 1.3.1.

7.2.1 Current warehouse capacity

Some interview subjects identified current warehouse capacity as insufficient. The scale of the issue varied between the companies, from a major issue to something that could be an issue at certain points during the year. Certain companies have products that are sold on a seasonal basis and thus require more warehouse capacity during the off-season to build up inventory.

An issue raised by a questionnaire done by SINTEF in the spring of 2018, was the lack of production space in the industrial park. Did the logistics managers of the industrial park see freeing space for production expansion as an important part of the new logistics center? This was not the case for the questionnaire, but we could inquire further about the opinion of the different firms. It turns out that there is a need for extra production space in general, and that our results differ from the questionnaire. The various managers saw the need to replace warehouse space with production, to varying degrees naturally, but all were reasonably

interested in the idea. This difference in results likely follows from methodological differences in information gathering, as discussed in Chapter 5.

A driver of demand for warehouse capacity that we identified is that certain companies in the industrial park face challenges related to lifetime contracts. This concept relates to car manufacturing and some other industries. The companies that are granted a production contract for a given unit tie themselves to be able to produce the given unit, for a certain number of years. This period goes beyond the end of the customer's production and is used for spare parts. This is a significant influence on the need for warehouse space.

The companies involved with such contracts mentioned five, ten, and fifteen year's contracts as typical. The final option, which was not typical, but still happened occasionally, were unlimited contracts. They commit themselves to be able to supply parts for an indefinite time with uncertain production levels. This sort of lifetime contracting has different effects depending upon what the company decides. Some prefer to produce a predicted stock of the required materials, while others maintain the production equipment and produce the items when needed. The advantage of the first is that they do not have to re-tool for producing the reserve parts when needed. However, it increases the need for storage space of tools, which they intend to store over long periods. This would conflict with the guiding principles of LEAN, if they are implemented in that company, and is also a cost driver in general. The advantage with the other option is that storing the production equipment, takes up less storage space, but it means that every so often they would have to re-tool the production. If they have other production they cannot delay, then it could be a long time before they can produce lifetime goods. That would be poor service and likely bring some financial compensation to the customer awaiting the production. With regard to spare-parts production, it is possible that it would be easier to prepare for, and organize if there were dedicated facilities for storing, either reserve stock of parts, or tooling for the production. This could be part of the logistics center since there is potential for cross-company cooperation in this regard. However, it would be in breach of the high throughput principle of the logistics center in our model.

7.2.2 External warehouse

The companies involved who are currently using external warehouses outside the borders of the industrial park agree that they are creating local environmental challenges. All firms using external warehousing capacity are using the local transportation and warehousing providers, Toten Transport AS and LRN Transport AS. They are located in the light industrial location Prøven, just south of Raufoss and the transportation to and from the site goes through Raufoss city center. (Addresses in the two maps are waypoints traveled by every route between Prøven and the companies in the industrial park, but the specific addresses are not to any of the companies covered). Due to county restrictions on the usage of the main entrance to the Industrial Park, the only entry and exit point for trucks to the park is the Northern Gate. It is known as “Parkeringsplassen” on the maps.

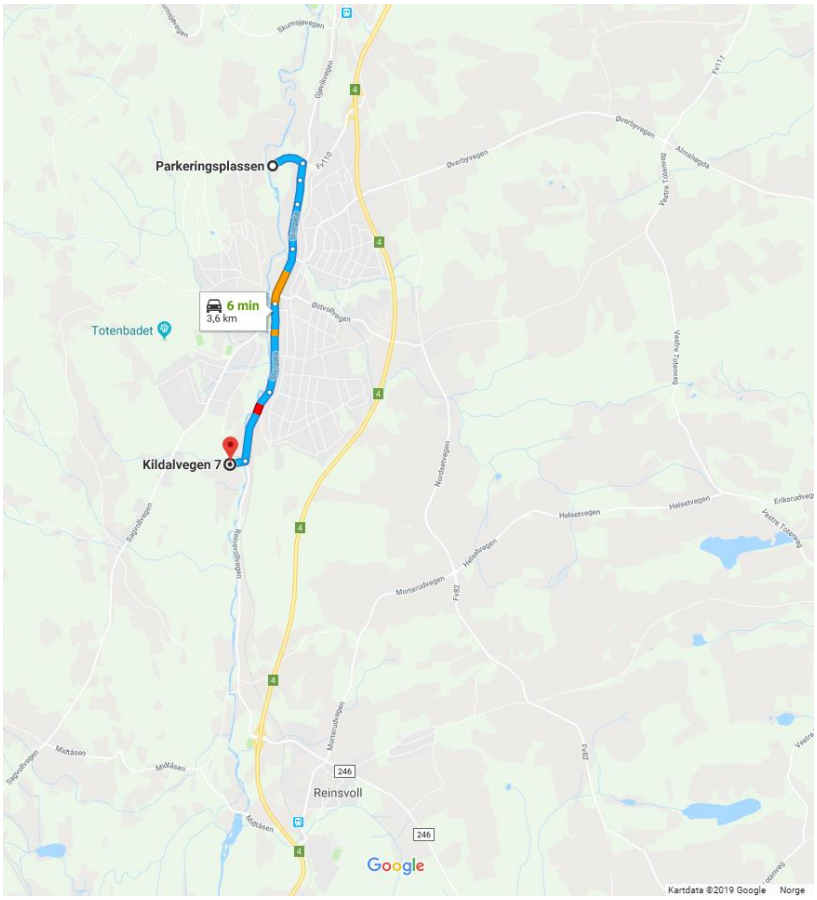


FIGURE 10 - GOOGLE MAPS ROUTE PLANNER FOR CURRENT SITUATION

The number of daily trips between the industrial park and Prøven is nine to ten roundtrips. This comes in addition to any truck that has a partial load and is going to Prøven for cross-docking or grouping of transportation assignments. This has a significant environmental and infrastructural impact locally. Due to this, the local municipality have been discussing, and are planning to establish Main Street as an environmental street. The planned environmental regulation of the main road through Raufoss (*Trafikksikkerhetsplan Vestre Toten Kommune 2018-2021*, 2018) will have a significant impact on this transportation.

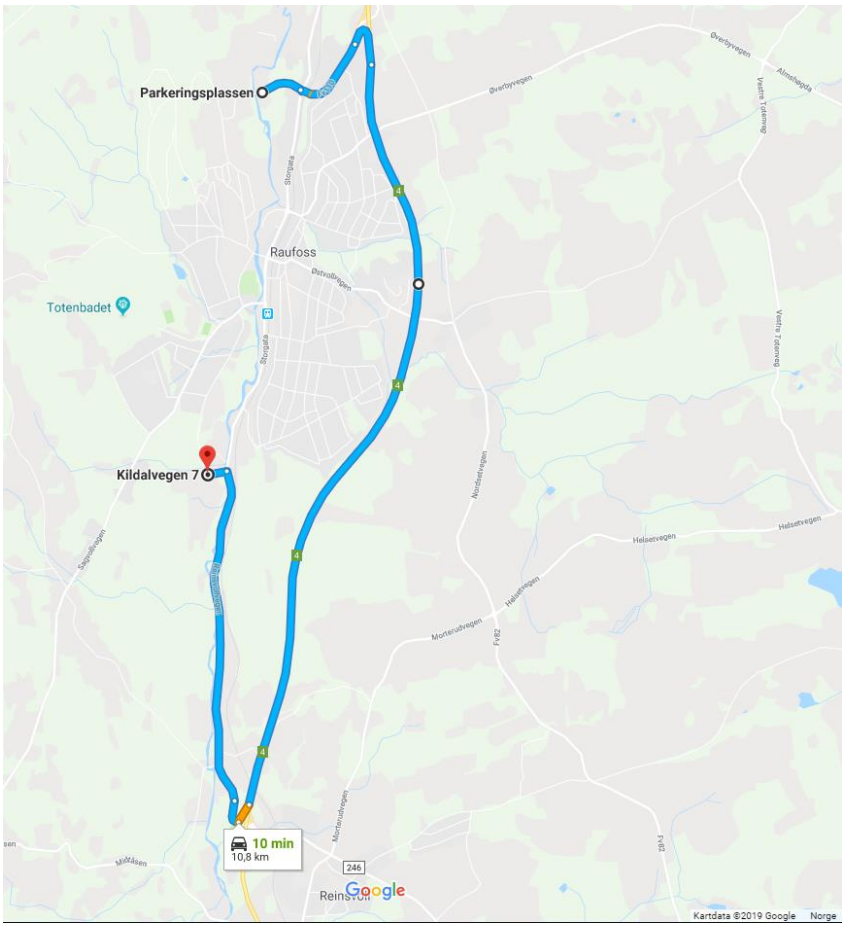
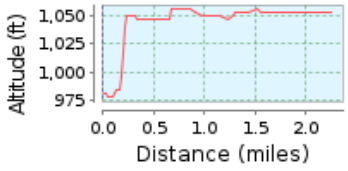


FIGURE 11 - GOOGLE MAPS ROUTE PLANNER FOR ALTERNATIVE SITUATION WITH NO TRUCK ACCESS THROUGH RAUFOSS

The purpose of the regulation is to make the local environment better, improve pedestrian safety and lower road wear and tear by limiting the amount of heavy-duty traffic allowed in populated areas. It would block heavy transport vehicles from traveling through the city center and would divert all the truck transport to other roads. This means that the distance traveled goes from 3,6 km to 10,8 km. This would increase tire and fuel usage almost threefold, increase the time spent per trip by more than four minutes, and force the trucks to travel a road with a much higher altitude difference, increasing the wear on brakes and engines. Naturally, this is going to increase the costs of each trip, such that the companies currently renting external warehouse space at Prøven would see a cost increase. This could be an important deciding factor, especially as the implementation of the county plan approaches

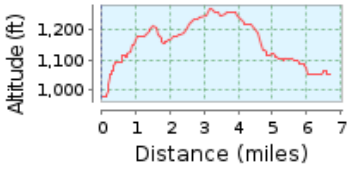
completion. It is likely that companies using an external warehouse would be more positive to using the new logistics center, when the street is closed.

The costs of using an external warehouse are related to renting space and transportation back and forth. Some pay for a fixed area for them to use as they see fit, while others only pay for the area used. The pay structure is different, depending on the company's requirements. Additionally, the cost of transportation back and forth from the warehouse is significant. Currently, the cost of one roundtrip is based on distance, time, fuel, and terrain elevation factors.



Altitude range 78 feet (978 to 1056 feet)
Total climb 85 feet
Total descent 13 feet

FIGURE 12 - CURRENT SITUATION - HTTPS://WWW.GPSIES.COM



Altitude range 292 feet (978 to 1270 feet)
Total climb 361 feet
Total descent 289 feet

FIGURE 13 - FUTURE SITUATION WITH NO ACCESS THROUGH RAUFOSS CENTER - HTTPS://WWW.GPSIES.COM

The two previous figures (12 & 13) illustrate the change in elevation profile between the two alternate routes from figures 10 & 11. As we can see, the total altitude change goes from 98 feet (29,87 meters) to 650 feet (198,12 meters). This represents a significant change in the wear and tear we can expect on the trucks driving this route several times a day. This increases the need for maintenance, thus the cost charged for transport will increase.

The transportation back and forth is done with semi-trucks, where the trailers are left at the production location and filled by the warehouse operators and then picked up by the transportation company at a given time. Some of the companies use a milk-run type system, where they are picked up regularly without any further ordering of transport. This type of transportation is only performed during the day, such that there is a buildup through the night for the companies that have continuous production.

If the proposed logistics center is built, it will change the access point for the industrial park. The above-mentioned "Parkeringsplassen" will no longer be the access point. However, the above transportation issue will not change. Only the distance traveled will increase for both possible routes to and from the industrial park and Prøven. This will have little effect beyond

the longer travel route. (See appendix 6 for new zoning plan for the industrial park in Norwegian)

7.2.3 Environment

The environmental impact of transportation through Raufoss city center we have already described; however, the impact of long-distance transportation is also of importance to the companies in the park. All of them have expressed an interest in performing their business as environmentally friendly as possible. With this in mind, the usage of FCA transportation becomes an issue due to the European emission standards classification. For Norway, a recent study indicates that 70% of all kilometers driven by trucks are in the Euro VI class (Stølen, 2019). This class is very fuel efficient and has very low emissions per driven kilometer (Weber and Amundsen, 2016).

The complaints from Norwegian transporters who operate as environmentally friendly as possible, is that foreign transporters are not held to the same standards, while they can still drive on Norwegian roads (Stølen, 2016). Thus, the international company can use trucks that are cheaper to use but are much worse for the environment, both locally and on a larger scale. The use of environmentally friendly vehicles (Euro VI) is partially why Multisped is seen as a viable competitor despite the higher costs.

7.2.4 Health and Safety

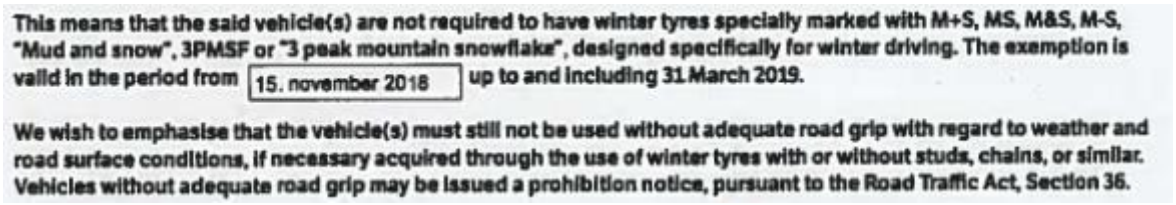
All interviewees agree that the health and safety aspect of transportation is important. We were partially influenced into inquiring about this due to the media focus that has been on the subject during the 2018/2019 winter (Thonhaugen and Kristoffersen, 2019) (Kinn and Nygaard, 2019). Several traffic incidents involving foreign transporters have made it a focus area, and the FCA terms in purchasing and the Ex-works terms in sales are contributing to the issue. The transport the companies can control themselves is best kept to transporters who follow the guidelines and rules set by the Norwegian government in terms of equipment and driving & rest times. The reason is twofold; concerning insurance, they are safe from indemnities because of faulty equipment in an accident. Thus, they are not financially liable to the same degree.

However, most important is the knowledge that they hire transporters who adhere to the rules of the road and who are less likely to be involved in a collision. Describing a scenario, where a truck they hired is in a fatal accident, was a nightmare that many interviewees told us they

would not want to experience. They told us this without prompt, in the interviews, so it is likely something they have thought about.

To this end, Multisped demands that the transporters use equipment that goes beyond the government requirements. The demands are that tires need to be in the Three Peak Mountain Snow Flake (3PMSF) classification, while the regulatory demands are that the tires are in Mud + Snow (M+S) or better (*Tyres on heavy vehicles*, 2019). However, there is an exception made in the rules. If you are running a vehicle with a specific hub size, there are no 3PMSF or M+S tires available for that size (*Application for exemption from winter tyre requirement*, 2019).

If you use tires with the dimension of "455/40 R x 22,5", for example, then there is no way of obtaining winter tires for that dimension (Karlsen, 2019). Because of this, they can apply for an exemption. If they get the exemption, then they must only fulfill the minimum demands of summer tires. This is not sufficient for Norwegian winter conditions. We observed an instance of a truck being stuck on flat, even roads inside the industrial park. Technically the law states that the driver is responsible for using adequate equipment:


This means that the said vehicle(s) are not required to have winter tyres specially marked with M+S, MS, M&S, M-S, "Mud and snow", 3PMSF or "3 peak mountain snowflake", designed specifically for winter driving. The exemption is valid in the period from 15. november 2018 up to and including 31 March 2019.

We wish to emphasise that the vehicle(s) must still not be used without adequate road grip with regard to weather and road surface conditions, if necessary acquired through the use of winter tyres with or without studs, chains, or similar. Vehicles without adequate road grip may be issued a prohibition notice, pursuant to the Road Traffic Act, Section 36.

FIGURE 14 - EXCERPT FROM "APPROVAL OF APPLICATION FOR EXEMPTION FOR WINTER TYRES REQUIREMENTS" (*APPLICATION FOR EXEMPTION FROM WINTER TYRE REQUIREMENT*, 2019)

With the observed instance in mind, it appears that the last paragraph of figure 14 is not emphasized onto the drivers of trucks with the exemption.

Considering the general focus in society and media during the early months of 2019 on dangerous situations involving trucks; the lack of public knowledge regarding this exemption is unfortunate, considering the consequences faced by accident victims (Andersen and Isaksen, 2019), (Hanssen and Bergsaker, 2019) and (Reigstad, 2019).

As said in the theoretical approach, Multisped is a horizontal cooperation between three different distributors Schenker, Toten transport and LRN transport. The most significant challenges they face come primarily from foreign competition, and this is due to the different cost levels. The total cost difference can be as much as 30% for any given transport from Raufoss to the European continent, depending on the destination and whether it is a routine transport (Karlsen, 2019).

The difference in cost levels is due to wage structures. Multisped has it as a principle to pay a living wage in terms of Norwegian cost levels. Compared with the foreign companies, where the drivers are often from Eastern Europe and paid in accordance with their home country's cost level. The pay they receive is enough for an acceptable living standard in their home countries. However, they are often on the road in high cost countries for months at a time, and the payment is not sufficient to keep them at a decent living standard when on the road in high cost countries (Karlsen, 2019).

7.2.5 Incoterms Issues

This category is related to comparing Multisped's services with the alternative ways of transportation and is related to "Step 4" in our model.

FCA and Ex-works (ICC, 2010) transportation is part of the daily transportation for most of the companies in the park. This presents some challenges that we observed for ourselves and are representative of the further issues described during the interviews, but not seen firsthand by us. Some of the companies are having issues with FCA and Ex-works transportation. Specifically, it involves the customers of the companies in the park having agreements with individual transporters, where the Raufoss companies do not have any input on the choice of the transporter.

For the observed instance, there was an order for a customer specific product that was finished by Monday, and to be picked up by a foreign transporter Tuesday the same week. The transportation agreement did not involve the production company at Raufoss as the transportation was Ex-works. Due to this, time between pick-up and delivery was longer than needed, so the transporter was speculating in the time needed to transport the goods. Because of this, we could observe the goods remaining in place at the pick-up point on Thursday, two days later than the agreed pickup date. The experience of the production company was that it would probably be picked up on Friday, the day after our latest observation. This situation is not unique and is an experience shared by most of the companies using FCA and Ex-works agreements with their customers.

How serious this is for the companies is dependent upon the available storage and production space for the specific company and how well they can handle a delay in pick-up, depending upon the size of the order. The cost consequences of such incidents are mostly hidden; however, excessive use of warehouse space is noticeable, but challenging to measure. If the warehouse is already at capacity, then we will have an overflow. Additionally, the production

plan could have reserved the space for future production. With this in mind, the occupation of said space could make the operations of the warehouse worse, such that it is more time consuming for the operators to do their work. Further, it could make the situation more complex to operate in, and thus increase the chances of health and safety issues arising or accidents occurring.

7.2.6 Logistical Operations

A problem found for certain firms is the logistical complexity involved. This is tied to the number of different locations the managers have to deal with. External warehouse capacity is part of this, as seen above the distance between the warehouse and production facilities makes it harder to control, monitor, and maintain workflow at the warehouse. The control issues can be improved with the application of proper IT-systems and high skilled warehouse personnel.

Some companies do not use external warehouse capacity but have to deal with complexity. Their complexity is more related to the different production facilities they operate. Certain companies have more than one building inside the park, each housing different production, and operations. Each building its own location for incoming and outgoing goods, with other locations in between production processes as well. With so many different locations and degrees of completion, this in itself is a source of complexity. This complicates the logistical situation, but the implementation of suitable IT-systems can control this issue. With such complex situations, an IT-system that allows for one hundred percent tracking of goods becomes very important. It would help the companies in such a position get better control of production and warehouse usage.

For the companies that need production space, there is a different sort of logistical complexity. Due to the limited floor space available, the production flow inside their production locations is sub-optimal. Internal transport inside the buildings lowers the throughput and increases the chances of errors. Additionally, increased non-automatized internal transport in production areas is a driver of health and safety risk, because transportation must occur in areas close to production. The personnel in nearby then has a higher risk of being involved in accidents concerning that transport.

The time pressure involved with delivering to customers with costly production lines can create issues. If your delivery is delayed, then the production of your customer stops, and you will be held financially responsible. This is part of a regular supplier contract, that stipulates

penalties and exceptions. Due to this, there are instances of less than ideal transportation situations. An instance could be a production batch that is supposed to be finished on a Friday, which is not completed at the correct time. Due to the vast financial consequences associated with delayed delivery, the necessity of sending whatever you have is significant. This means that a planned full truck, may only be half-full, and a supplemental truck will be needed to transport the leftover production. Meaning that there are two half-full trucks, driving to the same location. These circumstances often occur due to unforeseen conditions, and it would be difficult to prevent, however, there are significant extra costs involved with such occurrences. Sometimes air transport is also used, and that is even more expensive, but relatively cheap compared to a production stop at the customer. The number of such issues can be reduced by better planning and coordination with customers and suppliers, alongside the implementation of Unified transportation Coordination in our model. With unified transportation coordination, it is more likely that there are synergetic effects in transportation. This could lower the frequency of instances and lower extra costs involved with emergency transportation orders.

7.2.7 Organizational structure

There are varying degrees of integration in the management functions of the companies. Some have an integrated Supply Chain Management function, where the chief of logistics has purchasing, logistics, and production planning responsibilities. On the opposite hand, other companies have a more divided structure, where the functions are de-coupled.

In one instance, the transportation department is located in a completely different building to the purchasing department. Previously, this had caused purchasing to make decisions, which ended up creating extra costs in terms of transportation. Combined with this, some companies have production planning separated from transportation, such that the planners publish/release a production schedule, and then the transportation is planned based on that. However, if the plan is changed after the transportation is ordered, in such a manner that the original transportation order cannot be changed, you can risk ordering more transportation at a higher cost than if the planning was done in unison. It would be better combining transportation orders into a single order that can lead to a higher fill rate on the truck, and thus a lower cost.

Specifically, a case we were told of, involved the purchaser getting good price for certain production processes to be done in low cost countries. Before partially finished goods returned to Raufoss for final processing. In purchasing terms, this made sense as the cost per

unit was very low compared to insourcing or buying the process in high-cost countries in closer proximity. This type of production organization would have massive impact on the before mentioned capital binding, additionally, it would mean that production will have approximately 6 months lead-time. On top of that, comes the complexity of having to control and monitor the entire supply chain, with all the involved parts. This was naturally changed and now the product is not shipped across the world for completion. The benefits that this change brought, in terms of reducing complexity and a lowering of transportation costs were significant.

The purpose of this story is to illustrate what can happen when purchasing and transportation decisions are not integrated. As the system arose because a purchaser found the lowest possible price for the partial production that occurred in a low-cost country, and the transportation costs were not sufficiently considered. In hindsight, that seems obvious, and a new managerial position has been made in the company to try to prevent similar situations in the future. Academic focus on integrating purchasing and transportation decisions have been imprinted upon us thanks to the lectures on purchasing by Professor Buvik in SCM-702, based on the book by Van Weele (2014). Other authors also focus on integrating supply chains, though that is in a more cross-company setting (Bowersox *et al.*, 1999). We can see examples of both integrated and non-integrated organizations in the industrial park.

7.2.8 IT systems

The need to uncover this information was based on the sixth step of our model. That step requires integration of all IT-systems currently used by the manufacturing companies towards the logistics center. The utility of this finding is to discover what systems are in place, and if there are any dominant systems in the park. If the information uncovered showed that all companies use one enterprise resource planning-system (ERP), then the system integration would be easier than if every company has their own ERP-system. Additionally, the warehouse management system (WMS) used are of interest. If everyone uses the same system, then it would be simple to implement that for the logistics center.

Both tables are randomized and anonymized, such that there is no relation between the placement of a company in the tables.

TABLE 4 - ERP SYSTEMS IN USE TODAY (OWN TABLE)

ERP systems in use								
	1	2	3	4	5	6	7	8
SAP		X	X	X				
Oracle	X							
Microsoft Dynamics NAV					X	X		
Infor LN							X	
Micrsoft Dynamics AX								X

TABLE 5 - WMS SYSTEMS IN USE TODAY (OWN TABLE)

WMS systems in use								
	20	21	22	23	24	25	26	27
SAP			X			X		Z
SD2				X			X	
Infor LN					X			
Astro	X							

As we can see, there is no dominant ERP-system, and many different are in use. One company does not use a WMS-system, and saw no need for it. The red square marks a company that uses SAP as a WMS-system; however, they are not using it as well as they can. SAP can, for example, maintain location control of both stock shelves and other locations usually found in a warehouse. The company in question, however, is not using that functionality, and the extent to which they are using location control, it is used on a zonal basis. In this way, they know a part is in a certain zone, but not the exact location. Practically this means that operators can spend time trying to locate items in a specified zone, instead of knowing exactly where it is. This is a sub-optimal adaption and makes it more likely that the company buys into a more advanced concept with a functioning location control system. This could save them time and money compared with implementing such a system themselves.

7.2.9 Improvement systems

All the companies interviewed have implemented an improvement system.

TABLE 6 - PRODUCTION IMPROVEMENT SYSTEMS IN USE TODAY (OWN TABLE)

Production improvement systems in use								
	30	31	32	33	34	35	36	37
LEAN	X		X	X	X		Z	X
5S			X	X				
6 Sigma		X				X		

The purpose for wanting to uncover this information was in relation to how the new warehouse could be seen by production managers. What kind of arguments could be used when trying to get the companies in the industrial park to agree to commit to the logistics center? As for the logistics center's effect, it could be in accordance with the principles put in

place through those systems. We chose to separate 5S and LEAN into two parts since the implementation of LEAN does not necessitate that 5S methodology is used.

The company, which is marked as red, has the system in place, but it has not been a focus for them for a long time. This means that the system can still have a positive effect on the production, if the system remains in the processes of production, despite the lack of focus. This can occur if the employees accepted the system, and the procedures became second nature to them.

In relation to adaption to LEAN operations, one issue arose when combined with Just in time (JIT) demands from customers. The problem is about everything being produced JIT, which leads to smaller production batches, with shorter lead-time requirements from customers. This can be counterproductive to the efficiency of production for some companies, where changing the product is not as easy as just turning a dial. Alternatively, the change can be simple, but the preparations are extensive and time-consuming. This issue was only brought up by one company, as they struggle with a large number of different articles, in combination with long preparations for product change. The small batches create additional costs in transportation as well, as the cost structure for shipping full trucks are lower than shipping smaller quantities. Smaller batches with time-critical delivery also make the merging of transportation harder and could lead to them having to use more vehicles than ideal. If that is the case, then there is an additional issue, that does not hit the production companies directly, but will increase costs over time; lack of return goods issues. The more trucks needed for the transportation out of the park, the harder it is for transporters to find return loads, especially if the transporters are local (See section 4.3).

8 Conclusions

Revisiting the main research question:

1. “Uncover what the logistics managers in the industrial park think about the proposed new logistics center.”

Referencing table 3: We recommend that the concept chosen should be at “Step 6: Transferring warehouse management to the logistics center”. It is the most advanced concept with a positive overall opinion. It is unlikely that all companies will want to participate in that step; however, the advantages for the companies involved are significant. When we consider which companies were positive to the step, the size of the firms, and the total volume of goods they administer; we can say that the volume and financial feasibility is good.

Since previous steps are part of our solution, we expect all the companies interviewed to utilize the logistics center partially. The most positive aspects were longer opening hours, which will allow greater flexibility for transporters and manufacturers, in distribution and receiving goods. To exploit this step, an internal transportation system is the second most positive aspect. It will help the interested companies utilize the longer opening hours and allow for greater just-in-time adaption. Establishment of the logistics center, Unified transportation planning through Multisped, and the Customs and consignment warehouse are third. Step 7 was the only step that generated an overall negative opinion, and we, therefore, do not recommend this as part of the solution.

We recommend that Raufoss Næringspark and Multisped invest in preparing the logistics center for an expansive operation in line with Step 6.

9 Managerial Implications

Our results are of particular interest to companies located in an industrial cluster or an industrial park, where there is the potential to employ the concepts developed. We have shown that a manufacturing cluster, in overall terms, is positive to merging their logistical operations into a partner company and that they believe the system is viable. This means that the collaboration we saw in the textile cluster as described in Kayvanfar *et al.* (2018) is partially transferrable to manufacturing clusters.

The academic research into how horizontal cooperation can help transporters gain a competitive edge is confirmed through the existence of Multisped. They are a good example of horizontal cooperation, and would indicate to other transporters in high cost countries, that horizontal cooperation is a good way of ensuring future operations in line with research done by Verdonck (2017), Cruijssen (2006) and others.

10 Suggestions for Further Research

The internal transportation solution we have suggested be implemented presents some exciting possibilities for future research.

Firstly, it will be an interesting vehicle routing problem to coordinate this internal transportation. How this coordination should be done, and how the communication is organized is also very interesting. Industry 4.0 and IOT (internet-of-things) technology are interesting possibilities if it makes this system work as intended, as seen in Qu *et al.* (2015). With communication in place, then the question becomes, how do you solve the vehicle routing problem? Models for automation of the pickup routes dependent upon sensory technology should present an interesting scenario for developing and optimizing a model.

Secondly, autonomous vehicles are a compelling case for the industrial park. Due to the nature of the location, since it is closed to the public and there is a system of controlled entry, the dangers of autonomous vehicles are decreased. With a limited number of people with access, there are fewer people to train regarding how to act around such a system. This means, that it would be an interesting testing ground for makers of such vehicles. The personnel in the area can receive specialized training and thus behave more competently in avoiding accidents with autonomous vehicles. There is also a limited amount of road available, such that simpler models of autonomous vehicles can also be of interest. We suggest that collaborating with a manufacturer of autonomous vehicles to uncover if it is a viable solution is a good subject of future research.

Thirdly, models for solving warehouse management issues. Specifically, we think of re-order points and order sizes, when accounting for the need for all the different companies. The transport planning associated with re-ordering and purchase costs. Minimizing all these factors will be a complicated task, and worthy of further research if step 6 is the chosen concept.

Unrelated to the internal industrial park transportation, is the tire exception granted to foreign companies competing with Norwegian transport companies. Supply chain risk management in light of such exceptions can be worthy of future research, both for the transportation industry as a whole and for individual companies hiring transporters.

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12 Appendices

12.1 Appendix 1: Interview guide

Interview guide

Present ourselves and give the interviewee a brief introduction to the purpose of the study. Short description of the thesis. How was the task made, and who are we writing for? What is the benefit of the study, who will be involved in the interviews, and why them?

Recording and privacy – NSD protected. Confidentiality agreement, and no coercion. Anonymized to the extent possible. This thesis is planned published. Inform the interviewee that a recording will be made of the interview, and that this will be deleted after the evaluation of the thesis. Ensure consent to audio recording. Does the interviewee have any questions before we start? We give information about how we will use the gathered data from the interview, and we will check off all asked questions to ensure that all questions are asked.

Can you give a short introduction of your company and what you do?

Could you elaborate about how you handle the logistics today?

1. How is the warehouse situation today?
    a. External or internal warehouse
        i. How is the capacity
        ii. To low capacity
        iii. Hired containers for storage?
        iv. Customs warehouse as of today?
    b. How is the flow of goods?
    c. Opening hours for production and storage?
2. How is todays situation in connection to transport?
    a. How large is a typically order?
    b. Do you have any form of internal transportation?
3. Which transportation agreements do you have today?
    a. Do you have your own or join agreements?

b. Do you have specific corporate agreements that limit collaboration across companies in the park?

4. Information flow
    a. Systems
        i. ERP
        ii. WMS
        iii. WCS

How integrated are the daily processes in the company?

- How are the daily operations followed up?
- How are the communication between managers and departments?
- Is it an overall corporate governance principle in the company?
    - LEAN
    - SCM
    - 5S

Any challenges with the logistics today? Some things that could be better or different?

- Systems
- Storage space
- Planning
- Transport
- Are there some technological limitations to your ideal situation?

You have previously completed a questionnaire in connection to the new logistics center here in Raufoss Industrial park. We noticed a question about freeing up space for production, and are wondering about if this is something that may be relevant to you in the future?

If a new logistics center were to be built;

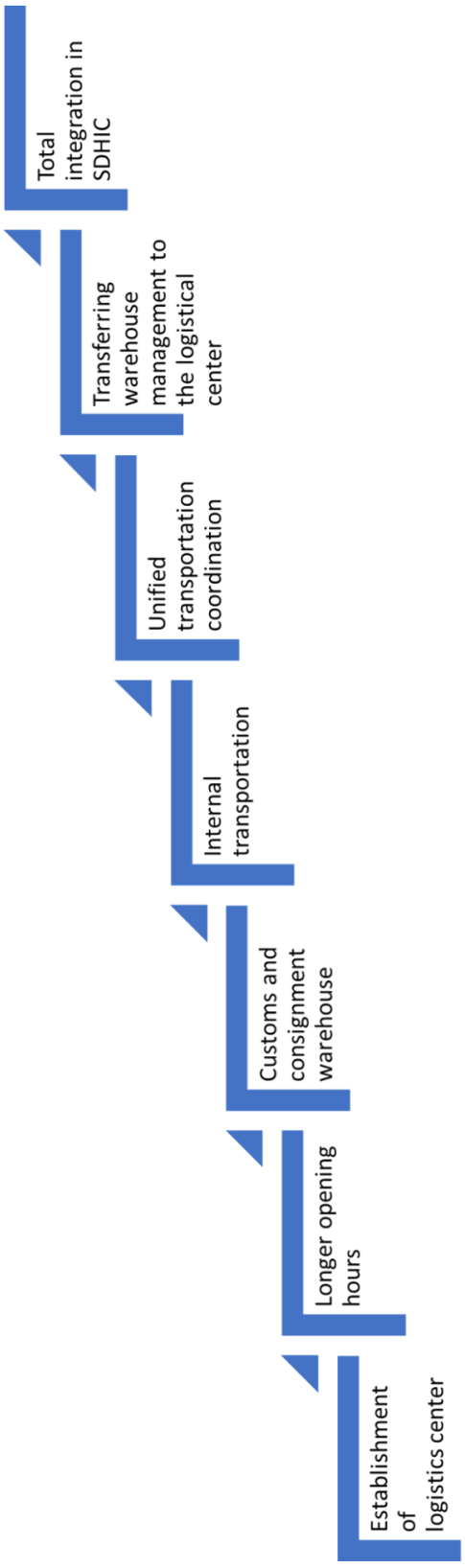
- Simple warehouse
- Longer opening hours
- Customs and consignment warehouse
- Internal transportation route
- Unified transportation planning and organization through Multisped
- Transferring warehouse function to the logistics center
    - Reorder point

    - Safety stock
    - Integration of data systems
- Supply Hub in Industrial Park – SHIP

Theory – Remember aid

- Clusters
    - Information flow
    - Cooperation – transportation/production/Storage spaces
    - Easy to recruit high skilled labour
    - Internal competition promotes growth
    - Promotes innovation and new ideas
    - Reduces the barriers to establish new businesses
- Horizontal coordination
    - Definition of the term
    - Synergy effect of cooperation Higher fill rate, fewer trucks, lower cost in total
- Supply Hub/Distribution center
    - Pilot study but result shows that it should be possible to acquire positive results/effects of a supply-demand hub.
    - Most of existing theory shows by models, that is would be possible to see positive effects.
    - Easier to avoid the bullwhip effect.
        - Definition
        - Do you have knowledge or heard of this phenomenon?

12.2 Appendix 2: Scale of Integration Model



12.3 Appendix 3: Simplified results of interviews

View on the new logistics center	40	41	42	43	44	45	46	47
Establishment of logistics center	M	Y	N	Y	M	Y	Y	M
Longer opening hours	M	Y	Y	Y	Y	Y	Y	M
Customs and consignment warehouse	M	M	N	Y	Y	Y	Y	M
Internal transportation	M	Y	Y	Y	Y	M	Y	M
Unified transportation coordination	Y	N	Y	M	Y	Y	Y	N
Transferring warehouse management to the logistics center	N	Y	N	Y	Y	M	M	M
Supply demand hub in industrial cluster - SDHIC	N	M	N	M	M	M	N	N

12.4 Appendix 4: Numerical results of interviews with average

View on the new logistical center	40	41	42	43	44	45	46	47	Average
Establishment of logistical center	2	1	3	1	2	1	1	2	1,625
Longer opening hours	2	1	1	1	1	1	1	2	1,25
Customs and consignment warehouse	2	2	3	1	1	1	1	2	1,625
Internal transportation	2	1	1	1	1	2	1	2	1,375
Unified transportation coordination	1	3	1	2	1	1	1	3	1,625
Transferring warehouse management to the logistical center	3	1	3	1	1	2	2	2	1,875
Supply demand hub in industrial cluster - SDHIC	3	2	3	2	2	2	3	3	2,5

12.5 Appendix 5: Table of opening hours

	50	51	52	53	54	55	56	57
01:00:00	0	0	0,5	0	0	0,5	0	0
02:00:00	0	0	0,5	0	0	0,5	0	0
03:00:00	0	0	0,5	0	0	0,5	0	0
04:00:00	0	0	0,5	0	0	0,5	0	0
05:00:00	0	0	0,5	0	0	0,5	0	0
06:00:00	0	1	0,5	0	0	0,5	1	0
07:00:00	1	1	1	1	1	1	1	1
08:00:00	1	1	1	1	1	1	1	1
09:00:00	1	1	1	1	1	1	1	1
10:00:00	1	1	1	1	1	1	1	1
11:00:00	1	1	1	1	1	1	1	1
12:00:00	1	1	1	1	1	1	1	1
13:00:00	1	1	1	1	1	1	1	1
14:00:00	1	1	1	1	1	1	1	1
15:00:00	1	1	1	1	1	1	1	1
16:00:00	0	1	1	0	1	0,5	1	1
17:00:00	0	0	0,5	0	0	0,5	0	1
18:00:00	0	0	0,5	0	0	0,5	0	1
19:00:00	0	0	0,5	0	0	0,5	0	0
20:00:00	0	0	0,5	0	0	0,5	0	0
21:00:00	0	0	0,5	0	0	0,5	0	0
22:00:00	0	0	0,5	0	0	0,5	0	0
23:00:00	0	0	0,5	0	0	0,5	0	0
00:00:00	0	0	0,5	0	0	0,5	0	0

12.6 Appendix 6: Zoning plan for Raufoss industrial park