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Navigating through the Purchasing Department's Role in Technological Uncertainty: An Investigation into Supply Chain Resilience in New Product Development

A case study at a leading OEM in the automotive industry

Master's thesis in Supply Chain Management

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CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2023
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Report No. E2023:047

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SUMMARY

Numerous automotive companies have begun to offer electric vehicles in their model range which currently is undergoing rapid development. This places pressure on how the purchasing department interacts with stakeholders where the traditional ways of working quickly become less effective in the technologically uncertain environment of new product development projects. The rapid development in the technologically uncertain environment also stresses the importance of applying supply chain resilience in organizations to build a system that can experience disturbance and maintain function and control in this rapidly evolving market. Therefore, this thesis has examined how the relationship between the purchasing department and new product development projects can achieve a resilient supply chain in a technologically uncertain environment.

Through a single case analysis examining OEM X where the main practices in the upstream supply chain have been in focus, challenges in the new environment have been identified and addressed. The case company and its processes have been investigated through interviews, internal data, and observations that have contributed to findings that have then been analyzed in relation to literature and research done in the field. It was observed that the purchasing department and its relationship with new product development projects bring many challenges to both the department itself and other departments working on the same project. This was due to the late involvement of the purchasing department in the projects, challenges arising in technologically uncertain environments, resource constraints, and risk management in the supply chain. In conclusion, the thesis provides various suggestions for how OEMs operating in the same environment can ensure that the purchasing departments' operations promote upstream supply chain resilience. This is done by examining when the purchasing department should be involved in new product development projects and the challenges that may occur with an early involvement, but also how the relationship with potential suppliers should look like. However, the discussed improvements come with implications that should be considered by OEMs planning to implement these measures. The thesis also gives rise to further research that can be conducted to further strengthen the relationship between the purchasing department and new product development, operating in a technological uncertain environment.

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Keywords: Purchasing, New Product Development, Supply Chain Resilience, Technologically Uncertain Environment.

Acknowledgments

This master's thesis was conducted during the spring of 2023, within the master's program Supply Chain Management at Chalmers University of Technology, authored by Ninva Kasselia and Sebastian Somi. The thesis has been based on specifications from a vehicle OEM and then developed in collaboration with the researchers and Chalmers University of Technology.

We would like to express our sincerest gratitude to our supervisor Ceren Altuntas Vural, Associate Professor at the Division of Service Management and Logistics at Chalmers University of Technology. She has given us invaluable input and support throughout the spring, and her enormous commitment and contribution have made it possible to complete this thesis.

Furthermore, we would like to thank the focal company for this thesis for bestowing upon us this amazing opportunity to conduct the study. Our supervisor at the OEM has always been helpful and supportive throughout this journey. We would also like to thank the department employees who embraced us as part of their team during the completion of this thesis, as well as all the respondents for sparing their valuable time from their busy schedules to engage in insightful interviews and share their perspectives on the topic.

Ninva Kasselia
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Gothenburg, May 2023

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1. Introduction

The following chapter describes the background to the issue to be investigated, followed by the problem to be investigated and a formulation of the purpose of the work as well as the research questions to be answered. The limitations of the study are also described at the end of this chapter.

1.1 Background

The technological evolution in the manufacturing industry has become increasingly competitive in recent years, with innovative and technologically advanced solutions being used by many Original Equipment Manufacturers (OEMs) around the world. Currently, there exists a substantial shift in the automotive industry, whereby OEMs are actively developing and presenting electric vehicles (EVs) as a viable alternative to conventional internal combustion engines (ICEs) that predominantly rely on gasoline and diesel fuels. This trend is primarily attributed to the growing global consciousness concerning the environment. In tandem with this, various regulatory measures have been put in place, which limit the usage of ICE-powered vehicles in several regions worldwide, coupled with amplified demands on vehicle efficiency. Given that the propulsion system of an EV is electrically powered, it presents a potential solution to meet the requirements of such regulations while simultaneously satisfying consumer preferences for sustainability, contingent on the specific objectives of the OEM. As a result, this is predicted to lead to a surge in demand for EVs, while the demand for ICE vehicles is anticipated to decrease in the future (Sierzchula et al., 2012). Figure 1 shows a graphic representation of how the acceleration of the electric truck market is introduced over the coming time.

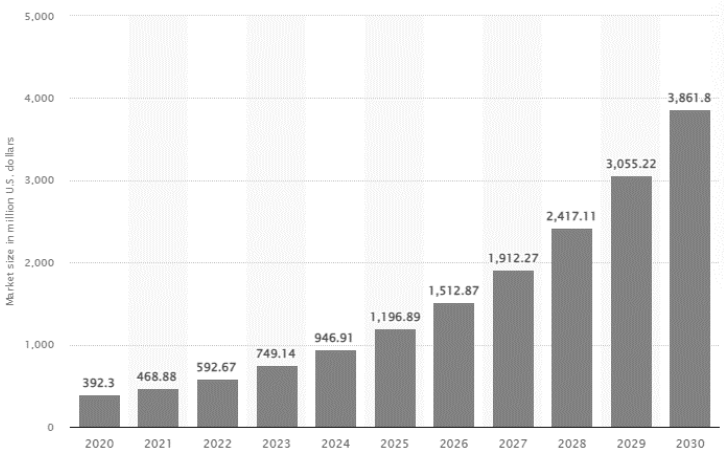

Figure 1. Projected electric truck market size (Statista, 2022).

The shift from ICE trucks to electric trucks will therefore result in R&D departments across many automotive companies having to develop new technologies and parts for the new type of vehicles. The technological evolution of electric trucks, for example, is very fast, and

innovative solutions in the automotive sector are becoming more and more common. This leads to a more complex industry while the competition for new technologies increases, where different OEMs want to be at the forefront. OEMs and suppliers are exploring opportunities to become more competitive to promote development processes (Oliveira et al., 2018b). The rapid product development processes are influenced by the technologically uncertain (TU) environment, where many OEMs do not know what technology will be available tomorrow. According to Oliveira et al. (2018b), this leads to products being developed and introduced to the market quicker than ever. As well as creates new demands within different OEMs where also different functions within organizations have different expectations. The expectations are not only changing and accelerating within organizations but also across entire supply chains.

Laios and Moschuris (2001) describe how organizations' purchasing departments are considered to have one of the most important tasks within organizations for many good reasons. Among other things, the purchasing department has a very large role in the size of expenditures in different companies, which can in many cases account for 60% of the total turnover. How the purchasing department is involved in other departments' operations will also have a very large impact on income, satisfaction, and competitiveness, among other things. During new product development projects, purchasing will thus play a very important role in long-term economic benefits (Di Benedetto et al., 2003). The author argues that the role of purchasing in product development projects can look very different for different types of products, where an assessment of the product type can determine the involvement of the purchasing department.

Another aspect to consider in this technologically changing environment is how the supplier base is shifting, as well as evolving during this time. OEMs that are manufacturing ICE vehicles currently have many suppliers that are well-established and have been around for many years. With the introduction of EVs, it has appeared that many of these suppliers cannot deliver the technology or services that OEMs require for their new product segment, hence a new supplier base emerges in the industry where, in some cases, neither party has previously worked with each other (Zhang et al., 2020). In many organizations, it is the purchasing departments that scan the market, handle the relationship with suppliers, and source many of the new components together with the R&D departments, and with the changing supplier base and a high degree of technological uncertainty, companies need to maintain a resilient supply chain to remain competitive on the market.

Supply chain resilience is a critical measurement that allows firms to ensure that they have a competitive advantage and a healthy network of supply chains to ensure they are protected from potential disruptions (MacCarthy et al., 2022). The extent to which organizations work to

achieve supply chain resilience differs by industry and product, however, most work around the topic falls on the desk of the purchasing department as much of it is about handling their suppliers and information flows. In a technologically uncertain environment, it is of utmost importance to work with supply chain resilience to maintain or accelerate one's market position (Ponis & Koronis, 2012). The changing supplier base that arises when new technology emerges, while there is a high level of innovation in the industry where technological uncertainty is very present, indicates that many companies must adapt their existing routines in new product development (NPD) projects, including how the purchasing department should work to continue to maintain a resilient supply chain.

1.2 Problem description

With a purchasing department whose role is rapidly changing, as well as resources and conditions are constantly evolving, purchasing departments can no longer work in the same way to contribute to an organization's ambitions of achieving a resilient supply chain. The changed way of working within purchasing implies that companies' purchasing, and procurement procedures are moving from a traditional to a strategic role (Steward et al., 2019). In an environment where NPD projects in a technologically uncertain environment can cause many inefficiencies in how departments work, it is important to study purchasing's involvement in this context. By observing the current research done on purchasing involvement in NPD projects in a technologically uncertain environment, there is a significant amount of research done on the subject (Di Benedetto et al., 2003). However, in the context of electrification within the automotive industry, there are other contextual factors and conditions that are not sufficiently covered by the current research. As the shift towards the electrification of vehicles is a rapid one, this topic will require a special focus to complement the current research to identify opportunities to promote a more resilient supply chain both in the context of the automotive industry, but also within other industries.

1.3 Purpose of the study

With the above reasoning on the aforementioned difficulties, the purpose of the study is to increase the understanding of how the purchasing department of OEMs, within the automotive industry in the electromobility sector, can achieve a resilient supply chain in a technologically uncertain environment through the involvement of NPD projects.

The following research questions have been formulated to achieve the purpose of the study:

RQ1: How does the relationship between NPD projects and the purchasing department function under a technologically uncertain environment?

RQ2: How can this relationship facilitate enablers, and eliminate barriers, to building a resilient supply chain in a technologically uncertain environment?

1.4 Limitations

This master thesis will be limited in some respects due to time and resource constraints during the execution of the report. The study is a single case study design hence it is limited by the case selection which will be referred to as OEM X from now on. External parties will therefore not be taken into account due to the above considerations. Within OEM X, mainly the purchasing department, which is responsible for purchasing products/components between the battery and the charging inlet, will only be studied. This further confirms that functions beyond the relevant parties will not be taken into account in this case study.

The purchasing department that manages these products is responsible for a wide segment of products/components. In this case study, only two products that the organization refers to as NPD projects will be examined, which means that only Product X and Product Y will be handled in the study, in order to achieve the purpose. The findings are therefore generalized with the purpose to be applicable to similar cases with NPD projects in a technologically uncertain environment. Only supply chain resilience in its current form will be investigated, hence any future planned actions will not be addressed in this master thesis.

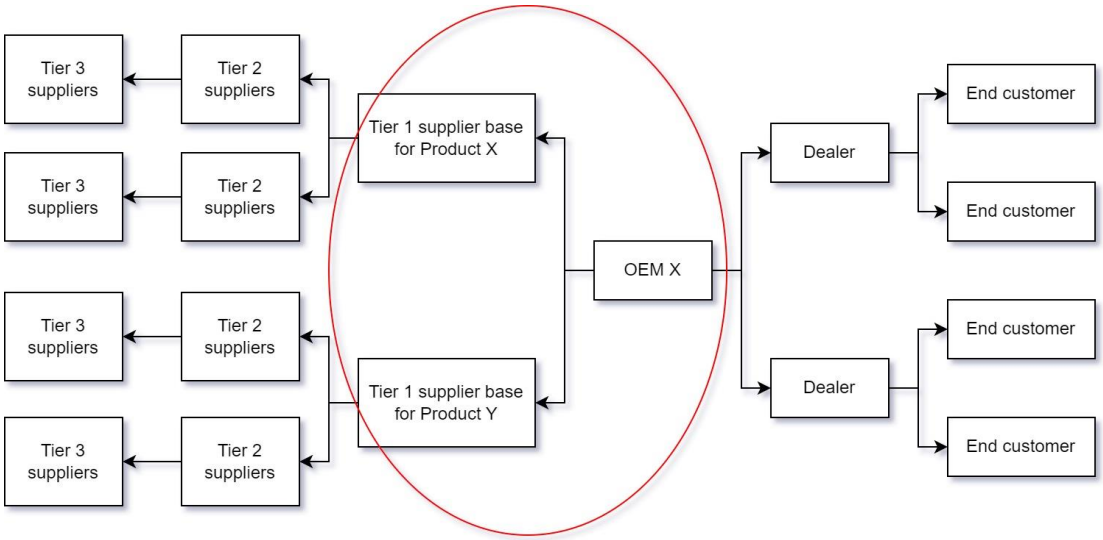

Figure 2. Upstream supply chain at case company OEM X.

To enhance the efficiency of the study as well as achieve its purpose, the prioritized area that is researched in this specific context is the upstream supply chain. Figure 2 illustrates that only OEM X and the Tier 1 supplier base for Products X and Y will be examined. Tier 1 suppliers will only be examined for the purpose of understanding which actors the purchasing department is involved with, and therefore will not contribute to any primary data collection.

2. Literature review

This chapter outlines a literature review for relevant areas in terms of technological uncertain environments, the role of purchasing in an organization, new product development projects, and early supplier involvement as well as an interpretation of supply chain resilience. The theoretical framework will provide an overview of the existing knowledge within these areas.

2.1 Technological uncertain environment

According to Porter (1997), companies are constantly striving for competitive advantage, whether the position relates to the product market or distinctive capabilities. Most companies take the approach of viewing customers, competitors, and suppliers as new potential market players, and work strategically to maintain market position through strong negotiation skills towards both suppliers and customers while maintaining their position in relation to competitors. However, Tushman and Anderson (1986c) argue that despite a strong strategy, technological changes in a dynamic market can disrupt even the strongest actors when new technological changes occur.

Tushman and Anderson (1986d) also state that technological newness can motivate economic growth and shape the structure of industries, pointing out that it plays a key part in the dynamics of competition and should be taken into account when organizations develop their strategy. Understanding and recognizing technological change has become more important, as a result of the emphasis on technology management and efficient product development, since it reflects the global economy's competitive demands. Furthermore, the authors Hanelt et al. (2021) argue that for stakeholders affected by a technologically uncertain environment, the capacity to develop products successfully is now considered a primary aspect in retaining competitive power. As a result, management of rapid technological change has gained prominence since it has a considerable impact on product development.

A study made by Barnett and Clark (1996) on *"Technological newness: An empirical study in the process industries."* showcased the findings that projects do not solely fall under the category of either radical or incremental changes. Rather, each project encompasses a spectrum of changes. A project might involve radical modifications on one dimension, while only incremental changes occur on other dimensions. In summary, the data suggest that technological changes take place to various degrees across multiple contributing dimensions, challenging the common practice of assessing projects based on a single dimension of change. Therefore, this result emphasizes the significance of evaluating projects on multiple dimensions of technological change. Gerwin and Barrowman (2002) further highlight that comprehending

the technological change in any project requires an understanding of several dimensions of technological newness. Furthermore, the authors conclude that there are some managerial implications to take into consideration when for example a company is to run a new product development project in a dynamic market. Firstly, characterizing technological change across multiple dimensions can help evaluate and select development projects, and determine potential difficulties, and required resources. This information can influence project selection and a firm's competitive strategy. Second, a regression model based on the characterization of change can predict project performance parameters such as development time and cost. It can also estimate development times accurately based on the variables that explain the data. Thirdly, linking the characterization of change and the performance variable of development time through a regression can provide insight into the relationships between different dimensions of technological change. This allows for the exploration of complex relationships between variables beyond the predictive value of a regression model, making it especially useful in managing projects (Barnett & Clark, 1996; Tatikonda & Rosenthal, 2000).

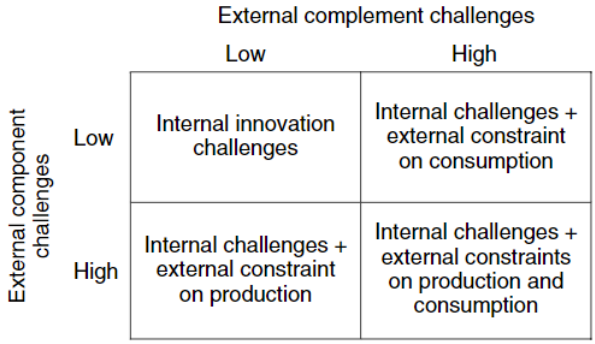

Figure 3. A framework for understanding the effect of ecosystem challenges on innovators (Adner & Kapoor, 2010).

Adner and Kapoor (2010) mention in their article that bottlenecks are a sign that challenges are not distributed equally among positions in an innovative ecosystem. The ability of the focal firm to generate value with its product can be limited by any challenge in the ecosystem, but challenges in different positions can do so in various ways. While challenges with downstream components limit the customer's ability to fully profit from the product's use, challenges with upstream components limit the company's ability to produce the product. These distinctions are shown in Figure 3. For example, creating zero-emission vehicles necessitates substantial advancements in engine design, components for engines, and infrastructure for fuel and battery supply. This would place such an organization in the bottom right quadrant, as it faces high-component and high-complement challenges, which corresponds to the greatest degree of environmental uncertainty.

When a technological change occurs, it often affects the abilities and motivations of suppliers, customers, and complementary companies, and these players can play a crucial role in the success of many firms. Research has demonstrated that in various industries, close relationships with suppliers are essential to the prosperity of manufacturers. Consequently, if suppliers' capabilities become obsolete due to technological advancements, firms must make a challenging decision to either stick with their current supplier or switch to a new one with capabilities that can meet the new demands (Afuah, A., 2000; Singh & Mitchell, 2007). Sticking with the existing supplier allows manufacturers to continue building on established relationships, but they may have to tackle issues related to the supplier's transition to the new technology. If the technological change is significant enough, suppliers may be unable to provide components with the quality needed for the manufacturer to stay competitive. Additionally, since suppliers can also be a source of innovation, having a supplier with outdated capabilities can deprive a firm of crucial innovation sources. On the other hand, changing suppliers entails building new relationships, which may be difficult if the firm's existing organizational procedures and routines are geared toward previous suppliers (Afuah & Bahram, 1995). Just as the aforementioned authors emphasize the critical role of suppliers in how a company develops in a technologically uncertain environment, it also highlights the importance of the purchasing department's responsibility of the sourcing function in analyzing and selecting suppliers that can benefit their supply chain.

2.2 Purchasing role as a department

The purchasing department has many functions within organizations, and it can look different between companies (Van Weele, 2018). However, from a general perspective, the purchasing department is responsible for the procurement process of a company. Its main function is to ensure that the acquisition of needed components and services is done at the lowest possible cost to the company in response to the internal needs within companies (Monczka, 2012). This involves a wide range of activities such as sourcing, ordering, negotiating, supplier management, and inventory management.

Sourcing is the process used to identify and analyze potential suppliers, something that the purchasing personnel are trained to do (Monczka, 2012). The analysis is based on predetermined factors that are in line with the company's own specification requirements, such as quality, price, or environmental impact. In the sourcing phase, there can be extensive research to identify new suppliers, companies can also choose to contact existing suppliers and then evaluate whether they meet the company's requirements. The purchasing department can in many cases also analyze whether to either make or buy certain components. Generally, it is

the R&D department within a company that develops products (Van Weele, 2018; Gadde & Håkansson, 1994). Supplier management is another important activity of purchasing departments once a supplier has been awarded. It includes managing relationships with existing suppliers, ensuring that requirements are met, and also dealing with any problems that may arise during the contract period. This work involves working closely with suppliers to form an understanding of their limitations and capabilities (Van Weele, 2018). Macbeth (1994c) describes how supplier management can be done through either adversarial or collaborative relationships. The adversarial relationship is based on a competitive and confrontational approach, while the collaborative is cooperative and has a mutual benefit approach. The two types of mentioned relationships are used differently based on the circumstances of both the buyers and suppliers and are often chosen based on an analysis that concludes which relationship will be most beneficial.

Negotiating, also mentioned as an activity within purchasing functions, involves a process of negotiating with suppliers so that the contract obtained is the best possible terms for the company. Negotiations may include discussions such as discounts, payment terms, and other factors that allow the company to reduce its costs, and bottom line (Van Weele, 2018). Kolchin and Giunipero's (1993) article also mentions how purchasing's role in regard to negotiation has a large impact on the success of the sourcing strategy.

Writing contracts is also a task that can fall to the purchasing department (Monczka, 2012). The author writes that there are many elements of the contract that should be considered when writing a contract such as definitions, scope of agreement, and payment specifications. A well-drafted contract will let the organization benefit positively (Monczka, 2012). Once contracts have been established with suppliers, the purchasing department will also be responsible for ensuring that orders are received by the suppliers, where they are responsible for ensuring that the goods or services are delivered on time, in the right quantity, and with the required quality. This may involve managing logistics during the delivery process, but also ensuring that the suppliers meet the requirements that the company has as its standard (Van Weele, 2018).

Inventory management will also be an activity that purchasing departments can carry out. With inventory management, the purchasing function will ensure that the company always has the right amount of items in stock to be able to carry out its operations. This can be done by, among other things, carrying out forecasting processes where demand can be predetermined, monitoring inventory levels, and placing orders to replenish stock as needed. Effective inventory management can reduce costs, minimize waste and ensure that the company's operations do not stop due to material shortages (Van Weele, 2018).

Cost control is also mentioned as an activity in purchasing departments, and this includes finding new ways to reduce costs while maintaining the requirements of the company. This can be through renegotiating with suppliers to obtain better prices, collaboration through partnerships, reducing waste and increasing efficiency, sharing of technology between buyers and suppliers, and optimizing the order point system to minimize inventory costs (Van Weele, 2018; Spekman et al., 1994d). In the case of renegotiating, distributive bargaining can be used, which means that two parties compete for a fixed amount of value where opposing relationships are persuaded. The actor with more power will in many cases be the winner in such a negotiation, while the actor with less power will be the loser. A win-win negotiation, also known as integrative bargaining, means that both parties understand each other's needs and focus on a common solution through joint efforts to solve problems (Monczka, 2012).

In conclusion, it can be said that the purchasing department has a critical role in ensuring that the company has the goods and services needed at the right time to carry out its operations in an efficient and cost-effective manner where the department has both a strategic and operational purpose. By managing the procurement process, the purchasing department will be able to ensure that the company has goods and services that meet the quality requirements, save money and at the same time have a good relationship with suppliers. Effective purchasing can be a key differentiator for companies operating in competitive markets, where competitive advantage is obtained, and superior value can be delivered to customers.

2.3 New Product Development

One of the main ways a company can achieve competitive advantage is by developing its own projects within the organization, namely new product development (NPD). Given the complex and competitive global market, which is undergoing rapid technological development, NPD can also offer great opportunities for growth and an opportunity for companies to improve their operations in order to remain profitable. Making a concept into a product is the goal of product development. This means that there are various stages involved in NPD processes, such as planning, concept design, product design and testing, and manufacturing startup. These steps can be carried out simultaneously or in sequence (Oliveira et al., 2018b).

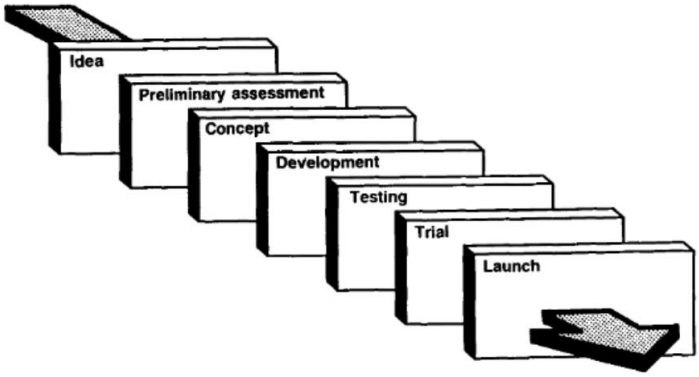

Figure 4. New product development activities (Cooper, 1988).

The process of developing a product is usually well structured and defined in different phases. Each phase often has a time frame and usually ends with the management deciding on the next phase and how the project should be progressed. As previously mentioned, in some cases the phases go in sequence, and some phases can overlap at the beginning and end, but it is difficult to work with different phases in parallel as the next phase is usually dependent on the previous one. A classic division of an NPD process can be seen in Figure 4, where Cooper (1988) portrays that the activities usually begin with a planning/idea phase, where requirements, requests, and demands that need to be fulfilled set the framework for what is to be developed. In the planning phase, the organization should also decide which market the product should target in order to be able to work towards meeting the customer's needs (Cooper, 1986). The next phase is the concept phase, in which the product's specifications and requirements are defined in more detail. The concept phase usually determines the market release date, technical performance, budgeting, organizational resources needed for the project, etc. Next up is the phase where the product design is formed, in this step the actual development of the physical product takes place, it is also here that decisions are made on how to handle trade-offs, and also in this step the idea is transformed into a tangible product. The product design phase can be divided into many smaller phases depending on how many changes you need to make along the way, and how much time, money, and resources you have. The last two phases involve testing the product and then releasing the product into production, which also means that in this phase it must be confirmed that the product has reached its objective, and thus achieves the customer value that was initially the reason for initiating the product development process (Davila, 2000; Cooper, 1986).

The authors' Hackman and Wageman (1995) mention in their article the importance of the teams involved in a new product development project working cross-functionally, as this can significantly improve quality. An increasing number of organizations use cross-functional teams consisting of different individuals from different functions in the organization, with the

common denominator that they all participate in the development of the new product. The organizational functions that are most often involved in a successful NPD project are e.g. R&D, marketing, manufacturing, and purchasing (Sethi, 2000). The benefits of involving several different functions of an organization are that the dynamics contribute to increased perspectives which can improve the decision-making process, and thus the quality of the outcome. Nevertheless, it is essential to understand that departments in an organization come from different backgrounds, therefore it is important that this is taken into account when exchanging information. It is a critical factor that there is a consistent common understanding throughout the project in order for the collaboration to work, and for an effective exchange of information (Dougherty, 1992).

2.3.1 Purchasing and NPD projects

Steward et al. (2019) writes in their report about how purchasing departments have previously acted as buyers of goods and services through transactional procurement but have recently taken on an increasingly strategic role in procurement. With increasing demands from consuming parties, rapid technological development, and growing global competition, the author further explains how the role of purchasing has evolved, which entails that buyers in organizations need to engage in communication with suppliers to an ever-greater extent than what was previously necessary in order to obtain a competitive position on the market. For organizations to maintain or excel in their competitive position, NPD has become a major factor in satisfying increasingly complex customer demands, as well as compensating for increased global competition with short technological life cycles (Nijssen et al., 2002). Short technological life cycles mean that R&D in many cases has to work with extensive NPD projects, and here Nijssen et al. (2002) argue that the involvement of purchasing departments in NPD projects can have a great impact on the performance of new products and provides a great opportunity for performance improvements.

Atuahene-Gima (1995) also discusses the purchasing departments' function in NPD projects and states how purchasing was previously considered to have a less important role in NPD. But according to the author, it has been shown that the inclusion of the purchasing function in many cases leads to more successful innovation work. Atuahene-Gima (1995) believes that an organizational buyer will be able to obtain external expertise in the form of supplier information and knowledge and also supply market information to benefit the process.

Di Benedetto et al. (2003) also write about how the purchasing department has an impact on the sourcing strategy. It appears that the more strategic the sourcing strategy is, the greater the

impact on the competitive advantage the purchasing department can have. Here the author has chosen to divide sourcing strategies into three stages: traditional, emerging, and strategic, and it is at the strategic stage that a purchasing department can have the largest value-adding competitive advantage in an NPD process. This can be done through supplier involvement, long-term relationships, single sourcing, and in cases where the supplier selection is reviewed before the design phase. Di Benedetto et al. (2003) highlighted that the role of purchasing may differ between companies, where factors such as size, competitive advantage, criticality of supply, and volumes, among others, play a role. However, the author concludes that the relationship between R&D and purchasing at an early stage is important in cases with a strategic sourcing strategy, as products often require some form of early supplier involvement (ESI) already in the design phase in order for companies to obtain high quality with competitive technology (Mendez & Pearson, 1994).

The authors Handfield et. al. (1999) discuss how open communication with suppliers can lead to a greater technological experience for companies, further emphasizing the importance of purchasing involvement in NPD projects. Petersen, et al. (2003) also confirmed in their report how the amount of valuable information a company has about its suppliers is linked to the amount of information sharing and involvement that takes place between the company and its suppliers. Handfield et. al. (1999) also highlights that during NPD projects it is important to use suitable suppliers to reduce the risk of contracting with suppliers who do not have the capabilities to deliver according to the contract or desired requirements. This requires that the purchasing department use supplier assessment tools to select suitable suppliers, and there are different types of criteria that can be applied in an assessment (Handfield, et al., 1999). As this can set a foundation for good cooperation between companies and their suppliers, as well as an effective product development process, which benefits the cases that require a high-quality product and punctual deliveries of products.

2.3.2 Early supplier involvement in NPD projects

The last few decades have seen rapid technological change, including rapid changes in the life cycle of products. This leads to a more competitive environment where suppliers increasingly play a role in the competitive advantage that firms have over each other. Handfield et. al. (1999) writes that 50% of the cost of goods can be traced back to the purchase of materials. Integrating suppliers into the product value and supply chain can thus have a major impact on the quality, cost, and technology of the products. Early supplier involvement (ESI) opens the possibility of accelerating research and development processes through risk sharing while obtaining new knowledge and assets. Dowlatshahi (1998) writes about how ESI can be interpreted as a form

of integration of a supplier's capabilities into a company's operations and supply chain. This then leads to the fact that products for end customers have advantageously been developed with suppliers' expertise in both manufacturing and design. Wieteska (2020c) has also investigated supplier involvement in product development processes and concluded that, in general, it is possible to achieve a more resilient supply chain by involving suppliers early in product development phases. This is something that Khan, et al. (2008) also recommend because it opens for the management of supply chain risks. The same authors also highlight the importance of intensive communication and collaboration with a good atmosphere, which has been shown to deliver better products in the design phase. According to Tavani, et al. (2013), a culture with a good atmosphere that promotes communication between company functions and suppliers can increase the ability to trust each other, which can then have a positive impact on the company's business performance.

The ESI concept has different levels and is therefore considered to be relative where suppliers' level of involvement can vary from low to high. At a higher level of involvement, a supplier can take on the responsibility of driving the development from concept to production, and at a lower level of involvement, companies can obtain information from suppliers to facilitate the development of products (Bidault et al. 1998).

Figure 5 presents how suppliers' involvement in ESI varies at different stages from “None” to “Black Box”. The level of involvement is dependent on among others trust between a focal company and suppliers and willingness to share risks (Petersen et al., 2005).

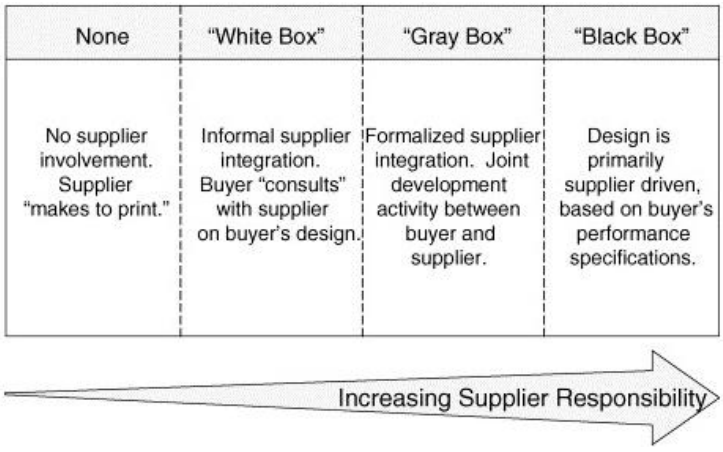

Figure 5. Supplier involvement in different stages (Petersen et al., 2005).

The different steps in the spectrum of supplier integration start at "None". At this stage, a supplier will have no involvement in the development of any product but can supply components to the product. At the next stage which is "White Box" involvement, the supplier

will consult the focal firm in the product development phase. According to Peterson et. al. (2005), there can be informal discussions between the focal company and the supplier regarding specifications and requirements between the parties, but it is ultimately the focal company that makes the final decisions regarding the product's design and specifications. The next step in the spectrum is the "Grey Box", and at this level of involvement, the activity between the focal company and the supplier will be more formalized. Rather than the focal company making all design and specification decisions on their own, suppliers will also be able to make joint decisions with the focal company through information and technology sharing. The next step in the spectrum of supplier integration means that the level of supplier involvement will be at the highest level according to the scale, also called the "Black Box". This step means that suppliers can, among other things, design products based on the focal company's specifications and requirements. The supplier may be informed of the requirements and specifications of the focal company, and then be given almost full responsibility for the development of the desired product. In this situation, the focal company will only have to check that the final product meets the specifications and design requirements that were originally requested (Petersen et al., 2005).

Kedzia & Staniec, (2022) discuss some of the benefits of Supplier Involvement in Product Development (SIPD) and how it can have a direct link to supply chain resilience. Some arguments that the author mentions include shorter product development times, better compliance, and quality. The factors behind these benefits are then linked to a reduction of risks in SIPD when designing processes, products, and supply chain networks (Handfield et. al. (1999). Chien and Chen (2010) also argue that joint product development is positively affected by cross-functional coordination and also internal integration. Von Haartman and Bengtsson (2015) describe how SIPD improves processes for both suppliers and customers and through qualitative research can be considered as a way to eliminate or reduce the risks that exist in supply chains, which in turn can increase resilience.

2.4 Supply chain resilience

Datta (2017) describes that supply chain resilience (SCR) is about allowing companies, through a dynamic process, to control their processes so that the companies stay away from danger zones that can trigger disruptive events, and if disruptive events should still occur, a resilient supply chain will be able to provide a very effective and rapid response where the consequences of a disruptive event can be minimized. Companies will often be able to obtain a dynamic stable state, or in those situations where the stable state has been disrupted, recovery will be short. Companies can then adapt their operations to changes in the environment, sometimes even before competitors. Gunderson and Holling (2002) define supply chain resilience as *"The*

capacity of a system to experience disturbance and maintain its functions and controls.". The concept of SCR is time-based and therefore there are different phases of disruption. Examples of these are: "before, during, and after" as described by Ali et al. (2017). Also considered are "readiness, response, recovery, and growth" by Hohenstein, et al. (2015).

To achieve an effective strategic supply chain management and optimize the flows among the actors for the purpose of improving supply chain resilience, it can help to map and define the current structure of the supply network in order to find the optimal strategy (Akdoğan & Demirtaş, 2014). Using a graphical representation to create a simplified model of the supply chain helps in the aspect of demonstrating the nodes and links, revealing information such as which actors are available within the network and what the organization's information flows look like, which is a sufficiently informative tool to use when visualizing, analyzing, and integrating supply chain management processes. It is possible to map supply chains with different levels of detail depending on the purpose of the map. For example, tracking carbon emissions requires different types of data compared to recycling processes (MacCarthy et al., 2022). Supply chains are very dynamic in nature and can change very quickly, hence the time constraint to create a sufficiently informative map can be challenging depending on what data you need to retrieve and to what extent. It is a laborious process that requires a lot of support from management and cooperative employees. Another aspect to keep in mind that can pose challenges is that some external parties, such as suppliers, do not always want to share information for various purposes, such as maintaining their market position or due to confidential contractual reasons (Mubarik et al., 2021).

Supply chain management is used by Cooper et al. (1997) to allow end users to use business processes to access value-adding services, products, and information, which is often provided by original suppliers. SCR is described according to Ponis and Koronis (2012) as the ability to design, plan, and act in a supply chain network where unexpected events that can be considered disruptive are expected to occur. In a disruptive event, the response should be adaptive where function and structure should be under full control and then return to the same state as prior to the event. The author also writes that in some cases it should be possible to return to a more robust state during disruptive events, this will then be able to give companies a competitive advantage. According to Ponis and Koronis (2012), the design of products and their supply chains should always take resilience into account. Furthermore, the author Pereira et al. (2014c) states that in order to achieve resilient supply chains it is important to identify potential enablers and barriers that influence the efforts of supply chain management in developing supply chains. The literature describes various enablers and barriers, while the following sections describe how these can be identified and how they contribute to creating SCR

2.4.1 Enablers to creating supply chain resilience

Wieteska (2018) has shown through a systematic review that the enablers that have the greatest impact on a resilient supply chain are identified as flexibility, transparency, redundancy, agility, visibility, information sharing, and collaboration. Pereira et al. (2014b) describe in their study that there are many disruptions that can affect a supply chain, including its nodes and links. Many risks can neither be predicted nor avoided, however, there are factors that can help prevent disruptions and allow an effective response to negative changes, and in turn benefit supply chain management. The following chapter presents seven different enablers that can strengthen supply chain resilience. The seven enablers are the most commonly used and mentioned in the literature and identified as the enablers that have the largest impact on supply chain resiliency (Wieteska, 2018; Pereira et al., 2014b; Faisal et al., 2006). Pereira et al. (2014b) have also investigated in their report the impact of barriers to a resilient supply chain. The study revealed that barriers have opposite characteristics to enablers, showing that barriers occur when enablers are lacking within an organization.

Flexibility

To enable flexibility in the supply chain, the required activities for procurement are to have the ability of a supply base that is able to respond to the demands and changes that are made in the buyer's plant, this will, in turn, improves the effectiveness in the buyer's plant in terms of responding to changes in trends and customer demand. A careful selection of the supply base is necessary in the case to remain flexible, as well as how a supplier is integrated, developing, and contributing to the buyer's changes (Giunipero et al., 2005b).

Transparency

Supply chain transparency means obtaining accurate and detailed data on products and operations, including their origins such as raw materials and sourcing, costs, logistics, and manufacturing processes (Bai and Sarkis, 2020). According to Montecchi et al. (2021), supply chain transparency can increase visibility where companies can easily track the movement of goods to anticipate unexpected events before they occur. This will then contribute to increased trust between actors in a supply chain because it is easier to detect disruptions, which in turn develops mutual trust and fosters relationships (Hernández-Espallardo et al., 2010). Mutual trust can in turn lead to a more effective collaboration, which also increases resilience. Montecchi et al. (2021) also describe how communication between different parties in a supply chain is made more effective by transparency. This in turn leads to joint responses to disruptions, which also increases resilience.

Redundancy

The capacity to withstand any disruption at any point in the supply chain by using backup resources is referred to as supply chain redundancy. This can be accomplished by accumulating extra inventory, keeping capacity utilization low, employing numerous suppliers, etc. Redundancies in the supply chain can have the effect of preventing slowdowns/shutdowns, providing safety stock in the event of delivery failure/loss, as well as supporting weaker nodes and links in the supply chain. Developing redundancies can ensure lean operations due to the fact that they assist in avoiding waste of time, energy, and resources. As a beneficial consequence of building a redundant supply chain can be for example, contracting with multiple suppliers which can minimize geographical risk, and thus improve resilience (Team, 2022). In the case where there is supplier involvement in product development, the sourcing process can in many cases be done through single sourcing (Wieteska-Rosiak, 2020).

Agility

Supply chain agility has proven to be one of the most important enablers for supply chain resilience. This is because agility allows companies to respond to volatility and other uncertainties in an efficient way, and thus allows companies to gain an initial competitive position in the market (Swafford et al., 2006). According to Fayezi et al. (2017), there are several dimensions within the theme of agility, and some important ones are:

1. Quickness: where companies' supply chains are characterized by speed and quickness through rapid responses to changes in customer demand, market conditions, and supply chain disruptions. It is possible for companies to have quickness through streamlined procedures and processes (Sharifi & Zhang, 1999b; Fayezi et al., 2017).

2. Proactivity: where an agile supply chain is proactive by anticipating potential disruptions and taking steps to eliminate or prevent them before they occur (Fayezi et al., 2017; Christopher, 2005).

3. Responsiveness: anticipates that the agile supply chain is responsive and able to sense and respond to changes that occur in, for example, market trends and disruptions. Responsiveness can be obtained through, among other things, real-time data, leveraging technology, and a good insight into supply chains (Bessant et al., 2002; Fayezi et al., 2017).

4. Adaptiveness: refers to the ability of an agile supply chain to adjust to changing market conditions where, for example, customer needs change. This is also made possible by monitoring supply chains and trends (Fayezi et al., 2017; Asree et al., 2010).

Visibility

The degree to which supply chain actors have access to the precise information they believe to be essential or helpful to their activities is referred to as supply chain visibility (SCV). It particularly refers to the visibility of demand and inventory data throughout the supply chain. The accuracy of demand forecasts is increased, manufacturing plans are adjusted more quickly to meet changing demands, delivery performance is enhanced, and inventory levels are decreased at all levels of the supply chain. End-to-end SCV, also known as SCV from first-tier vendors to end customers, allows supply chain partners to increase market responsiveness while reducing the risk of disruptions to the flows of materials and goods, contributing to a more resilient supply chain (Somapa et al., 2018).

Information sharing

Sharing information refers to disseminating knowledge that is beneficial to organizations, individuals, or systems. Four key issues should be addressed by organizations in order to improve the outcomes of information sharing: We question what to share, who to share it with, how to share, and when to share it first. The quality of responses will help to avoid redundancy, decrease sharing costs, and increase response time. With the development of information technology, various network structures can be modeled to improve collaboration between supply chain partners. This collaboration and coordination result in a more advantageous and successful supply network. The final customers will receive higher-quality goods at lower costs in less time as information flows will increase, uncertainty may be reduced, and these three factors will all come together to benefit the end users (Lotfi et al., 2013d).

The key element of supply chain collaboration, according to Min et al. (2005), is knowledge sharing. Giving attention to information sharing will enhance the bond between actors in the supply chain and further strengthen potential partnerships. Effective information sharing can lead to lowering costs and better inventory management. Information can be shared throughout a supply chain in different shapes and forms, the most usual types of information to be distributed in a supply chain are sales data and forecasting, order information, product ability information, inventory information, exploitation information of new products, etc. (Lotfi et al., 2013d).

Collaboration

Supply chain collaboration is also mentioned as an enabler for a resilient supply chain according to Wieteska (2018) and involves the creation of synergies between actors that allow, among other things, joint planning, and exchange of real-time data (Whipple and Russell, 2007). The collaboration will in many scenarios contribute to risk sharing, collective reward, and benefit where there is information sharing as a result of collaboration (Barratt, 2004). Cao et al. (2010) also offer a conceptualization of a supply chain collaboration where the activities include joint decision-making, information sharing, common objectives, incentive alignment, collaborative communications, and joint knowledge creation to achieve a more resilient supply chain. According to Scholten and Schilder (2015), collaboration and its mentioned activities will result in increased responsiveness and a reduced impact of disruptions. However, Christopher and Peck (2004) also discuss how collaboration in many cases involving single sourcing, can increase the risk of disruptions. There is also other research that indicates that increased collaboration and information sharing leads to faster risk response processes (Skjoett-Larsen et al., 2007).

Supply chain collaboration also implies the objective of internal collaboration in a cross-functional environment. Companies that promote an open culture in environments where collaboration between different teams takes place, generally enhance their performance. A typical internal cross-functional collaboration usually involves R&D, marketing, services, production, and purchasing sharing information with each other in order to pursue different goals (Barratt, 2004b).

2.4.2 Barriers to creating supply chain resilience

Just as there are known enablers that can promote supply chain resilience, there are also known barriers that can hinder the establishment of favorable conditions and thus achieve a resilient supply chain. For organizations that have difficulties in improving their SCR, it is important to identify and eliminate barriers (Shashi et al., 2020). According to Gupta et al. (2022), barriers can be difficult to overcome and complex in nature, hence more than one strategy is often required to eliminate barriers.

As previously described, SCR can be identified as a redundant, flexible, agile, responsive, collaborative, and visible supply chain that withstands unpredictable events and is capable of being prepared, responding, and recovering from them (Tukamuhabwa et al., 2015). Tushman and Anderson (1986b) describe in their article that organizations working in technologically uncertain environments are often exposed to a rapidly changing environment where technology

is constantly evolving. Hence, a technologically uncertain environment can be considered to be a barrier to achieving SCR in cases where organizations have not built a sufficiently resilient supply chain to cope with rapid changes and where the introduction of new market entrants can create disturbances that harm the organization (Gupta et al., 2022).

Furthermore, it is stated that barriers such as lack of coordination and control, lack of trust, and innovative and complex processes also limit the promotion of achieving supply chain resilience to the extent that, for example, lack of trust can damage both internal and external relationships and make it difficult to achieve common goals, while complex processes can be financially demanding and prevent the development and investment in new resources that can benefit the implementation of SCR (Kwak et al., 2018; Shashi et al., 2020b; Agarwal, 2021).

Shashi et al. (2020a) further mention in their article *"Managing supply chain resilience to pursue business and environmental strategies"* that inefficiencies in decision-making processes, supplier management, and information management systems, as well as lack of resources and capacity, are known barriers that hinder efforts to create supply chain resilience. In accordance with the rapid pace of development in a technologically uncertain environment, it is ever more imperative that inefficient processes and deficient areas are quickly identified and addressed to eliminate such barriers.

It is also worth mentioning that global disruptions can be considered barriers to building supply chain resilience in organizations. Majumdar et al. (2022) mention in their article how the COVID-19 pandemic created significant disruptions in many supply chains, making it difficult to obtain materials as many markets were shut down and different modes of transportation were not accessible as required, demand fluctuations and lack of supply of raw materials and components, disrupted supply chains and hampered resilience work. When the COVID-19 pandemic emerged, it challenged transport and logistics solutions as country borders were closed, the consequence of infected workers and those in quarantine caused labor shortages and remote working caused inefficiencies at many workplaces (Chowdhury et al., 2021).

2.5 Purchasing during technological uncertainty

Schmelzle and Tate (2022) describe in their research how purchasing's role under technological uncertainty can be applied to act as an "innovation facilitator". It appears that TU contributes to a lack of information about availability, prices, and technological advancements. According to Noke et al. (2008), technological uncertainty will depend on the level of technological complexity or newness. For purchasing departments, this will entail a need to adapt integration

processes and resource acquisition. According to Schmelzle and Tate (2022), the purchasing organization under technological uncertainty can improve the innovation process through, among other things, purchasing orchestration (PO), which significantly affects the department's capabilities. PO refers to bundling, structuring, and leveraging resource-based capabilities for a company to gain a competitive edge.

There are also other researchers who debate what the purchasing role should look like in markets with many innovation processes where technological uncertainty is common. Some scholars such as Mikkelsen and Johnsen (2019) and Schiele (2010) argue that purchasing in these environments should have a broader role or in some cases a "dual role". Luzzini et al. (2015) also discuss the role of purchasing which they described as a boundary-spanning role that acts as an essential facilitator between internal and external stakeholders.

There are thus different perceptions of purchasing's role in technologically uncertain environments between different scholars, but like Steward et al.'s (2019) conclusions, the aforementioned scholars argue for a more strategic role that purchasing is beginning to take on, moving away from a traditional role. During innovation processes, NPD projects are common, and technological uncertainty also tends to occur to a high degree in these environments. Atuahene-Gima (1995) also believes that purchasing should have a more important role in NPD projects. By involving purchasing early in NPD projects, a successful outcome of the project as well as the opportunities for ESI will increase significantly, which according to Wieteska (2020c) can increase the chances of achieving a more resilient supply chain.

Furthermore, for the purchasing department to avoid unexpected events leading to negative consequences, companies need a resilient supply chain that is capable of adapting to these changes. Pereira et al. (2014) discuss the importance of the role and impact of the purchasing department on supply chain resilience. In today's complex environment, the dynamic capabilities within organizations become important to achieve a resilient supply chain. Dynamic capabilities generally refer to organizations' ability to build, integrate and reconfigure external and internal competencies to meet changes in today's complex environment (Chicksand et al., 2012).

Pereira et al. (2014) also discuss enablers and barriers for supply chain resilience and how barriers are not clearly separated from enablers but are rather interconnected. This is something that goes in line with Wieteska (2018) research where enablers are presented and when these are not considered to be fulfilled, will act as a barrier. These can be used as tools by the purchasing department to identify areas of improvement and create a clear analysis of the

current situation, which is particularly important for companies experiencing accelerated technological developments and uncertainties while striving to be competitive (Gupta et al., 2022).

3. Methodology

The purpose of the methodology chapter is to describe the design and reasoning that has been taken to accomplish the aim of the master thesis. This chapter will outline the research strategy, data-gathering process, and methods for analyzing data. Views on data validity and reliability, as well as ethical considerations, will also be outlined.

3.1 Research design

According to Gerring (2004), a case study can be defined as an intensive study of a group, person, or unit. Through a case study, according to the author, it should be possible to generalize findings through several different units. Thomas (2011) defines a case study as the method of analyzing systems through comprehensive methods. The qualitative case study has some known problems. According to Baškarada (2014), it can be difficult to validate findings due to intricacy characteristics and conflicting epistemological hypotheses. The same author also describes how case studies have two functions in many cases where the first function fills studies in their own unit, and how the second function also fills studies for a larger group of units. Baxter & Jack (2008) discusses that case studies require that the right tools are used in the right way for the researcher to be able to study the case, and in cases where the methods are also applied correctly, conclusions about the studies can be formed with the help of theories.

Thomas (2011) clarifies that there are different methods to conduct case studies, where the approach and design of a study are heavily anchored in the purpose of the study as there are different suitable methods depending on what is to be explored. Furthermore, the author describes that a research approach should be chosen, that most appropriately aims to achieve the objective of the research. Patel and Davidson (2003) explain how there are two different research approaches that could be applied in the specific case. The two were deductive and inductive approaches where the first implies that a hypothesis based on current research is tested through data collection that can confirm the hypothesis. The second approach implies the collection of data, which will be a foundation for empirical findings. The empirical findings can then be explained through a theory.

Yin (2009) outlines how the research design can be formed as a single case study or a multiple case study depending on the context where if there is more than one single case, the author states that a multiple case study should be made. Through a multiple case study, the researchers will use several different cases to form an idea of the similarities and differences between the different cases (Stake, 1995). According to Yin (2009), a single case study can be carried out

with embedded units. The researchers will in these cases be able to analyze data within analyses, between similar analyses, and also through cross-case analysis. According to Dyer & Wilkins (1991), the difficulty with a single case analysis is for the researcher to understand and describe the context so that it can be perceived by other readers and also so that new theories can be formed from the study.

Yin (2009) authors how single case studies can be used in cases where the case is revelatory, can give rise to unusual research access, or when the case is extremely exemplary. Eisenhardt and Graebner (2007) highlight how multiple case studies in many cases can be superior to single case studies, but also highlight that single case studies in many cases can create a more complicated theory compared to a multiple case study because the researcher in a single case study can adapt the theory to the details of the particular case. Lewis and Ritchie (2003) also discuss the term "theoretical generalization" where theoretical concepts should be applicable in broad contexts, and sometimes even with a universal application. Stake (2000) argues how a single case can be more generalized in many cases due to being more in-depth compared to two compared cases. This is because the single case can create a precise understanding of different phenomenon occurrences and therefore can be more reliable.

Considering the above statements and reasoning from existing literature, the choice of methodology to conduct this case study was heavily anchored in the purpose of the study. Therefore, the research approach, as well as the design, has been selected appropriately to achieve the objective of the research. In order to increase the understanding of how the purchasing department of OEMs, within the automotive industry in the electromobility sector can achieve a resilient supply chain in a technologically uncertain environment through the involvement of NPD projects, a single case study research design with an inductive approach has been chosen. The single case study, performed at OEM X, will allow a deep and detailed exploration of a specific supply chain and the resilience it employs. As a result, valuable insights and information about real and complex supply chain management processes will be investigated, which will contribute to findings and conclusions that will generate the development of resilient supply chains. Furthermore, the single case study at OEM X will allow for an in-depth investigation of how different actors handle specific scenarios and address elements related to resilience in the supply chain, allowing the discovery of potential opportunities and areas of vulnerability in this context. As the primary data is available at the case company, the inductive approach is the most logical research approach in this context. The justification behind the inductive logic is that complex, reality-based phenomena in supply chain resilience will be investigated, which will facilitate the development of theories and concepts derived from observation and analysis of the specific case to contribute to a deeper

understanding and further research in the field, rather than starting with pre-existing theories and hypotheses. Figure 6 provides a visual representation of how the study was conducted.

Research method			
Background	**Data collection**	**Data analysis**	**Data presentation**
• Meetings • Observations • Workshops • Informal interviews • Manufacturing plant visit	• Semi-structured interviews • Observations • Internal documents	• Transcribed interviews • Qualitative research using thematic analysis	• Descriptive text presenting the findings • Tables illustrating quotes, sorted by theme/category

Figure 6. Visual representation of research method for the single case study with an inductive approach.

3.2 Data collection

Bryman and Bell (2015) discuss two different categories of data collection, primary and secondary data. The primary data consists of the data collected during research directly by the research group, while secondary data refers to data that has been analyzed and collected by someone that is not involved in the research that is being done, this data can then be sourced from external sources. This report has used a combination of both primary and secondary data when addressing the research questions. The primary data has been collected mainly through interviews and observations. The secondary data is collected from available literature, scientific journals, and internal data at the case company. Hence, it is concluded that the data collection is of a qualitative nature.

3.2.1 Data collection and sampling

During the gathering of primary data, a selection of stakeholders and industry experts has been interviewed in-depth with a selection based on the rationale in terms of being the most informative, also known as purposive sampling (Tenny et al., 2017). In conjunction with this statement, only stakeholders from R&D and the purchasing department for electromobility products and components, have been selected for in-depth interviews for this case study in order to collect the most informative and relevant data, associated with the objective of the study. The respective departments have the primary responsibility for the development of resilient supply chains when managing the NPD projects, hence it is not relevant to interview parties outside these institutions as they do not contribute to the purpose of this master thesis.

The primary data collection has been done in the form of interviews that were semi-structured which is beneficial during investigations of specific topics (Bryman & Bell 2015). The semi-

structured interviews enabled the participants to have more time to delve thoroughly into the respondent's opinions, drives, attitudes, and perceptions. Depending on the respondent's choices and availability, the interviews were either conducted in-person or remotely through video conference. However, to be able to observe the body language of the interviewees, most interviews were conducted in person to increase the validity of the answers (Bryman & Bell 2015). The interviews were also recorded and transcribed after permission was given, this is according to Bryman & Bell (2015) beneficial since notes will not have to be taken to the same extent, and might in some cases generate some follow-up questions that further strengthened the data collection. Phillips (2008) explains that interview questions should be designed to be precise, brief, and easy to answer. Hence a lot of time and thought was invested, to form the questions that were used during the interview sessions for our case study. To further confirm this, the interview was also tested in a trial run prior to the actual data-collecting sessions, where two persons with good insight into the electromobility purchasing sector answered the first draft of questions. This was done to ensure that the interview questions were easy to interpret and that the questions were constructed in an unbiased manner as well as for the research group to ensure that the questions are sufficient.

Different interview templates were tailored for different persons being interviewed. The R&D department for example had very different knowledge about a product and its suppliers, compared to the purchasing department of the same company. Therefore, the interview templates were customized to be fitting for each interviewed person's position and competence in regard to serving the purpose of the thesis. However, most of the interview guide was used consistently for all interviews conducted to ensure reliable data is collected for improved research quality, there were only a few questions that were tailor-made to fit the interviewee for a more effective data collection.

To ensure that the interviews were relevant and value-creating in terms of data collection, the interviewees were given an opportunity to see all the questions that were going to be used during the interview before the actual interview was conducted. With the questions in hand before the interview, the interviewees were able to prepare for the interview and also inform the researchers beforehand if they were missing the desired information or did not want to participate. All interviewees were also informed about their right to skip questions they did not want to answer. Table 1 presents the list of respondents at the case company.

Interview	Department	Date & Duration	Product X / Y
1	R&D	2023-02-21 48 min	X & Y
2	Purchasing	2023-02-22 26 min	Y
3	Purchasing	2023-02-22 45 min	X
4	Purchasing	2023-02-28 65 min	X & Y
5	Purchasing	2023-03-01 32 min	X & Y
6	Purchasing	2023-03-03 61 min	X & Y
7	Purchasing	2023-03-07 33 min	Y
8	Purchasing	2023-03-21 28 min	Y
9	Purchasing	2023-04-13 67 min	X & Y
10	Purchasing	2023-04-13 83 min	X & Y
11	R&D	2023-04-14 57 min	X & Y
12	R&D	2023-4-14 63 min	X & Y

Table 1. Primary data collection: list of respondents at the case company.

Snowballing was also used to identify the right people to interview. According to Bryman and Bell (2015), a person who is interviewed will be able to recommend more people with relevant expertise that can help in answering the research questions. However, it must be taken into account that snowballing may result in the answers obtained possibly being biased since snowballing might result in interviewing people with the same background (Bryman and Bell., 2015). Nevertheless, given that the investigated NPD projects are relatively unknown, and that the people currently working on them have different tasks and backgrounds at the case company, bias is not considered to be a potential risk in this specific case study.

3.2.2 Observations

In order to better understand the new product development projects that were under research, as well as their impact on end users, and their interaction with other components, observational

studies were carried out. The thesis was carried out for approximately 20 weeks where the research group was able to work directly at the case company's facilities, as observations could constantly be made. The observational studies involved live meetings, workshops, and visits to the manufacturing plant. The information collected during the observations was noted in a text format in a document either directly during the observation or shortly after.

3.2.3 Internal documents

The internal documents collected at the case company were also used to both confirm information from the interviews and also for complementary information used to answer the research questions. Much of the internal data available contained both information that was relevant and information that is not relevant to the report. Therefore, the internal data was carefully examined, and what was considered relevant was stored for the duration of the study, on computers provided by the case company as the information was classified. To ensure that all documentation used in the report was not at risk of being leaked, all work related to this master thesis has been conducted on the case company's own computer servers available during the study period and the information included from the internal data has been presented in the report in a confidential manner.

3.3 Data analysis

This research project aimed to answer the research questions by generating new data. In order to analyze the collected qualitative data, thematic analysis was used. According to Bryman (2018), the thematic analysis method is one of the most commonly used in qualitative analysis. The same author writes that thematic analysis is characterized by codes and subtopics that are compiled and structured to create themes. Jason and Glenwick (2015) describe thematic analysis as a research method that can generate descriptive data with little regard for numerical quantification. The following figure shows the different phases of a thematic analysis.

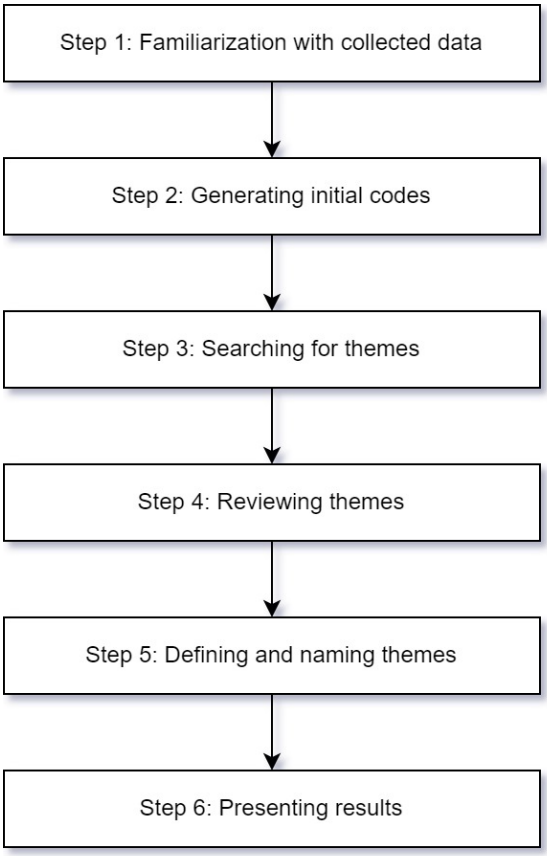

Figure 7. The six phases of thematic analysis (Illustration based on Braun & Clarke (2006)).

The first step involves the transcription of verbal data, and while transcribing the data, the researchers had the task of including both verbal and nonverbal information in accordance with Braun & Clarke (2006). After transcribing the verbal data, the researchers studied the transcripts in order to form an idea of possible themes and patterns. In accordance with Bryman (2018), the researchers had these patterns in mind when creating themes: metaphors, repetitions, analogies, similarities, transitions, linguistic differences, and distinctions. The researchers also accounted for Bryman (2018) that describes how a discovered pattern does not necessarily mean that it is considered a theme, but the patterns also need to be relevant to the study in the sense that they contribute to answering the research questions. Then the first draft of the initial codes was created. According to Braun & Clarke (2006), these codes and their information in the data can be considered valuable for the research questions, and the codes represent a very literal aspect of the data. The researchers then linked the different codes to a relationship with each other, where the link was based on an underlying interpretation. Then the researchers assessed the map to make sure that its validity was credible in relation to the full data set. Once a satisfactory map had been created, the researchers captured the core point of each theme, and the findings were presented in a narrative with quotes that supported the reasoning.

Braun & Clarke (2006) also emphasize how the researcher should avoid certain pitfalls when conducting a thematic analysis. According to the author, It is not enough to collect quotes and data from the interview transcripts, but a careful examination of the data is also required. According to Braun & Clarke (2006), the researcher should not use the interview questions as themes, as this can leave the analysis unreliable and poorly founded. How the data is perceived by the researchers also affects the quality of the analysis. A poorly executed interpretation of the answers can therefore affect the analysis negatively according to Braun & Clarke (2006). These were pitfalls that the researchers had in consideration to get a thematic analysis with a well-founded and valid analysis.

3.4 Research quality

The quality of the research is an important aspect to consider for all data collected, both internal and external. According to Bryman & Bell (2015), research quality can set the foundation for the methodological approach that the research should be designed around, in order to achieve as high quality in the study as possible. Further, the authors argue that ethical principles should also be taken into account and will further be discussed how this influence the quality of the research.

3.4.1 Reliability

Guba and Lincoln (1989) state that reliability is a condition that needs to be satisfied before validity can be achieved. Furthermore, the authors explain that reliability concerns data over time and its stability and that it is achieved by using the same instrument in the same phenomenon resulting in similar measurement data. Halldorsson and Aastrup (2003) describe in their article that changes in methods, hypotheses, or basic structures can threaten the reliability of a study as it disrupts the pattern over time, which is a fundamental condition for a study to be interpreted as reliable. To increase the reliability of this study, the same interview guide has been used for all interviews as a basis. All respondents have received identical information and each primary data collection occasion has been treated in the same manner. This establishes a pattern over time, which promotes the reliability of this case study and reduces the risk of collecting unreliable data.

3.4.2 Validity

Halldorsson and Aastrup (2003) argue that it is about being able to understand why certain interpretations may occur during the research process, and according to Bryman & Bell (2015),

validity is about assessing the researchers' compliance in investigating what has been said to be investigated. The same authors argue that researchers should consider both internal and external validity. Internal validity refers to whether the conclusions drawn are within a reasonable degree, and external validity determines whether the findings can be generalized.

Triangulation is a method that can be used to increase the validity of the collected data, thereby improving its quality. It involves using more than one source for the same question to gather information (Jick, 1979). Triangulations have been used during the research study by supplementing the interviews with documents such as internal documents and the Code of Conduct to increase validity. In accordance with Ellram & Tate (2015), the findings from the interviews have also been discussed with a supervisor from OEM X or Chalmers to ensure that reasonable conclusions have been drawn to obtain a high level of validity. Careful observations of the respective departments have been made continuously, without the study being influenced by the case company as all work on the report has been carried out separately from the primary data-collecting parties' environments. After mapping how the work is done at OEM X and analyzing the employees' routines and work culture, the selection of respondents has been chosen specifically to benefit the purpose of the report. To increase the possibility of general findings, interviews have been held with both R&D and purchasing to be able to create nuanced findings that contribute to the purpose statement, which according to Ellram & Tate (2015) increases validity.

From the above reasoning, it is argued that the validity of the study is of high nature, however, it is important to mention that Halldorsson & Aastrup (2003) highlight in their article that the transfer of best practices from one context to another, where circumstances can be different, might introduce inadequate transferability risks.

3.4.3 Ethics

According to Bryman & Bell (2015), ethical rules regarding data collection are of high priority as they can have a great impact on the outcome of the research. As the processing of the information in this study is of a sensitive nature, the entire research was treated in a confidential manner. All work on the thesis and the report itself has been issued after non-disclosure agreements (NDA) have been signed by the researchers, which means that generic titles are designed for company names and respondents to the study. Accordingly, throughout the report, the case company is referred to as OEM X.

Each interviewing candidate received confidentiality information in advance of the interview, and the researchers explained verbally before the interview began that all information was of an anonymous nature in accordance with the case company's requirements. Interviews were recorded only with the respondent's consent, despite the guarantee of anonymity. In addition, the respondents were informed that they were allowed to avoid questions of a sensitive nature or end the interview if desired. The following rules were believed to promote the collection of data as well as it is not relevant for the execution of the study that anonymized information is shared for both internal and external parties.

4. Empirical findings

The empirical findings based on data from interviews, internal documents, and observations will be presented in this chapter. First, a case description will be defined, followed by the data retrieved about the relationship between NPD projects and the purchasing department's function. Lastly, the current enablers and barriers for a resilient supply chain in a technologically uncertain environment will be presented, to identify the current state of the case company.

4.1 Case description

OEM X is a corporate entity that specializes in providing an array of transportation and industrial services including trucks, buses, construction equipment, financial services, and autonomous solutions. With an industry-leading presence, the company has manufactured diesel-operated vehicles for nearly a century. However, the company has recently shifted its focus towards developing more sustainable alternatives in response to the pressing environmental concerns of our time. Specifically, OEM X is currently prioritizing the development of electrified solutions, with future ambitions of delivering fossil-free transport solutions. The company places a significant emphasis on achieving customer value and works strategically towards realizing its goals. One such customer value is the establishment of a resilient supply chain to ensure that the company consistently delivers high-quality products to the market.

The purchasing department of the organization is of significant size, with a supply network of approximately 25,000 partners and a pipeline worth greater than 100 billion SEK. Within the organization, there are multiple departments responsible for various procurement activities. The purchasing department, under consideration in this case study, is a specific segment dedicated to transformational ambitions for components between the battery and charging inlet. The department procures various electrical components, among other items, with a team of about 10 professionals dedicated to this task. The team is responsible for purchasing activities for Product X and Product Y. Establishing a resilient supply chain for these products is a critical priority area for the organization, with concerted efforts underway to achieve this objective. While the organization collaborates to attain this goal, the primary responsibility for this critical undertaking rests with the purchasing department.

Product X is an NPD project that has been in progress for a certain period and is planned to be introduced on future platforms. During a Make or Buy analysis by OEM X, a strategic decision

was made that the product, in its entirety, falls under the "Buy" category, and as such, it will be outsourced to a selected development supplier who has been awarded the contract to supply OEM X with the product for an agreed period. Figure 8 gives a simplified graphical representation of the supply network for Product X.

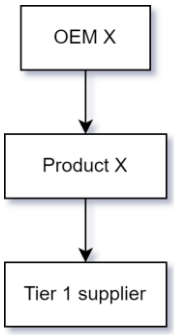

Figure 8. Graphical representation of the supply network for Product X.

Product Y is also an NPD project that has been in progress for a specific duration and is intended for future platform deployment with the goal of providing an enhanced user experience to the end consumer. Following a comprehensive Make or Buy analysis of Product Y, a strategic determination was made that the project, in its entirety, will be undertaken by OEM X and as such, falls under the "Make" classification. Product Y is a complex arrangement of several constituent components which can be seen in Figure 9. The constituent components of Product Y are of a complex nature, and there exist several variants of Component Y1, Component Y2, and Component Y3. Each of these three constituent components has its own supplier base and is treated as an individual product to be procured by the respective procurement department before being further assembled at OEM X's factory. Product Y is sold in its entirety to various business areas within the organization, where they work collaboratively in the early stages to create synergies and economic advantages.

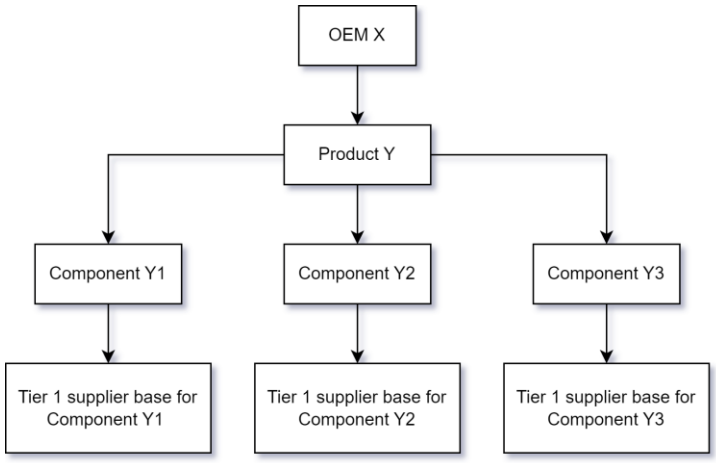

Figure 9. Graphical representation of the supply network for Product Y.

The two NPD projects have different-sized teams where the projects are mainly run by the R&D department, and when additional internal or external parties are involved, the departments join at different phases of the project. For Products X and Y, the NPD process is as follows, where Figure 10 also shows when the purchasing department for each project is involved in the development of the products.

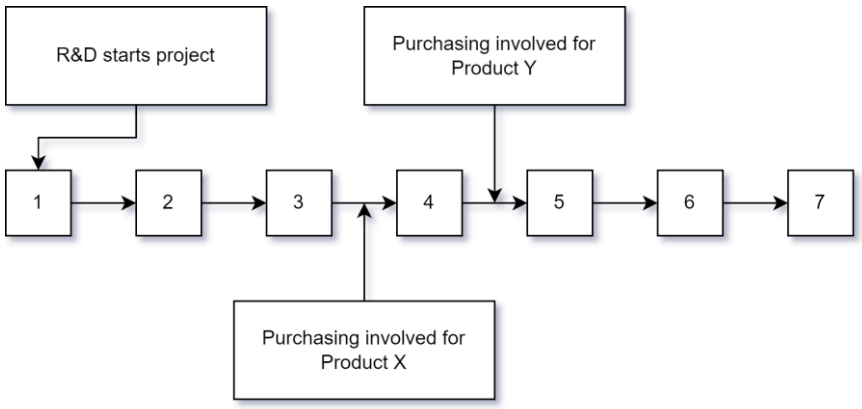

Figure 10. NPD process for Products X and Y, displaying purchasing's entry points.

The steps in Figure 10 are explained below:

1. Early, immature, concept phase where advanced engineering, either alone or in conjunction with a technology partner, defines the scope of the development project.

2. Before the project initiation, there will be a decision to be taken about how the project should be initiated. This is to allocate the correct resources to work on the project.

3. At this stage, the maturity of the concept increases by having some technological advancements, while a feasibility study is made simultaneously. The aim is to work on concept development. If a potential development supplier is to be involved, they are introduced here, which also implies that purchasing is usually introduced to the project at this stage.

4. Concept development phase initiated, including A-sample prototypes. A lot of technical elements are defined at this stage which is difficult to change later. If a development supplier is to be involved, they are introduced here.

5. Further product development stage where B-sample is introduced. If a product supplier is to be involved, they are introduced here.

6. The product development enters a verification stage where C-sample is introduced, working towards industrialization & commercialization.

4.2 Interdepartmental collaboration and constraints

In the thematic analysis, a theme was created concerning the relationship between R&D and the purchasing department in the environment in which these two NPD projects are conducted, as well as a theme concerning constraints. Table 2 demonstrates that codes based on how the primary data indicated that the organization is affected by factors such as lack of collaboration in project phases, the burden of purchasing activities on the R&D team, and conflicts among the departments. The following section will explain what the empirical data on this issue reveals.

4.2.1 Relationship between R&D and purchasing

When examining the collaboration between R&D and purchasing, it appears that the involvement of the purchasing department in the NPD projects has a great impact on the success of the projects. However, deficiencies are observed in the activities carried out by purchasing and also in the degree of involvement of purchasing in these projects. It appears, among other things, that the purchasing department and R&D cooperate well at a managerial level, but as soon as the projects start, it is noted that the cooperation between purchasing and R&D is insufficient in the day-to-day business operations. In general, R&D is responsible for developing products according to needs, and purchasing is involved in, among other things, when procurement processes are to commence. In the case of OEM X, the purchasing department may be involved too late, which in turn leads to a loss of expertise in the projects and difficulties in finishing the project till the start of production. Collaboration is also lacking in terms of how different departments work in "silos" where the correspondents experience that other departments are regarded as a different organization with separate responsibilities, having a negative impact on the projects.

"Blur the lines between us and them [R&D and purchasing]. It works best if we have a mutual dependency, that we have the same goal and the same idea of how to get there."

- Interviewee 12

According to the purchasing department, in some cases, it is good to be involved at a very early stage in new product development projects, but this is resource intensive and also requires R&D to know enough about the needs of the OEM for purchasing to fulfill any function. According

to R&D, purchasing has in many cases been involved far too late, which has resulted in R&D having to both design products, but also act as buyers and perform work tasks belonging to a purchasing department, as an engineer states in an interview "*(...) our team had to work as both purchasers and designers at the same time*." (Interviewee 12). This affects OEM X negatively in that purchasing sometimes cannot provide input in the form of its own expertise and gets stuck collaborating with already involved suppliers that were not selected by properly educated people with the right tools, while R&D has to put valuable time into work tasks that should be performed by another department.

Between purchasing and R&D, it appears that there are conflicts regarding when purchasing should have been involved in the development of Product Y, as well as conflicts regarding the distribution of tasks between the departments. Figure 10 shows a graphical representation of when the purchasing department was introduced to the new development project for Product Y. R&D believes that purchasing is involved too late into the project and that R&D is left to do much of the work that purchasing should carry out. At the same time, it also appears that there are differences of opinion on what should be carried out in the different phases of product development. R&D state that they want to have suppliers nominated as early as possible while purchasing want to be able to choose between different suppliers later in the product development process where technical requirements are more established.

As for Product X, primary data indicates that the collaboration on the project was better, compared to Product Y. Figure 10 shows the entry point of the purchasing department in the project where Make or Buy analysis, review of the potential market, and negotiations, have taken place in collaboration with several different teams involved in the development of the product from OEM X. Product X's selected development supplier will run the project together with OEM X, and is responsible for most of the work and the competencies regarding the ingoing components of the product.

The R&D respondents also state that there is a need for improved communication between different functions within the case company where, for example, R&D and purchasing in a collaborative partnership can select suppliers at an early stage. This can then be considered to help avoid costly mistakes and risks associated with delays. R&D also believes that purchasing in many cases can slow down a sourcing process through strict purchasing conditions, and this could then be inhibited by sacrificing secondary purchasing conditions.

"I think the earlier we involve at least a few good suppliers, the better it is. This does not necessarily mean that we need to involve a lot of documentation paperwork right from the

beginning. But at least to get some stomach feeling feedback, that would be very helpful (…) and perhaps sacrifice secondary purchasing conditions." - Interviewee 11

4.2.2 Technologically uncertain environment

By analyzing how technological uncertainty affects OEM X's efforts to achieve resilient supply chains for Products X & Y, it is acknowledged that technological development moves rapidly with great uncertainty as it is not known what new technology is available tomorrow on the market. The purchasing department and its supplier base have changed due to the technologically uncertain environment which OEM X is facing. Their current supplier selection strategies are impacted by new market entrants and the rapid pace, as a respondent from the purchasing department states, "The technological uncertainty heavily impacts the selection of the suppliers." (Interviewee 10). The new technology and emerging markets also lead to OEM X not knowing which competencies are needed in different projects, which leads to further time delays before the right competencies are added to the projects. Furthermore, interviewed candidates mention that even internal processes and frameworks that are routinely followed to ensure qualitative work are nowadays an obstacle in new product development processes where the market is moving faster, and competitors are gaining market shares quicker.

"The impact it [the technologically uncertain environment] has today is that sometimes the sourcing process will be a bit too long because we request a lot from the suppliers, and while we still at the same time have a very tough and tight time plan, meaning that we haven't found yet the right process to be able to select a supplier at the correct maturity level, while still protecting the NPD project time plan." - Interviewee 11

It is also evident that the supplier base is relatively new where in some cases new collaborations are initiated with suppliers that OEM X has not previously collaborated with. Data collection also shows that there is little to no previous experience of some suppliers. The reason for the new supplier base that OEM X now chooses to focus on is that the existing supplier base does not have the necessary technology needed for the development of products that OEM X uses. The number of suppliers that can deliver the necessary components is also few, and the requirements that OEM X demands from its suppliers lead to a very scarce supplier base.

"We really had to start from scratch because there was no supplier base and it was rather difficult to do that because of a limited number of suppliers and none of them have actually been working with our type of vehicles]." - Interviewee 8

In the case of Product X, it appears from the interviews that a high degree of supplier involvement was chosen during the development of the product. The respondents emphasize the importance of involving the selected supplier and that they had an important role in the details of the product and also in ensuring that Product X fits the needs of OEM X. Interviewee 11 emphasizes that Product X is a full system that is sourced from a supplier and that this approach has led to a relatively smooth development process because much of the responsibility has been delegated to the supplier. These statements indicate that OEM X is open to relying on their suppliers for system-level solutions and values their input in the development process.

As for Product Y, the interviews imply that there has been limited supplier involvement. Interviewee 11 describes how they initially thought that the ingoing components would be available off the shelf and that there would therefore be no need for extensive supplier involvement. But later in the development process, it was noted that the components were more complex than expected and that many of the components that Product Y required, did not have any suppliers that could fulfill the requirements. This indicates that OEM X underestimated the complexity of the component and the level of supplier involvement needed for it.

"If you look at [Product Y] and the ingoing components… then unfortunately not so much [supplier involvement] we kind of thought, OK, you know this is laying somewhere off the shelf in the warehouse we can just buy these pieces. Yeah, we simplified that a bit too much, we now see that it's much more complex. It's much more work and there are not really suppliers that are capable of meeting our requirements." - Interviewee 11

Interviewee 12 suggested that there was a supplier involvement in the product development of Product Y, but that the involvement should have taken place earlier to learn from the suppliers' expertise. Overall, it appears from the interviews that there has been limited supplier involvement in the development of Product Y, which has led to some difficulties in the development.

A challenge that has been evident in the supplier involvement process is directly linked to the technologically uncertain environment where OEM X in many cases has not clearly defined the needs and requirements. This then results in OEM X not being able to define which products or components to develop at an early stage. The consequence of this is that it becomes difficult to use supplier expertise because OEM X does not get much support when they do not know what they are supposed to fulfill. In cases where suppliers can be involved at an early stage, it has been shown that OEM X severely limits the possibilities to choose other suppliers because they are locked in with the suppliers they have chosen to involve early in their NPD project.

4.2.3 Constraints

There are also clear constraints that make the work of the purchasing department considerably more difficult. Resource allocations, for example, have proved to be a constraint where the purchasing department has difficulties in effectively putting together competent teams for the right projects, which has proved to be time-consuming and can have a negative impact on the various phases of the projects. Resource boundaries also exist in the department, where there are currently not enough staff and monetary resources in combination with low volumes and high production costs that limit OEM X from being able to run projects with more than one supplier. A very tight time plan for project development also leads to shorter process times for the purchasing department, in a technologically uncertain environment this contributes to tight and complex projects.

Table 2. Purchasing in NPD projects and supplier involvement under a technological uncertain environment.

Theme	Code	Illustrative quotes	Interviewee (I)
Relationship between R&D and purchasing	Lack of collaboration	*"As soon as you enter a project phase and both segment leader and also me as chief engineer kind of go to the next phase and then we see the people doing the real work in the project there, I see less collaboration."* *"I think our [purchasing department] involvement was too late."* *"I don't know if it's a conflict of interest or if it's just the fact that we all work in silos and that we think, yeah, this is a different organization."*	I (10, 9, 12)
	Burden of purchasing activities on the R&D team	*"For the B-sample phase, we were struggling to get any support from purchasing. And that has been a rather heavy burden for the team to carry because no suppliers or purchasers were involved."*	I (12)
	Conflicts between the departments	*"R&D reaches out to suppliers, it's something they sometimes do on their own."* *"There is always conflict between R&D and purchasing."*	I (10, 7)
Technologically uncertain environment	Unfreezable requirements	*"Technological uncertainties mean that we are not able to freeze any requirements."*	I (10)
	Challenges in supplier selection	*"The technological uncertainty heavily impacts the selection of the suppliers."*	I (10)

	Importance of clear specifications	*"I would say it's from part to part, sometimes it's better to get them involved earlier but you will not get so much support from the supplier if you don't know what they are supposed to fulfill."*	I (6)
	Challenges with supplier involvement	*"[...] for example, that some of the suppliers we have to work with them because they were involved already early on. So then we are locked, yeah, we don't have any sayings exactly."* *"We are nominating the suppliers for C-samples but you can't do that because then it is too late and you lose the learning phase of the supplier"*	I (10**,** 12)
Constraints	Resource allocation	*"[...] also another complex is typically seen with new parts and new technology combining and to find the right team within purchasing [...] we need to have a more structured way to find the right team"*	I (9)
	Resource boundaries	*"And if you look at the amount of resources needed, both money and personal, to drive new developments both for us but also with our suppliers, it will be too expensive to have more than one supplier. The volumes do not justify it and the combination of the relatively low volumes and the very high product cost and project cost cannot justify dual development. Because this technology does not exist off the shelf."*	I (11)
	Tight and complex NPD time plan	*"It's a very tight time plan from the start and everyone knows that, which means also shortening the time for purchasing."* *"Sometimes the sourcing process will be a bit too long because we request a lot from the suppliers, and while we still at the same time have a very tough and tight time plan."*	I (9, 11)

*These quotes are representative of a larger set of data, further data is available upon request.

4.3 Supply chain resilience in NPD projects

Table 3 represents a thematic analysis that is anchored in the topic of supply chain resilience, where the source of themes and codes are derived from. The primary data shows how OEM X performs in different areas, and the following chapter explains how the relationship between the purchasing department and the NPD project deals with enablers and barriers in this context.

4.3.1 Adaptability and responsiveness

OEM X is a small player with small volumes in this new emerging market and therefore it may be difficult to influence the suppliers in the supply chain to a greater extent: *"OEM X is still a small player in this market [. . .] we are neglectable when it comes to size. So our ability to let our suppliers make quick changes is small."* (Interviewee 12). This implies that OEM X currently does not have the bargaining power that they are used to, such as it previously did with ICE vehicles. Even in cases where OEM X has some bargaining power, suppliers generally will not be able to implement faster changes, which they refer to because of the technologically uncertain environment they are currently facing. Overall, it appears that there are challenges concerning flexibility, adaptability, and responsiveness, especially when it comes to rapid changes. But the specific level of flexibility will be influenced by the suppliers and the nature of the component or system being developed.

4.3.2 Information sharing and transparency

In regard to information sharing, OEM X has predefined systems and processes in place, which currently occur on a regular basis. However, it seems that there are challenges to the extent and effectiveness of information sharing. For example, there may be circumstances where information sharing is delayed and, in some cases, information is lost through the information-sharing systems currently in use. It also appears that both OEM X and other actors in the supply chain regularly exchange important information and that different parties are constantly working to improve information sharing and its processes. It also seems that OEM X is selective in sharing information and transparency to actors that are not considered to be able to contribute to the projects. However, in many cases, OEM X does not get the insight into the supply chain that should give rise to a resilient supply chain. To cope with this, digital tools to facilitate visibility are under development and will be implemented in the future, but as interviewee 10

mentions, it may be that some actors in the supply chain will not share the information they possess due to contractual reasons. According to interviewee 11, there is good cooperation between OEM X and its Tier 1 suppliers, but it seems that there is no interaction with other suppliers further up the chain. The digital tools that are currently being developed will thus also enable OEM X to gain visibility beyond Tier 1 suppliers.

For Product X, there is an agreement on the level of transparency and information sharing between the selected supplier and OEM X, which is believed to be beneficial for the project. As for Product Y, the level of transparency varies depending on which component is to be sourced and from where to buy it as the supplier base looks different for each component. However, for the case company to even initiate some form of collaboration with a supplier, transparency is stated as a prerequisite in the contract, so suppliers will always need to have some level of transparency and information sharing towards OEM X. In cases where communication challenges arise, OEM X will at an early stage try to address these and try to eliminate the challenges.

4.3.3 Risk management in the supply chain

OEM X has previously experienced shortages for other sourced components, such as semiconductors, therefore the company has ensured that proactive measures are implemented to ensure agile actions in the event of changes. For example, OEM X has a task force that ensures that an agile supply chain is promoted where they have mapped out different suppliers and sub-suppliers to be able to act proactively against changes. This is done through various tools developed and used by OEM X during the sourcing process, among other things. It also appears that the agile ability to implement changes in product development at an early stage is relatively high, and then gradually decreases the deeper into the product development that the products have reached.

4.3.4 Collaboration and relationship dynamic

Interviewee 2 describes how the criteria of the best offer for product, cost, and timing are used when awarding suppliers. This does not prioritize collaboration or long-term partnerships. OEM X uses both adversarial and collaborative relationships in different situations. OEM X's goal is to build more in-depth relationships with its suppliers and also to move away from the traditional adversarial relationship that exists today, but some in the team still consider the relationship to be adversarial. The nature of the relationship is based on the components to be procured. However, Interviewee 10 believes that if more work is done to understand the needs

of electromobility outside of Products X and Y, this can lead to a more strategic view, which can shift from a traditionally adversarial relationship to a collaborative one. Overall, it seems that OEM X is open to developing more strategic relationships with its suppliers but has not yet fully implemented a strategy for doing so. In general, OEM X finds that they collaborate well with suppliers in Tier 1, but that Tier 2 suppliers and beyond have much less collaboration.

4.3.5 Sourcing strategies and challenges

When selecting suppliers, OEM X considers geographical positions due to geopolitical reasons, lead times, cost, and for sustainability reasons. However, the case company currently doesn't have practices to prevent slowdowns/shutdowns for Products X & Y, and they currently use single sourcing for most of their components to secure their inventory, because of the scarce supplier base and the low volumes. Even though they state that the ultimate scenario is to have two suppliers in two different parts of the world, there sometimes are not enough suppliers or resources to implement such a strategy.

Table 3. Thematic analysis of enablers and barriers at OEM X in the context of supply chain resilience for Products X & Y.

Theme	Code	Illustrative quotes	Interviewee (I)
Adaptability and responsiveness	Supplier change speed	*"In general no, they don't change quickly [the suppliers], sometimes we want quick changes, but they rarely do, so change is not really a strength."*	I (10)
	Small market player	*"OEM X is still a small player in this market [. . .] we are neglectable when it comes to size. So our ability to let our suppliers make quick changes is small."*	I (12)
Information sharing and transparency	Limited information sharing	*"If it does not contribute to the manufacturing product then we don't reveal information."*	I (9)
	Selective transparency	*"Yes, we are trying to be as transparent as possible…for example project requirements, forecast volumes. However, there is certain information which we share only to some specific suppliers with whom we see a benefit to do so, meaning we will not share all the information. We will adjust depending on how strategic it is and how useful it can be for the business relationship."*	I (10)
	Supplier prerequisites	*"These are typically inputs we request as a prerequisite to our suppliers to receive before we can nominate them…So on all those different areas we do get a generally good transparency level. Some suppliers are harder to work with and all this. But in general we get what we want."*	I (6)

	Visibility improvement	*"We ask suppliers to give us visibility, but we don't get it from all suppliers and we don't get it from the upstream supply chain. So this is something that is to be improved (...)"*	I (10)
	Regular information sharing	*"We share information regularly, but it depends on the strategic importance of the supplier and what we want to achieve with that supplier."*	I (5)
	Predefined systems	*"There are predefined systems and processes in place to share information with our suppliers, and we use them to ensure that we are aligned."*	I (11)
	Communication challenges	*"There are sometimes challenges in communication between us and our suppliers, but we try to address them as early as possible to maintain a healthy relationship."*	I (4)
	Efficiency in information sharing	*"We have an efficient system for sharing information with suppliers to make sure that they have the necessary inputs to perform well."*	I (6)
Risk management in the supply chain	Supply chain resilience mapping	*"We have learned a lot from the semiconductor shortages at OEM X...we have been able to set a task force in a very efficient manner. And at the time, we still have it and we have then use some of the tools that were used during this task force now in our sourcing process, one of it being supply chain resilience mapping where we are asking now each potential suppliers to map all the the suppliers, the sub-suppliers, they will be working with their location and then different element of information when it comes to lead time, buffer stock and so on."*	I (10)

	Late incoming request impact	*"At an early phase, it doesn't impact very much. It's rather easy to do, but for example, we had to change, or a late incoming request for change that sounded like an easy change, but it was basically a major redesign. So, for sure you don't do that like, yeah in the swiftly move, you will need to scrutinize it, that this is really the way we want to do it and when you need to do the changes because at the end it must be good for OEM X."*	(I, 12)
Collaboration and relationship dynamic	Tier 1 collaboration	*"We have a strong collaboration with our Tier 1 suppliers, and this helps us to manage the entire supply chain more effectively."* *"I think when it comes to our Tier 1 suppliers we generally have very good collaboration. I think when it comes to either our customers or let's say our Tier 2 suppliers then we have much less collaboration, we could probably be more proactive."*	I (3, 11)
	Adversarial vs collaborative relationship	*"We strive to create relationships with our suppliers that are based on collaborative relationship, rather than just adversial interactions."*	I (8)
	Best offer priority	*"We always prioritize the best offer from suppliers, considering both cost and quality, to ensure that we get the best value for our business."*	I (2)
	Collaboration in the long term	*"Our goal is to establish long-term collaboration with our suppliers, as this helps us to build a strong and resilient supply chain."*	I (1)
	General supplier performance	*"I think generally they [the suppliers] do quite OK."*	I (11)

Sourcing strategies and challenges	Single sourcing	*"It's tough enough to get one supplier. We haven't even considered multiple sourcing because we have a small volume"*	I (12)
	Geopolitical risks	*"(...) there is also the geopolitical situation and there is always a risk in some countries more than others, where we want to make sure that we also reduce the risk as much as possible."*	I (11)
	Logistics and geography	*"The geography is very important due to logistics (...) and how that can affect in the future for transport as we have just in time. You also need to have as much green logistics as possible."*	I (6)

*These quotes are representative of a larger set of data, further data is available upon request.

5. Discussion

The results presented in the empirical chapter are intended to add value to the literature by providing knowledge about challenges, opportunities, and current strategies. In the following chapter, a discussion will be carried out where literature will be compared with empirical data to discuss, elaborate and support different reasoning. The chapter is divided into two sub-sections where the first section refers to the report's first research question, and the second sub-section refers to the report's second research question.

5.1 Exploring the interdepartmental dynamics in NPD

When examining the relationship between the purchasing department and NPD projects, the empirical findings show that the involvement of the purchasing department in NPD projects has a great impact on the success of the project. This is in line with the Hackman and Wageman (1995) article which also emphasizes the importance of purchasing departments' involvement in NPD projects. Benedetto et al. (2003) who discusses three different levels of strategic assignments that the purchasing department can have, comes to the conclusion that the most strategic stage is the one that can provide the most value creation in NPD projects. Within OEM X, it appears that at a managerial level, there is a lot of cooperation cross-functionally between the departments, but in the day-to-day operations, the collaboration between the different departments does not work as desired, instead, the different departments are considered separate "silos". Tavani, et al. (2013) discuss the culture within organizational functions and state that through an atmosphere that promotes communication, it will be possible to influence the business performance. It should also be taken into account that in many cases departments within the organization come from different backgrounds. Therefore, the collaboration between different departments can be affected, something that may happen at OEM X. It is important that the actors involved in a project have a consistent common understanding and information sharing, for the collaboration to be considered successful between different departments (Dougherty, 1992).

Product X which OEM X is outsourced to a supplier and has already at an early stage made use of supplier expertise in product development. In this case, OEM X has chosen to transfer much of the responsibility to a supplier who is responsible for delivering product X to OEM X ready for use. For this product, the purchasing department has been involved in the concept development phase, where the purchasing department has assisted R&D in the process of

scanning the market and making a make-or-buy analysis. Since it was decided during the make-or-buy analysis that the major responsibility for the new product development process would be borne by a supplier, this product development is considered to have been relatively untroubled. (Bidault et al. 1998) discuss how, during an early supplier involvement, suppliers can be allowed to take responsibility for the development of products where OEMs lack the knowledge to produce the products in-house. According to Petersen et al. (2005), who discuss the level of ESI, it can be determined that the supplier integration in the product development for Product X has been between stages "Grey box" and "Black box" where the design of the product has been mainly supplier driven, with input from OEM X. In the case of Product X, the purchasing department has therefore had a more operational role, ensuring that the procurement phase is in line with OEM X requirements, something that Van Weele (2018) discusses when describing the role of the purchasing department.

Product Y which OEM X has chosen to produce in-house is differentiated from Product X because the responsibility for the entire new product development project lies within OEM X. This suggests that the relationship between the purchasing department and the NPD project becomes more critical due to the fact both teams are involved in developing Product Y. In the product development of Product Y, many respondents believe that the purchasing department has been involved too late, Hackman and Wageman (1995) also discuss the importance of early involvement with a well-functioning cross-functional collaboration for the end products to get the desired quality. Since the purchasing department was involved just after the concept phase, this reveals that large parts of the product design were already predetermined before the involvement of the purchasing department. At this stage, the supplier will only act as a product supplier delivering the desired components. As described in the empirical findings, this has led to the purchasing department trying to acquire components where the supplier base cannot fulfill the specifications that OEM X requires. Afuah & Bahram, (1995) discuss how in environments with technological advancements it may mean that current suppliers do not have the capability to deliver the products that the OEMs demand, and therefore companies may have to turn to a new supplier base to be able to procure new components where other requirements are set. Van Weele (2018) highlights the importance of being able to build a relationship with the new supplier base where the purchasing department is responsible for a large part of the work. In accordance with these authors, if purchasing had been involved earlier, they would gain more time and had a chance to involve suppliers that meet the technical requirements.

When supplier involvement in product development is examined for product Y, it is observed that supplier involvement in the development of Product Y in accordance with the Petersen et

al. (2005) model can be considered as "None", which implies that OEM X has not consulted with suppliers during the development of the product. During this process, ESI could have been used to integrate suppliers' capabilities into OEM X operations in order to use suppliers' expertise in both manufacturing and design (Dowlatshahi, 1998). According to Wieteska (2020c), ESI can then give rise to a more successful outcome, as it enables OEMs to utilize the expertise of suppliers in new product development processes. In the case of OEM X, where it is currently not possible to find suppliers that meet the requirement for certain components, the situation could have been different if ESI had been utilized in the new product development for Product Y.

Concerning purchasing relationships in NPD projects in the technologically uncertain environment that OEM X currently is experiencing, there are divided opinions inter organizationally on when the purchasing organization should be involved in the new product development process. There is a conflict between the purchasing department and R&D who are both involved in NPD projects as was clearly stated in the empirical findings. This conflict can be linked to, as previously mentioned, a lack of collaboration and communication where the parties share different views on how the processes should unfold. Steward et al. (2019) writes about what the purchasing role should look like in NPD projects. The author believes that the purchasing department should have a more strategic role where the purchasing department is involved in the product development process at an early stage, this is something that Atuahene-Gima (1995) also emphasizes as important. The extent to which and when the purchasing department should be involved in the new product development process is perceived differently by the R&D and purchasing department. R&D believes that purchasing could have been more involved in the development of Product Y while purchasing would have liked to have been involved earlier as well but purchasing also believes that early involvement can be difficult when R&D has not defined technical needs and requirements, thus making them unfreezable. The purchasing department cannot commence with its activities if R&D hasn’t defined clear requirements for the NPD. At the same time, the purchasing department also highlights the importance of not involving suppliers at an early stage during a product development phase because suppliers' inputs can leave OEM X locked into negotiating only with the involved suppliers and thus losing a large part of the bargaining power as well as expertise from other potential suppliers.

Petersen et al. (2005) mention that early supplier involvement requires, among other things, trust between OEMs and willingness to share a common risk. Lack of trust can also damage internal and external relationships, making it difficult for OEMs to target different product developments (Kwak et al., 2018; Shashi et al., 2020b; Agarwal, 2021). With this theoretical

foundation, it can be determined that building a relationship with suppliers in a technologically uncertain environment requires not only an adversarial relationship but a collaborative relationship. Macbeth (1994c) describes how supplier management can use both adversarial and collaborative relationships. OEM X has tried to use a collaborative relationship during the development of Product Y, but in practice, the relationship corresponds to an adversarial relationship. The technically uncertain environment also leads OEM X to compose shorter contracts with clauses that allow termination of the contract if new technology replaces the existing technology of another player. This then further gives rise to the adversarial relationship that OEM X tries to avoid.

The purchasing department also mentions that due to a lack of resources and capacity, they currently do not reach out to a large number of suppliers as this is considered very resource intensive. Therefore, single sourcing is currently used for many of the ingoing components. At present, OEM X does not consider it justifiable to use more than one supplier, and you also have a dual development of some products. This, together with a very tight and complex schedule and difficulties in finding the right skills for each team, means that the purchasing department within OEM X experiences resource constraints. Shashi et al. (2020a) describes how insufficient resources prevent OEMs from creating a resilient supply chain. However, many authors argue that it is possible to use single sourcing for NPD projects in technologically uncertain environments. But as mentioned earlier, this is based on a mutual trust where OEM X and suppliers share trust in each other and take a common risk in product development.

5.2 Resilient supply chains in technologically uncertain environments

The purchasing department and all the engaging teams in the two NPD projects are well aware that they are working in a technologically uncertain environment when developing Product X & Y. Based on the empirical chapter, it is frequently emphasized that the fast pace and uncertainty create a pressure on the purchasing department, which in turn creates difficulties in finding and cooperating with suppliers, as well as developing new products suitable for future markets. In addition, OEM X finds difficulties in finding the necessary competencies for the projects, which is another time-consuming factor. The internal processes and frameworks that were previously effective in ensuring qualitative purchasing work, are now hindering the new product development process as the development time is scarce. This suggests that a technologically uncertain environment can be considered a barrier to achieving a resilient supply chain (Tushman & Anderson, 1986b) and that OEM X is strongly affected by this. In addition to technological uncertainty, inefficiencies in decision-making processes, supplier management, and information management systems as well as a lack of resources and

capabilities are known to hamper SCR efforts (Shashi et al., 2020a). Furthermore, the lack of coordination and control, lack of trust, and innovative and complex processes can limit the promotion of achieving SCR to the extent that they can damage both internal and external relationships, making it difficult to achieve common goals (Kwak et al., 2018; Shashi et al., 2020b; Agarwal, 2021). The findings and literature reviewed thus provide practical implications for OEM X to increase their resilience in supply chain management. To overcome these challenges, OEM X must identify the necessary competencies and quickly address inefficient processes and deficient areas. In addition, OEM X must build trusting relationships with suppliers, as previously mentioned, as it will encourage agile and flexible supply chain practices that can quickly adjust to changes in the rapidly changing technological environment.

Based on the empirical findings, it is evident that there is potential for OEM X to develop in many ways to achieve a more resilient supply chain in the context of these two NPD projects. The purchasing department can, with the cooperation of the teams involved in the NPD projects, increase the flexibility of its supply chain for the new emerging market that has arisen, as the empirical chapter showed that there is an opportunity for development in this aspect. The company emphasized several times that it is difficult to influence suppliers in development projects as OEM X's volumes are small and there are larger actors in the market who have stronger negotiating power than OEM X.

However, this does not necessarily prevent OEM X from making changes or prevent the company from creating a flexible supply chain with suppliers that respond quickly to demand and changes. Giunipero et al. (2005b) mention that a careful selection of a supply base can improve effectiveness in responding to changes. Here, the authors Kolchin and Giunipero (1993) also mention in their article that the role of the purchasing department in negotiations plays a major part in both parties understanding each other's needs and focusing on a common solution through joint efforts to solve problems, which is also mentioned by Monczka (2012), indicating that OEM X may need to work closely with its suppliers to ensure that they understand their needs and the challenges OEM X face in the market. Monczka (2012) also describes that win-win negotiation, also known as integrative bargaining, where both parties understand each other's needs and focus on a common solution through joint efforts to solve problems, can be beneficial to promote flexibility in a supply chain and should thus be investigated by OEM X.

Furthermore, it is stated that the case company has predefined systems and processes for information sharing, but many respondents claim that challenges still exist to the extent and effectiveness of information sharing. There can often be delays and loss of information, and the

company is also selective about what information is shared and to whom it is shared. This aligns with the literature that states that inefficient information sharing can pose a barrier to creating supply chain resilience (Shashi et al., 2020a). Transparency is also treated selectively as OEM X claims to be transparent only to the extent that it contributes to the success of the new product development projects. This selectivity in information sharing may hinder OEM X's ability to provide and gain the necessary supply chain insights to create a resilient supply chain. Given that the literature emphasizes the importance of supply chain transparency to increase visibility and trust among supply chain actors, which can lead to more effective collaboration and proactive joint responses to disruptions (Montecchi et al., 2021; Hernández-Espallardo et al., 2010). The challenges identified in the results, such as delayed information sharing and information loss through current systems, can lead to redundancy, increased costs, and reduced response time (Lotfi et al., 2013d). OEM X can therefore benefit from reviewing and improving its information management systems to improve supply chain resilience. Although selectivity in information exchange is common practice in supply chain management, Montecchi et al. (2021) argue that supply chain transparency can increase visibility and mutual trust between actors, which in turn promotes effective collaboration and increased supply chain resilience. OEM X can thus benefit from being more transparent with its supply chain partners to foster mutual trust and cooperation.

The digital tools currently under development to facilitate visibility beyond Tier 1 suppliers may also contribute to increased supply chain resilience, as visibility across the supply chain is known to reduce the risk of disruption (Somapa et al., 2018). However, the current lack of interaction with other suppliers further up the chain highlights a potential gap in supply chain visibility that needs to be addressed. The tools being developed that will enable OEM X to gain visibility beyond Tier 1 suppliers are a step in the right direction. This will allow OEM X to identify potential disruptions further up the supply chain and take proactive measures to reduce the risk of such disruptions. The digital tool however requires that suppliers upstream in the supply chain choose to use and implement the tool in their processes. With the low bargaining power described by OEM X, this can pose a difficulty.

In order to facilitate and remove barriers to achieve resilient supply chains, companies must have effective strategic supply chain management and optimize the flows between actors (Akdoğan & Demirtaş, 2014). This can be achieved by mapping and defining the current structure of the supply network to find the optimal strategy. Based on the company's previous experience with shortages of purchased components, such as semiconductors, OEM X has now taken proactive measures to ensure agile supply chain operations in case of disruptions. Ponis and Koronis (2012) highlight the importance of being proactive and implementing agile

practices early to ensure supply chain resilience. OEM X has tools that are used during sourcing processes to map suppliers and subcontractors, thus ensuring an agile supply chain. OEM X also takes into account geographical positions for geopolitical reasons, lead times, costs, and sustainability when selecting suppliers, which further facilitates supply chain resilience in the context of redundancy (Wieteska-Rosiak, 2020).

There is room for improvement in preventing the slowdown or shutdown of material supplies to the components of products X and Y, and OEM X may consider diversifying its sourcing strategy to minimize the risk of inventory shortages due to scarce supplier bases and low volumes. Since OEM X currently uses single sourcing for most of its components to secure inventory, OEM X may consider exploring alternative sourcing strategies, such as dual sourcing or multisourcing, to increase supplier options and reduce supply chain risks (MacCarthy et al., 2022). However, as previously mentioned, in cases where there is supplier involvement in product development in environments with a scarce supplier base, the sourcing process can in many cases be done through single sourcing (Wieteska-Rosiak, 2020). Since product X has a development supplier involved in the project, OEM X can benefit from single sourcing, given that the chosen supplier's capabilities can accommodate technological advancements and meet OEM X's demands (Afuah, A., 2000; Singh & Mitchell, 2007).

6. Conclusion

In this chapter, the research questions will be addressed with concluding answers covering the purpose of the thesis. Implications for practitioners and future research will also be drawn from the concluding results.

The purpose of the study is to increase the understanding of how the purchasing department of OEMs, within the automotive industry in the electromobility sector, can achieve a resilient supply chain in a technologically uncertain environment through the involvement of NPD projects. To fulfill the purpose of the study, relevant existing literature has founded a basis for the report. A case company has then been examined through a single case analysis using interviews, internal documents, and observation. The empirical data has then been treated through a thematic analysis.

To conclude, the relationship between the purchasing department and NPD projects in technologically uncertain environments is crucial but also challenging. Some of the key findings through the study reveal that early involvement of the purchasing department in a new product development project has the potential to enhance the success of the project. In cases where OEMs are running NPD projects in-house, where the company carries the responsibility for the development of the product, siloed operations, and late involvement of internal actors have shown to be barriers impacting the success and quality of the project. Single sourcing is also often used in these circumstances, despite the known risks and limitations. For NPD projects in technologically uncertain environments, there is thus a need for cross-departmental collaboration and communication for all ingoing teams, especially between purchasing and R&D, in order to define and meet technical requirements early in the process to be able to meet achieve resilience. Also, ESI can in many cases offer benefits to the project but requires careful management to balance trust, risk-sharing, and bargaining power between OEMs and suppliers. In technologically uncertain environments, a barrier can be uncertainties in the specifications or requirements of the ingoing components in the NPD products set by the OEMs, making the purchasing department have to work with unfreezable requirements. This in turn affects the relationship between the purchasing department and NPD projects negatively, and contracting with suppliers becomes more complex. Thus, the interplay between early involvement, effective collaboration, and strategic supplier management characterizes the relationship between NPD projects and the purchasing department, and future research could be done to optimize the mentioned strategies in the contextual environment.

To further facilitate enablers and eliminate barriers to building a resilient supply chain in a technologically uncertain environment, the study suggests that increasing flexibility by working closer with suppliers to ensure a coherent agreement is acquired, as well as for purchasing to select a supplier base with consideration to their capabilities. Furthermore, the study reveals that it is of great importance that information management systems work flawlessly both internally and externally. Situations, where OEMs lose information or do not have access to relevant information, can damage the resilience work as it requires joint efforts by all relevant parties to create supply chain resilience. Furthermore, the study highlights that transparency is something that benefits both the relationship between the purchasing department and the NPD project as well as improving collaboration between actors in the supply chain. This was shown to be an area of improvement in the study and is relevant for all OEMs in this context. The study also showed that visibility is of great significance when conducting NPD projects in technologically uncertain environments, as companies can identify potential disruptions at an early stage and take proactive measures to reduce risks. Overall, OEMs need to consider strategic supply chain management processes, which can be done by mapping out and defining current structures of the supply network, thus creating a perception of which actors are available in this technologically uncertain market in order to work in accordance with the right circumstances. Since an important part of supply chain resilience is about reviewing the sourcing strategies, it can be useful to try to implement dual and/or multiple sourcing, as to increase supplier options and reduce supply chain risks. By addressing these key areas, the purchasing departments in NPD projects in the context of technologically uncertain environments, can improve supply chain resilience and therefore be more successful in the competitive marketplace.

6.1 Implications for research

This study and its findings have provided OEMs in similar environments with an opportunity to get their purchasing departments to implement changes and strategies to act as a catalyst for improving supply chain resilience during NPD projects. However, in relation to the current literature, the technically uncertain environment described in the literature has not addressed how a lack of knowledge of specifications and requirements in NPD projects means that they are unfreezable during product development. This in turn makes the involvement of purchasing departments much more difficult. This is something that this thesis can contribute to the current literature.

This study presents important insights into supply chain resilience in technologically uncertain environments where there is potential for the development of theory, literature, and scientific

research. There is thus a need to refine existing models to accommodate the nuances of technological uncertainty, and also refine traditional processes and competencies. supplier relationship management emerges as crucial, where an in-depth exploration of fostering trust, negotiation, and mutual understanding.

6.2 Implications for practitioners

The findings of this study will offer valuable insights for practitioners operating in a similar environment of technological uncertainty. An increased pace of technological uncertainty change necessitates an adaption of internal processes that were previously effective. For OEMs to keep pace with change it will therefore be important to avoid obstacles to product development, practitioners will thus need to identify necessary competencies and address inefficient processes regularly.

Building trustful relationships with suppliers has also proven to be crucial. Practitioners can engage in integrative bargaining strategies, focusing on common solutions to problems and ensuring that suppliers understand the products and challenges in the market early in the process. This can then contribute to an agile and flexible supply chain, allowing rapid adjustment to changes that may occur in a technologically uncertain environment.

Also challenges for the extent and effectiveness of information sharing, together with a selectivity in transparency show that practitioners should review and improve their information management systems. Effective information sharing and increased transparency can thus contribute to proactive responses to disruptions and increased trust and collaboration between different actors in the supply chain. The findings in the study also highlight the importance of considering other sourcing strategies, such as dual- and multisource, to reduce supply chain risks.

This combined will then provide a basis for supplier involvement in product development. Engaging suppliers in product development, especially in cases where the supplier base is scarce, can enhance technological advancements and allow organizations to meet their demands. It should be kept in mind that supply chains are of a dynamic nature and change over time. Thus, the degree of generalizability for different industries will depend on each unique situation. The findings presented should therefore be investigated by practitioners before implementation as a decision based on situation and context should be a prerequisite.

6.3 Limitations and future research

Given the limitations of this study to focus on OEM X where different people within the organization have been interviewed, with a limited amount of external data collected, benchmarking with other actors in a similar environment could have been applied. This could have been done through a multiple-case analysis where other organizations are analyzed to form more nuanced findings. However, given the need for detail required during this research, in this specific environment, the choice of single case analysis has been the most appropriate to achieve the purpose of this thesis. Future research will therefore be able to contribute to benchmarking with other organizations to get a more nuanced view of the problem. The limitations that have also been used during the research where only the upstream supply chain has been investigated should also be considered for OEMs participating in these improvement proposals. Therefore, future research can also investigate how upstream supply chains should be treated by purchasing departments in technologically uncertain environments during NPD projects. When it comes to the adaptability of existing scholars where it has been concluded that the purchasing department should have a more strategic role, there are still barriers as previously mentioned, this is something that can be further investigated and updated in the current research. This can then be about, for example, the limitations that exist in bargaining power where further studies can focus on how OEMs can maximize their bargaining power in these environments, such research can also investigate how negotiation strategies can be adapted to situations in technological uncertainty. The role of digital tools is also something OEM X has started to investigate, where it could theoretically be beneficial for OEMs to use these tools to strengthen the visibility throughout the supply chain. Future studies could therefore examine the development, adaption, and effectiveness of these tools more in detail. Given the difficulty in finding necessary competencies for projects, it would also be useful for research to examine strategies for competence development within rapidly changing technological environments. This could include studies on effective training methods or hiring strategies.

Despite proactive measures to increase the reliability and validity of the study, it should be kept in mind that the possibility of the study being subject to information bias is possible. Systematic errors such as recall bias, observer bias, or performance bias could possibly have had an influence on the study and affected the conclusions.

7. References

Adner, R. and Kapoor, R. (2010), Value creation in innovation ecosystems: how the structure of technological interdependence affects firm performance in new technology generations. Strat. Mgmt. J., 31: 306-333. https://doi.org/10.1002/smj.821

Afuah, A. (2000), How much do your co-opetitors' capabilities matter in the face of technological change?. Strat. Mgmt. J., 21: 397-404. https://doi.org/10.1002/(SICI)1097-0266(200003)21:3

Afuah, A., & Bahram, N. (1995). The hypercube of innovation. Research Policy, 24(1), 51–76. https://doi.org/10.1016/0048-7333(93)00749-j

Agarwal, N. S. N. (2021). Analysis of supply chain resilience barriers in Indian automotive company using total interpretive structural modelling. Journal of Advances in Management Research, 18(5), 758–781. https://doi.org/10.1108/jamr-08-2020-0190

Akdoğan, A. A., & Demirtaş, Ö. (2014). Managerial Role in Strategic Supply Chain Management. Procedia - Social and Behavioral Sciences, 150, 1020–1029. https://doi.org/10.1016/j.sbspro.2014.09.114

Ali, A., Mahfouz, A., & Arisha, A. (2017). Analysing supply chain resilience: integrating the constructs in a concept mapping framework via a systematic literature review. Supply Chain Management: An International Journal, 22(1), pp. 16-39

Asree, S., Zain, M., & Razalli, M. R. (2010). Influence of leadership competency and organizational culture on responsiveness and performance of firms. International Journal of Contemporary Hospitality Management, 22(4), 500–516. https://doi.org/10.1108/09596111

Atuahene-Gima, K. (1995). Involving organizational buyers in new product development. Industrial Marketing Management, 24(3), 215–226. https://doi.org/10.1016/0019-8501(94)00083-9

Bai, C., & Sarkis, J. (2020). A supply chain transparency and sustainability technology appraisal model for blockchain technology. *International Journal of Production Research*, *58*(7), 2142–2162. https://doi.org/10.1080/00207543.2019.1708989

Barnett, B. D., & Clark, K. B. (1996). Technological newness: An empirical study in the process industries. Journal of Engineering and Technology Management, 13(3–4), 263–282. https://doi.org/10.1016/s0923-4748(96)01009-0

Barratt, M. (2004b). Understanding the meaning of collaboration in the supply chain. Supply Chain Management, 9(1), 30–42. https://doi.org/10.1108/13598540410517566

Barroso, A., Machado, V., & Machado, V. (2011). Supply Chain Resilience Using the Mapping Approach. InTech EBooks. https://doi.org/10.5772/15006

Baškarada, S. (2014). Qualitative Case Study Guidelines. The Qualitative Report, 19(40), 1-25.

Baxter, P., & Jack, S. (2008). Qualitative Case Study Methodology: Study Design and Implementation for Novice Researchers. The Qualitative Report, 13(4), 544-556.

Bessant, J., Knowles, D. A., Briffa, G., & Francis, D. J. (2002). Developing the agile enterprise. International Journal of Technology Management, 24(5/6), 484. https://doi.org/10.1504/ijtm.2002.003066

Bhardwaj, S., & Mostofi, H. (2022). Technical and Business Aspects of Battery Electric Trucks—A Systematic Review. Future Transportation; Jun2022, Vol. 2 Issue 2, p382-401, 20p

Bidault, F., Despres, C. & Butler, C. (1998). The drivers of cooperation between buyers and suppliers for product innovation. Research Policy 26 (7-8): 719-732.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative Research in Psychology, 3(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Bryman, A. & Bell, E. (2015) Business research methods 4th Edition. New York: Oxford University Press

Cao, M., Vonderembse, M. A., Zhang, Q., & Ragu-Nathan, T. S. (2010). Supply chain collaboration: conceptualisation and instrument development. *International Journal of Production Research*, *48*(22), 6613–6635. https://doi.org/10.1080/00207540903349039

Chicksand, D., Watson, G., Walker, H., Radnor, Z., & Johnston, R. (2012). Theoretical perspectives in purchasing and supply chain management: an analysis of the literature. Supply chain management: an international journal, 17(4), 454-472.

Chien, S., & Chen, J. (2010). Supplier involvement and customer involvement effect on new product development success in the financial service industry. *Service Industries Journal*, *30*(2), 185–201. https://doi.org/10.1080/02642060802116354

Chowdhury, P., Paul, S. K., Kaisar, S., & Moktadir, M. A. (2021). COVID-19 pandemic related supply chain studies: A systematic review. Transportation Research Part E-logistics and Transportation Review, 148, 102271. https://doi.org/10.1016/j.tre.2021.102271

Christopher, M. (2005). Logistics and supply chain management : creating value-adding networks. *Financial Times Prentice Hall EBooks*. https://ci.nii.ac.jp/ncid/BA7130290X

Christopher, M., & Peck, H. (2004). Building the Resilient Supply Chain. *The International Journal of Logistics Management*, *15*(2), 1–14. https://doi.org/10.1108/09574090410700275

Cooper M. C., Lambert D.M., Pagh J. D. (1997). Supply Chain Management: More Than a New Name for Logistics. International Journal of Logistics Management, (8), pp. 1-14.

Cooper, R. G. (1986). An investigation into the new product process: Steps, deficiencies, and impact. Journal of Product Innovation Management, 3(2), 71–85. https://doi.org/10.1016/0737-6782(86)90030-5

Cooper, R. G. (1988). Predevelopment activities determine new product success. Industrial Marketing Management, 17(3), 237–247. https://doi.org/10.1016/0019-8501(88)90007-7

Datta, P. (2017). Supply network resilience: a systematic literature review and future research. The International Journal of Logistics Management, 28(4), pp. 1387-1424.

Davila, T. (2000). An empirical study on the drivers of management control systems' design in new product development. Accounting Organizations and Society, 25(4–5), 383–409. https://doi.org/10.1016/s0361-3682(99)00034-3

Di Benedetto, C. A., Calantone, R. J., Vanallen, E., & Montoya-Weiss, M. M. (2003). Purchasing Joins the NPD team. Research-Technology Management, 46(4), 45–51. https://doi.org/10.1080/08956308.2003.11671576

Dougherty, D. (1992). Interpretive Barriers to Successful Product Innovation in Large Firms. Organization Science, 3(2), 179–202. https://doi.org/10.1287/orsc.3.2.179

Dowlatshahi, S. (1998). Implementing early supplier involvement: a conceptual framework. International Journal of Operations and Production Management 18: 143-167

Dyer, W. G., Jr, Wilkins, A. L., & Eisenhardt, K. M. (1991). Better stories, not better constructs, to generate better theory: A rejoinder to Eisenhardt; better stories and better constructs: The case for rigor and comparative logic. The Academy of Management Review, 16(3), 613.

Eisenhardt, K. M., & Graebner, M. E. (2007). Theory building from cases: opportunities and challenges. Academy of Management Journal, 50(1), 25-32.

Ellram, L., & Tate, W. L. (2015). Redefining supply management ′ s contribution in services sourcing. Journal of Purchasing and Supply Management, 21(1), 64-78.

Faisal, M. N., Banwet, D. K., & Shankar, R. (2006). Supply chain risk mitigation: modeling the enablers. Business Process Management Journal, 12(4), 535–552. https://doi.org/10.1108/14637150610678113

Fayezi, S., Zutshi, A., & O'Loughlin, A. (2017). Understanding and Development of Supply Chain Agility and Flexibility: A Structured Literature Review. *International Journal of Management Reviews*, *19*(4), 379–407. https://doi.org/10.1111/ijmr.12096

Gadde, L., & Håkansson, H. (1994). The changing role of purchasing: reconsidering three strategic issues. European Journal of Purchasing & Supply Management, 1(1), 27–35. https://doi.org/10.1016/0969-7012(94)90040-x

Gerring, J. (2004). What Is a Case Study and What Is It Good for? American Political Science Review, 98(2), 341–354. https://doi.org/10.1017/s0003055404001182

Gerwin, D., & Barrowman, N. (2002). An Evaluation of Research on Integrated Product Development. Management Science, 48(7), 938–953. https://doi.org/10.1287/mnsc.48.7.938.2818

Giunipero, L. C., Denslow, D., & Eltantawy, R. A. (2005b). Purchasing/supply chain management flexibility: Moving to an entrepreneurial skill set. Industrial Marketing Management, 34(6), 602–613. https://doi.org/10.1016/j.indmarman.2004.11.004

Guba, E. G., & Lincoln, Y. S. (1989). Fourth Generation Evaluation. SAGE.

Gunderson, L., & Holling, C. S. (2002b). Panarchy: Understanding Transformations in Human and Natural Systems. https://ci.nii.ac.jp/ncid/BA55772345

Gupta, H., Yadav, A. C., Sarpong, S. K., Khan, S. A., & Sharma, S. (2022). Strategies to overcome barriers to innovative digitalisation technologies for supply chain logistics resilience during pandemic. Technology in Society, 69, 101970. https://doi.org/10.1016/j.techsoc.2022.101970

Hackman, J. R., & Wageman, R. (1995). Total Quality Management: Empirical, Conceptual, and Practical Issues. Administrative Science Quarterly, 40(2), 309. https://doi.org/10.2307/2393640

Halldorsson, A., & Aastrup, J. (2003). Quality criteria for qualitative inquiries in logistics. European Journal of Operational Research, 144(2), 321–332. https://doi.org/10.1016/s0377-2217(02)00397-1

Handfield, R. B., & Bechtel, C. (2002). The role of trust and relationship structure in improving supply chain responsiveness. Industrial Marketing Management, 31(4), 367–382. https://doi.org/10.1016/s0019-8501(01)00169-9

Handfield, R., Ragatz, G., Peterson, K. & Monczka, R. (1999). Involving Suppliers in New Product Development? California Management Review 42: 59-82.

Hanelt, A., Bohnsack, R., Marz, D., & Marante, C. (2021). A Systematic Review of the Literature on Digital Transformation: Insights and Implications for Strategy and Organizational Change. Journal of Management Studies, 58(5), 1159–1197. https://doi.org/10.1111/joms.12639

Hernández-Espallardo, M., Orejuela, A. R., & Sánchez-Pérez, M. (2010). Inter-organizational governance, learning and performance in supply chains. *Supply Chain Management, 15*(2), 101–114. https://doi.org/10.1108/13598541011028714

Hohenstein N. O., Feisel E., Hartmann E., Giunipero, L. (2015). Research on the phenomenon of supply chain resilience: a systematic review and paths for further investigation. International Journal of Physical Distribution & Logistics Management, 45(1/2), pp. 90-117.

Jacobsen, I. D. (2002). Vad, hur och varför? – Om metodval i företagsekonomi och andra samhällsvetenskapliga ämnen. Lund: Studentlitteratur.

Jason, L. A., & Glenwick, D. S. (2015). Handbook of Methodological Approaches to Community-Based Research. In Oxford University Press eBooks. https://doi.org/10.1093/med:psych/9780190243654.001.0001

Jick, T. D. (1979). Mixing qualitative and quantitative methods: Triangulation in action. Administrative science quarterly, 24(4), 602-611.

Johnsen, T. E. (2009). . Journal of Purchasing and Supply Management, 15(3), 187-197.

Kędzia, G. (2018). THE IMPACT OF SUPPLIER INVOLVEMENT IN PRODUCT DEVELOPMENT ON SUPPLY CHAIN RESILIENCE: THE MEDIATING ROLE OF COMMUNICATION. International Journal for Quality Research, 16(4), 973-1000.

Khan, O., Christopher, M., Burnes, B. (2008). The impact of product design on supply chain risk: a case study. International Journal of Physical D

Kwak, D. W., Seo, Y. J., & Mason, R. J. (2018). Investigating the relationship between supply chain innovation, risk management capabilities and competitive advantage in global supply chains. International Journal of Operations & Production Management, 38(1), 2–21. https://doi.org/10.1108/ijopm-06-2015-0390

Laios, L., & Moschuris, S. J. (2001). The influence of enterprise type on the purchasing decision process. International Journal of Operations & Production Management, 21(3), 351–372. https://doi.org/10.1108/01443570110364687

Lewis, J., & Ritchie, J. (2003). Generalizing from qualitative research. In: Qualitative Research Practice. London: Sage.

Lotfi, Z., Mukhtar, M., Sahran, S., & Zadeh, A. (2013d). Information Sharing in Supply Chain Management. Procedia Technology, 11, 298–304. https://doi.org/10.1016/j.protcy.2013.12.194

Luzzini, D., Amann, M., Caniato, F., Essig, M., & Ronchi, S. (2015). The path of innovation: purchasing and supplier involvement into new product development. Industrial Marketing Management, 47, 109–120. https://doi.org/10.1016/j.indmarman.2015.02.034

Macbeth, D. K. (1994c). The role of purchasing in a partnering relationship. European Journal of Purchasing & Supply Management, 1(1), 19–25. https://doi.org/10.1016/0969-7012(94)90039-6

MacCarthy, B. L., Ahmed, W. A., & Demirel, G. (2022). Mapping the supply chain: Why, what and how? International Journal of Production Economics, 250, 108688. https://doi.org/10.1016/j.ijpe.2022.108688

Majumdar, A., Agrawal, R., Raut, R. D., & Narkhede, B. E. (2022). Two years of COVID-19 pandemic: Understanding the role of knowledge-based supply chains towards resilience through bibliometric and network analyses. Operations Management Research. https://doi.org/10.1007/s12063-022-00328-x

Mendez, E. G., & Pearson, J. F. (1994). Purchasing's Role in Product Development: The Case for Time-Based Strategies. International Journal of Purchasing and Materials Management, 30(4), 2–12. https://doi.org/10.1111/j.1745-493x.1994.tb00261.x

Mikkelsen, O. S., & Johnsen, T. E. (2019). Purchasing involvement in technologically uncertain new product development projects: Challenges and implications. Journal of Purchasing and Supply Management, 25(3), 100496.

Min, S., Roath, A. S., Daugherty, P. J., Genchev, S. E., Chen, H., Arndt, A. D., & Richey, R. G. (2005). Supply chain collaboration: what's happening? The International Journal of Logistics Management, 16(2), 237–256. https://doi.org/10.1108/09574090510634539

Monczka, R. M. (2012). Purchasing and supply chain management. In Routledge eBooks (pp. 312–335). https://doi.org/10.4324/9780080492940-15

Montecchi, M., Plangger, K., & West, D. B. (2021). Supply chain transparency: A bibliometric review and research agenda. International Journal of Production Economics, 238, 108152. https://doi.org/10.1016/j.ijpe.2021.108152

Mubarik, M. S., Naghavi, N., Mubarik, M., Kusi-Sarpong, S., Khan, S. A., Zaman, S. M. A., & Munir, M. J. (2021). Resilience and cleaner production in industry 4.0: Role of supply chain mapping and visibility. Journal of Cleaner Production, 292, 126058. https://doi.org/10.1016/j.jclepro.2021.126058

Nijssen, E. J., Biemans, W. G., & De Kort, J. F. (2002). Involving purchasing in new product development. R&D Management, 32(4), 281-289.

Noke, H., Perrons, R. K., & Hughes, M. (2008). Strategic dalliances as an enabler for discontinuous innovation in slow clockspeed industries: evidence from the oil and gas industry. R&d Management, 38(2), 129-139.

Oliveira, J. M., Nunes, M. L., & Arezes, P. (2018b). New Product Development in the Context of Industry 4.0: Insights from the Automotive Components Industry. In Springer eBooks (pp. 83–94). Springer Nature. https://doi.org/10.1007/978-3-030-14973-4_8

Patel, R., & Davidson, B. (2003). Forskningsmetodikens grunder. Att planera, genomföra och rapportera en undersökning. Studentlitteratur.

Pereira, C., Christopher, M., & Da Silva, A. L. (2014b). Achieving supply chain resilience: the role of procurement. Supply Chain Management, 19(5/6), 626–642. https://doi.org/10.1108/scm-09-2013-0346

Petersen, K. J., Handfield, R. B., & Ragatz, G. L. (2005). Supplier integration into new product development: coordinating product, process and supply chain design. Journal of Operations Management, 23(3–4), 371–388. https://doi.org/10.1016/j.jom.2004.07.009

Petersen, K. J., Handfield, R. B., Ragatz, G. L. (2003). A model of supplier integration into new product development. Journal of Product Innovation Management, 20(4), 284-299.

Phillips, P. P., & Stawarski, C. A. (2008). Data Collection: Planning for and Collecting all Types of Data (1st ed.). Pfeiffer.'

Ponis, S. T., & Koronis, E. (2012). Supply Chain Resilience: Definition Of Concept And Its Formative Elements. Journal of Applied Business Research, 28(5), 921. https://doi.org/10.19030/jabr.v28i5.7234

Porter, M. E. (1997). COMPETITIVE STRATEGY. Measuring Business Excellence, 1(2), 12–17. https://doi.org/10.1108/eb025476

Giunipero, L. C., & Handfield, R. B. (2004). Purchasing education and training II. Tempe, AZ: CAPS Research.

Schiele, H. (2010). Early supplier integration: the dual role of purchasing in new product development. R & D Management, 40(2), 138–153. https://doi.org/10.1111/j.1467-9310.2010.00602.x

Schmelzle, U., & Tate, W. L. (2022). Purchasing orchestration practices – Introducing a purchasing-innovation framework. Journal of Purchasing and Supply Management, 28(2), 100756. https://doi.org/10.1016/j.pursup.2022.100756

Scholten, K., & Schilder, S. (2015). The role of collaboration in supply chain resilience. *Supply Chain Management*, *20*(4), 471–484. https://doi.org/10.1108/scm-11-2014-0386

Sethi, R. (2000). New Product Quality and Product Development Teams. Journal of Marketing, 64(2), 1–14. https://doi.org/10.1509/jmkg.64.2.1.17999

Sharifi, H., & Zhang, Z. P. (1999b). A methodology for achieving agility in manufacturing organisations: An introduction. *International Journal of Production Economics*, *62*(1–2), 7–22. https://doi.org/10.1016/s0925-5273(98)00217-5

Shashi, Centobelli, P., Cerchione, R., & Ertz, M. (2020b). Managing supply chain resilience to pursue business and environmental strategies. Business Strategy and the Environment, 29(3), 1215–1246. https://doi.org/10.1002/bse.2428

Sierzchula, W., Bakker, S., Maat, K., & Van Wee, B. (2012). Technological diversity of emerging eco-innovations: a case study of the automobile industry. Journal of Cleaner Production, 37, 211-220.

Singh, K., & Mitchell, W. (2007). Precarious collaboration: Business survival after partners shut down or form new partnerships. Strategic Management Journal, 17(S1), 99–115. https://doi.org/10.1002/smj.4250171008

Skjoett-Larsen, T. , Schary, P.B. , Mikkola, J.H. and Kotzab, H. (2007), Managing the Global Supply Chain , Copenhagen Business School Press, Gylling.

Somapa, S., De Baere, E., & Dullaert, W. (2018). Characterizing supply chain visibility – a literature review. The International Journal of Logistics Management, 29(1), 308–339. https://doi.org/10.1108/ijlm-06-2016-0150

Spekman, R. E., Kamauff, J. W., & Salmond, D. (1994). At last purchasing is becoming strategic. Long Range Planning. https://doi.org/10.1016/0024-6301(94)90211-9

Stake, R. (2000). The case study method in social inquiry. In Norman K. Denzin & Yvonne S. Lincoln. The American tradition in qualitative research. Vol II. Thousand Oaks, California: Sage Publications.

Stake, R. E. (1995). The art of case study research. Thousand Oaks, CA: Sage

Statista. (2022, June 16). Projected electric truck worldwide market size 2021-2030. https://www.statista.com/statistics/1312976/global-electric-truck-market-size-forecast/

Steward, M. D., Narus, J. A., Roehm, M. L., & Ritz, W. (2019). From transactions to journeys and beyond: The evolution of B2B buying process modeling. Industrial Marketing Management, 83, 288–300. https://doi.org/10.1016/j.indmarman.2019.05.002

Swafford, P. M., Ghosh, S., & Murthy, N. N. (2006). The antecedents of supply chain agility of a firm: Scale development and model testing. *Journal of Operations Management*, *24*(2), 170–188. https://doi.org/10.1016/j.jom.2005.05.002

Tatikonda, M. V., & Rosenthal, S. M. (2000). Successful execution of product development projects: Balancing firmness and flexibility in the innovation process. Journal of Operations Management, 18(4), 401–425. https://doi.org/10.1016/s0272-6963(00)00028-0

Tavani, S. N., Sharifi, H., Soleimanof, S., Najmi, M. (2013). An empirical study of firm's absorptive capacity dimensions, supplier involvement and new product development performance. International Journal of Production Research, 51(11), pp. 3385-3403.

Team, T. O. (2022, June 24). Supply Chain Resilience & Redundancy | Optimising Your Supply Chain. OCI. https://www.oci-group.co.uk/supply-chain-resilience-redundancy-optimising-your-supply-chain/

Tenny, S., Brannan, G. D., Brannan, J. M., & Sharts-Hopko, N. C. (2017). Qualitative study.

Thomas, G. (2011). A typology for the case study in social science following a review of definition, discourse, and structure. Qualitative Inquiry, 17(6), 511- 521.

Tukamuhabwa, B. R., Stevenson, M., Busby, J., Zorzini, M. (2015). Supply chain resilience: definition, review and theoretical foundations for further study. International Journal of Production Research, 53(18), pp. 5592-5623.

Tushman, M. L., & Anderson, P. W. (1986c). Technological Discontinuities and Organizational Environments. Administrative Science Quarterly, 31(3), 439. https://doi.org/10.2307/2392832

Von Haartman, R., & Bengtsson, L. (2015). The impact of global purchasing and supplier integration on product innovation. International Journal of Operations and Production Management, 35(9), 1295-1311. https://doi.org/10.1108/IJOPM-03-2015-0128

Weele, A. J. (2018). Purchasing and Supply Chain Management: Analysis, Planning and Practice. Cengage Learning.

Whipple, J. M., & Russell, D. M. (2007). Building supply chain collaboration: a typology of collaborative approaches. *The International Journal of Logistics Management*, *18*(2), 174–196. https://doi.org/10.1108/09574090710816922

Wieteska G. (2018b). Design of resilient supply chains. Economic and Social Development, (1849-7535), pp. 571-578.

Wieteska-Rosiak, B. (2020). Real Estate Sector in the Face of Climate Change Adaptation in Major Polish Cities. Real Estate Management and Valuation, 28(1), 51–63. https://doi.org/10.2478/remav-2020-0005

Wohlin, C., Kalinowski, M., Felizardo, K. R., & Mendes, E. (2022). Successful combination of database search and snowballing for identification of primary studies in systematic literature studies. Information & Software Technology, 147, 106908. https://doi.org/10.1016/j.infsof.2022.106908

Yin, R. K. (2009). Case studies: design and methods, 4th ed. Thousand Oaks: Sage Publications.

Zhang, Y., Rysiecki, L., Gong, Y., & Shi, Q. (2020). A SWOT Analysis of the UK EV Battery Supply Chain. Sustainability, 12(23), 9807. https://doi.org/10.3390/su12239807

8. Appendices

Appendix A - Interview template purchasing department

Introduction:

- Could you please describe your position and role in the company
- How long have you been working here?
- What is your academic background?
- How long have you been working with purchasing?

Section 1:

- Can you describe any challenges or issues that arise in managing Project Y in a technologically uncertain environment? For example, how does the uncertainty of emerging technologies impact the supply chain decision-making process in this context?
- How do you resonate about supplier selection in a technologically uncertain environment, do you prefer to stick with your current supplier or switch to a new one with more up-to-date capabilities?
- Are there any specific actions or initiatives that the purchasing department can take to mitigate risks and uncertainties in the supply chain?

Section 2:

- Do you think that you supply NPD for Product X and/or Product Y with market information that benefits the project?
- Are your components sourced through a single source or multiple sources for Product X and/or Product Y?

Section 3:

- To what extent were your suppliers involved in the process of developing Product X and/or Product Y?
- Did you consult with suppliers during the project? At what stage and for what purpose?
- What would the optimal collaboration between a supplier and OEM X be, in order for the project to be successful?

Section 4:

- Is the awarded supplier/sub-suppliers your only option for sourcing this component?

- How do your supplier/suppliers respond to changes?
- Are you transparent to the extent that you reveal supply chain information such as origins of raw materials and sourcing, costs, logistics, and manufacturing?
- Do you think your suppliers are transparent with you in the same manner, or are they holding back on some information? If yes, what information do you think is difficult to retrieve?
- Do you employ numerous suppliers for a single component?
- If numerous suppliers are employed, do you consider their geographical position?
- Would you consider that you have implemented practices that enable you to avoid potential disruptions and take steps to eliminate or prevent them before they occur?
- How are you adjusting to changing market conditions?
- If yes, are these changes accommodated quickly or do they take longer than you wish?
- Would you claim that you have visibility in your supply chain from first-tier vendors to end customers?
- How do you forecast demand and inventory data throughout the supply chain?
- To what extent do you share information with your suppliers?
- Do you think you receive enough information from your supplier or are you often surprised about new events?
- Are there any specific strategies or tools that you use to manage information sharing?
- Regarding the collaboration with your suppliers for Product X and/or Product Y, would you say that it is an adversarial or collaborative relationship?

Appendix B - Interview template Research & Development

Introduction:

- Could you please describe your position and role in the company
- How long have you been working here?
- What is your academic background?
- How long have you been working with R&D?

Section 1:

- Can you describe any challenges or issues that arise in managing Project Y in a technologically uncertain environment? For example, how does the uncertainty of emerging technologies impact the supply chain decision-making process in this context?

- How do you resonate about supplier selection in a technologically uncertain environment, do you prefer to stick with your current supplier or switch to a new one with more up-to-date capabilities?

- Are there any specific actions or initiatives that R&D can take to mitigate risks and uncertainties in the supply chain?

Section 2:

- To what extent were your suppliers involved in the process of developing Product X and/or Product Y?

- Did you consult with suppliers during the project? At what stage and for what purpose?

- What would the optimal collaboration between a supplier and OEM X be, in order for the project to be successful?

Section 3:

- Is the awarded supplier/sub-suppliers your only option for sourcing this component?

- How do your supplier/suppliers respond to changes?

- Would you consider that you have implemented practices that enable you to avoid potential disruptions and take steps to eliminate or prevent them before they occur?

- How are you adjusting to changing market conditions?

- If yes, are these changes accommodated quickly or do they take longer than you wish?

- How do you forecast demand and inventory data throughout the supply chain?

- To what extent do you share information with your suppliers?

- Do you think you receive enough information from your supplier or are you often surprised about new events?

- Are there any specific strategies or tools that you use to manage information sharing?

- Regarding the collaboration with your suppliers for Product X and/or Product Y, would you say that it is an adversarial or collaborative relationship?

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