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Impacts of Supply Chain Management Practices on the Commercialization of Open Innovation in a Large Company

International Business
Master's thesis

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This thesis examines the impacts of supply chain management practices on the commercialization of open innovation in a large company. The empirical data of the thesis is collected by nine semi-structured interviews with managers from both supply chain management and technical departments in a large mining company. Six dimensions of supply chain management practices are used to investigate their impacts on the commercialization stage, including strategic supplier partnerships, customer relationships, information sharing level, information sharing quality, lean practices, and postponement. First, the practices of supply chain management and its six dimensions as well as commercialization in a large company is exhibited. In this step, the challenges of commercialization are emphasized. Second, the negative impacts of the six dimensions are described. Third, the positive impacts of the six dimensions are presented. The thesis' findings theoretically contribute to literature of both supply chain management and open innovation regarding the connection and interaction between the two concepts. Managerial implications present possible practical application for large companies in supply chain management and open innovation management. In general, the thesis provides insights into how supply chain management practices via six different dimensions can be deployed to hinder and foster the commercialization of open innovation.

Key words: Open Innovation, Commercialization, Supply Chain Management practices, Strategic supplier partnerships, Customer relationships, Information sharing level, Information sharing quality, Lean practices, Postponement.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

1.1 Background of the research

Nowadays, businesses encounter unprecedented environmental instabilities stemming from swiftly evolving technologies, information explosion, and novel business models. To survive and become key players in the market, companies must constantly improve and innovate their products and services (Pilav-Velić & Marjanovic 2016, 398.) Under high pressure from the market, many firms consider innovation an essential factor in the development of a company (Christensen 1997). Innovation is now widely seen as a collaborative process involving various contributors, both inside and outside of organizations (Chesbrough 2003). The concept of open innovation is first introduced by Chesbrough (2003). Along with the growth of strong business networks globally, open innovation is one of the common methods that many companies choose to innovate their products or services, in which the involvement of external partners is a necessity for the success of these innovations (Chesbrough 2003).

The success of supply chain management (SCM) strategies relies on the integration, cooperation, and collaboration among its stakeholders. This integration is built upon shared objectives, transparent communication, and a mutual willingness to share resources, risks, and rewards. (Soosay et al. 2008, 160.) In other words, supply chain management utilizes the flow of information and materials across multiple stages and partners in the supply chain, with the goal of optimizing supply chain efficiency and enhancing customer satisfaction (Stein & Voehl l998; Tan 2002; Talib, Rahman & Qureshi 2011). Having said that, supply chain management and open innovation have a close relationship and mutual interaction with each other. Some researchers argue that open innovation is just a new concept of supply chain management (Simchi-Levi & Fine 2010, 24). Meanwhile, Badawy (2011, 66) disagrees with this thought but argues that open innovation is seen as a business model or a paradigm, while supply chain management functions primarily as a tool within a system aimed at enhancing efficiency of supply chain in companies. Although the overlapping between supply chain management and open innovation remains controversial, it is presumed that both concepts can efficiently support each other to foster innovation.

Supply chain management practice is “a set of activities undertaken in an organization to promote effective management of its supply chain and is proposed to be a multidimensional concept" (Li et al. 2005, 620). Suggested by Li et al (2005), there are six dimensions of supply chain management practices, including strategic supplier partnership, customer relationship, level of information sharing, information sharing quality, lean practices and postponement. In the study of innovation, many studies review the influence of suppliers (Wagner & Bode 2014; Jajja et al. 2017), customers (Vaisnore & Petraite 2011; Piller & Ihl 2009), knowledge (Wittke & Hanekop 2011), lean practice (Chesbrough & Tucci 2020) on innovation practices. These studies mostly investigate the impact of each factor separately and independently from others. Supply chain management can be seen as the organized effort to effectively manage the supply value chain (Stein and Voehl l998, 263) in which the strategic nature of coordination between partners is emphasized (Li et al. 2004, 107). In other words, supply chain management practice is a set of activities with involvement of different partners. Therefore, when it comes to the impacts of supply chain management, its dimensions should be investigated altogether. However, there is very little attention paid to the relationship between supply chain management and open innovation through the lens of the above-mentioned six factors overall, as well as the combined effects by these six factors on open innovation.

1.2 Research questions

This study aims to investigate the impact of supply chain management practices on the commercialization of open innovation in the context of a large company. This purpose is obtained by answering the main research question: **How do the supply chain management practices impact the commercialization of open innovation in a large company?** To find the answers to the main research question, I first describe the dimensions of supply chain management practices and then examine their impacts on the commercialization stage of open innovation. These steps are specified by sub-research questions as follows:

- What are the dimensions of supply chain management practices that influence the commercialization of open innovation in a large company?
- How do the supply chain management practices hinder the commercialization of open innovation in a large company?
- How do supply chain management practices foster the commercialization of open innovation in a large company?

The study will contribute to the literature of supply chain management practices as well as the cross disciplinary interaction of supply chain management and open innovation, specifically the commercialisation stage. Following the theoretical contribution, this study will propose several suggestions that might be applicable for large companies to take advantage of supply chain management practices to foster their open innovations, reinforcing their competitiveness in the market.

2 COMMERCIALIZATION OF OPEN INNOVATION AND SUPPLY CHAIN MANAGEMENT PRACTICES IN LARGE COMPANIES

This chapter exhibits definitions and theories relevant to the topic of investigation. It is structured into four subchapters. The first subchapter consists of three parts: theories of open innovation, open innovation practices, and the focus on the commercialization stage in large companies. The subsequent subchapter describes supply chain management practices in large companies and its dimensions. The third subchapter exhibits the impact of supply chain management practices on open innovation in large companies. Finally, the last subchapter provides the recap of the theoretical foundation and introduces the initial framework for this study.

2.1 Open innovation

2.1.1 Types of open innovation

Firm's innovation strategies have become more open and reliant on outside information (Laursen & Salter 2006a, 131). Numerous innovative companies allocate minimal resources to research and development, yet they effectively innovate their products or services by leveraging knowledge and expertise from diverse external sources (Laursen & Salter 2006a, 132). This trend is described by the open innovation model, proposed by Chesbrough (2003). Defined by Chesbrough (2006, 2), open innovation is "the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively". Chesbrough later clarified that open innovation is "a distributed innovation process based on purposefully managed knowledge flows across organizational boundaries" (Chesbrough 2006, 2). In contrast to the closed innovation framework, the concept of open innovation theory highlights the shift from relying only on internal research and development expenses (Pavitt 1991, 43), which are typically associated with a vertically integrated system, to the increased significance of external knowledge and ideas as valuable sources for innovation (Chesbrough 2003). Open innovation has been acknowledged as effective in numerous industries and types of businesses, although its applicability is not always easy (Santoro et al. 2018, 563).

There are three types of open innovation: inbound (outside-in), outbound (inside-out), and coupled process (Grassman & Enkel 2004, 1). Inbound process is "enriching a company's own knowledge base through the integration of suppliers, customers, and external knowledge sourcing can increase a company's innovativeness". (Grassman & Enkel 2004, 1.) Businesses in low-tech sectors often lean towards an inbound approach in open innovation. Historically, these companies, often small or medium-sized, acted as knowledge intermediaries or creators for larger firms, or they occupied a subsequent role in the value chain. Those specializing in inbound methods typically exhibit a high degree of knowledge intensity, relying on external knowledge to enhance their internal abilities. In the inbound process, companies choose to cooperate with external stakeholders, for example: customers and suppliers, to integrate external knowledge into their resources. This process can be done by earlier supplier integration, customer co-development, external knowledge sourcing and integration, in-licensing, and buying patents. (Grassman & Enkel 2004, 7 – 10.)

Evidently, the involvement of suppliers can enhance firm's success by leveraging supplier capabilities to innovate and develop new products (Bonaccorsi & Lipparini 1994, 136 -140). Many studies (Handfield et al. 1999; Chesbrough 2003; He et al. 2014) agree that when companies engage with their suppliers, they can gain substantial benefits. These advantages may encompass operational optimizations like early detection of technical issues, reduced alterations to engineering orders, or access to prototypes (Grassman & Enkel 2004, 8). Indeed, strategic partnerships with suppliers also emerge as an effective tool to reduce development cost, mitigate defects, enhance quality, and reduce time to market (Bonaccorsi & Lipparini 1994, 136 -140).

Addressing unmet customer needs is pivotal in creating new value for customers (Pinchot 1985). Companies should involve customers in the new product development process to gather insights into their preferences and to possess technological competencies (Piller & Ihl 2009, 35-36). In a framework by Dahan and Hauser (2002), the involvement of the customer in a new product development process can be categorized into three types, including "listen into" the customer domain, "ask" customers, and "build" with customers. The first mode involves designing products for customers, while the second mode involves soliciting input from customers for the company's innovation process. In both modes, customers are not directly involved with the company. However, the third mode actively involves customers in the creation or improvement of products, often through the use of tools provided by the company. (Piller & Ihl 2009, 14.) Therefore, customers are active contributors to value creation, serving as co-creators within the innovation process due to their inherent competence. Beyond consumers, external knowledge sources such as licensed patents from other companies, and technological insights from regional innovation clusters also hold significant value in new product development. (Grassman & Enkel 2004, 8.)

In contrast to inbound open innovation, outbound open innovation is “the external exploitation of ideas in different markets, selling intellectual property and multiplying technology by channelling ideas to the external environment” (Grassman & Enkel 2004, 1). Companies employing an outbound strategy may either prioritize being research-driven or aim to reduce fixed costs associated with research and development, branding, and establishing standards by leveraging spillover effects. The outbound process revolves around externalizing knowledge and innovation of companies to expedite the introduction of new ideas to the market, surpassing internal development timelines. This shift often entails altering companies’ revenue model by licensing intellectual property or transferring technology to other entities. For example, outsourcing is one of the most common strategies in outbound open innovation. (Grassman & Enkel 2004, 11 – 12.) It presents multiple offering cost advantages through all research and development, production, and economies of scale (Gillett 1994, 45 - 46).

Some companies may combine both inbound and outbound process – named as coupled process. Selecting a coupled process enables a company to pursue standard setting, boost returns, form alliances with complementary partners, develop products with crucial interfaces, and adopt a relational perspective on the firm (Grassman & Enkel 2004, 13).

Company size affects how open innovation is approached differently in large companies and small and medium-sized enterprises (SMEs) (Spithoven et al. 2013; Van de Vrande et al. 2009; Giardino, Cristofaro & Marullo 2022). In the next section, open innovation in large companies is discussed with a focus on the comparison between large companies and SMEs, as well as the role of intellectual properties in open innovation.

2.1.2 Open innovation in large companies

2.1.2.1 Large companies vs. small and medium-sized companies

Open innovation practices vary from company to company. The differences in the nature of large companies and small and medium-sized enterprises lead to different approaching ways to open innovation in those companies. SMEs are limited in various resources, including finance, manpower, technology, and market information, to accelerate new product development (Lee et al. 2010, 296). A large company is quantitatively defined as a company operated by over 5000 employees, generating 200M$ in sales turnover per year (Bhatty, 1981). Large companies are market-dominating, systematic and strategical, well-structured, and financed by banks and open market (Velu 1980). Therefore, large companies face fewer constraints on their resources. Indeed, large companies possess full internal capabilities to search for, assimilate, and synchronize external knowledge in open innovation. First, large companies can provide dedicated resources including human resources to approach a wide variety of input information sources and explore applicable external knowledge which can be turned into new products or services later. Second, these external knowledge and technologies necessitate significant adjustment before being applied at commercialization which requires innovating companies to possess capabilities to absorb and exploit new knowledge. (Spithoven, Vanhaverbeke & Roijakkers 2013, 542.) Therefore, open innovation is suitable and widely practiced by large companies where the definition of open innovation was first investigated and introduced.

In large companies, open innovation takes place throughout whole innovation process from ideation to commercialization. However, the role of external partners in each stage varies during the evolution of the new products. External ideas can be from partners, vendors, soliciting the external scientific community such as universities or laboratories, SMEs or startups, idea contests, or external product designers (Cooper & Edgett 2008, 3). However, ideas from partners and vendors are also the most popular methods in open innovation (Cooper & Edgett 2008, 3; Zynga 2018, 22). This trend is also supported by a later study conducted by Brunswicker and Chesbrough (2018). Even though the involvement of customers in open innovation is emphasized, large companies still practice intensive collaboration with entrepreneurs and suppliers to innovate their products. Along with suppliers and universities, entrepreneurs and startups are involved significantly in large companies' open innovation. (Brunswicker & Chesbrough 2018, 41.) Although SMEs or startups partners play a crucial role in open innovation at large companies, the differences in nature between SMEs and large companies can be attributed to the incompatibility during their collaboration in an open innovation project. Indeed, the differences in strategic and management orientation, research and development setting, organizational environment, and factors contributing to competitive advantage are the main causes of different innovation approaches of the two models (Giardino, Cristofaro & Marullo 2022, 1167). First, SMEs usually focus on a limited number of innovation projects which tremendously impact their business. Conversely, managing a wide range of projects simultaneously, large firms assume open innovation as a standard business practice (Spithoven et al. 2013, 553). Second, it is worthy to note that the way that SMEs manage open innovation initiatives is different from what practiced by large companies. Given the fact that small and medium-sized companies are typically managed by the founders or entrepreneurs rather than a specialized management team (Dollinger & Kolchin 1986, 33 - 35), open innovation in these companies is also viewed as a part of entrepreneurship, where their network is significantly contributed by information networking and trust (Lee et al. 2010). Meanwhile, large companies own hierarchical managerial structures, monitoring management orientation, stage-gate decision processes, structure, etc. (Giardino, Cristofaro & Marullo 2022, 1167) which can be seen as tools to standardize open innovation process in these companies. Third, resources play a significant role in how SMEs and large companies practice open innovation differently (Spithoven et al. 2013; Van de Vrande et al. 2009; Lee et al. 2010). Indeed, small and medium-sized companies, which are restrained in information sources and financial resources to assemble important information for innovation, face difficulties in seeking and deciding partners to establish effective networks serving innovation (Lee et al. 2010, 296). In contrast, large companies are more equipped to participate in innovative partnerships as they possess skilled workers and necessary research and development facilities to collaborate effectively with various innovative counterparts (Spithoven et al. 2013, 544).

2.1.2.2 Intellectual property management in large companies

Knowledge flow is the cornerstone of open innovation (Chesbrough & Bogers 2014, 9). Choosing the suitable type of open innovation to commercialize new ideas is very crucial (Grassman & Enkel 2004, 1). As projects progress, knowledge is more likely exchanged between parties (Chesbrough & Bogers 2014, 23), making open innovation rarely a one-sided process. In the meantime, the knowledge flow can be pecuniary or non-pecuniary (Dahlander & Gann 2010, 700). These complexities make making decisions in managing open innovation projects more critical and intricate (Brunswicker & Chesbrough 2018, 33). Thus, knowledge management is essential in managing open innovation. Intellectual property management refers to "the management of knowledge assets, which are eligible for protection under intellectual property laws" (Henao-Calad, Rivera Montoya & Uribe Ochoa 2017, 138). Intellectual property management plays an important role not only as a protecting shield but also a form of organizational knowledge, facilitating the creation, storage, transfer, and utilization of additional knowledge (Henao-Calad, Rivera Montoya & Uribe Ochoa 2017, 138).

It is suggested that outside-in open innovation in large companies is more prevalent than inside-out (Brunswicker & Chesbrough 2018, 35). Specifically, their study points out that pecuniary and nonpecuniary inbound flows in large companies are approximately equal among practiced projects, whereas pecuniary outbound flows greatly surpass nonpecuniary outbound flows in these companies. Overall, larger firms usually receive more external knowledge for free meanwhile they tend to protect their intellectual property when sharing outward. (Brunswicker & Chesbrough 2018, 38.) This is in line with other studies (López & Roberts 2002, 998; Laursen & Salter 2006b, 19) that firms tend to emphasize knowledge protection while cooperating with external partners. Thus, intellectual property protection becomes one of the significant concerns of large companies during open innovation practice, especially in outbound open innovation.

Controlled outbound open innovation involves mechanisms like licensing or selling patents, which contrast with intellectual property-revealing approaches (Dahlander & Gann 2010, 703-704). Non-financial outbound knowledge sharing can occur without relinquishing intellectual property rights; for instance, a firm might offer free usage rights while maintaining intellectual property control (Brunswicker & Chesbrough 2018, 38). A clear drawback of revealing intellectual properties to obtain overall technology advances is the challenge of fully capturing the resulting benefits (Helfat 2006, 87) since competitors might own competitiveness in facilities to take advantage of the revealed technology (Dahlander & Gann 2010, 704). Therefore, when engaging in outbound open innovation, firms usually assert some level of intellectual property control (Brunswicker & Chesbrough 2018, 38).

Intellectual property protection strategies of large firms are also varied in each stage of open innovation. In the early stage of the innovation process, firms selectively share knowledge to define the problem and generate ideas. As projects progress into the development stage, they become even more cautious, seldomly waiving full control over the new knowledge. Instead, the control over the new technology and its application is retained. These selective approaches are vital for motivating external partners, particularly those situated earlier in the value chain, which is commonly observed with smaller enterprises. (Brunswicker & Chesbrough 2018, 40.)

Open innovation involves a balance between sharing knowledge with external stakeholders and maintaining control over that knowledge for benefits of innovating companies. This balance does not necessarily require an all-or-nothing approach, but firms have the flexibility to be selective in sharing and retaining control. (Brunswicker & Chesbrough 2018, 43.) Indeed, revealing knowledge or technology does not always decrease the probability of success (von Hippel 2005, 85 - 88; Henkel 2006, 966 - 967). Free revealing can increase the diffusion of innovations to the market, enhancing the chances that new products are widely accepted. By freely disclosing innovation, the innovating company can also decrease manufacturing costs by involving potential users in improving the new products. (von Hippel 2005, 86 – 87.) Instead, the key lies in strategic decisions concerning what knowledge to share, how, and what level of legal control to uphold. Selective strategy in managing intellectual property rights is essential in all stages of open innovation and plays a significant role in a project's overall success. (Brunswicker & Chesbrough 2018, 43.)

Commercialization is very important stage of open innovation. Companies who aim to commercialize their ideas and those of other firms, while also deploy external processes to introduce their ideas to market beyond their current operations, are capable of initiating an “era of open innovation” (Grassman & Enkel 2004, 1). The efficiency of commercialization is also seen as a prime factor to measure the productivity of research and development activities of a company (Chun, Chung & Bang 2015, 895). In the next section, commercialization practices in large companies are described.

2.1.3 Commercialization of open innovation

Commercialization is the final stage of the innovation process and plays a determining factor in the success of innovation. Commercialization activities happen internally (inhouse strategy) and externally (outsourcing, in and out-licensing, partnership and collaboration knowledge sales, divestment of company units) (Henttonen & Lehtimäki 2017, 332). This classification covers almost all forms of knowledge commercialization which are studied by other researchers.

An in-house strategy involves leveraging internal knowledge for commercializing products and services. However, companies need possess the capability to effectively assimilate and integrate knowledge from external sources to fully leverage the knowledge assets (Chesbrough 2003). Increasingly, firms view external commercialization of knowledge as a proactive component of overall business strategy (Lichtenthaler 2005, 231). Outsourcing, licensing, divestment of company units, partnership and collaboration knowledge sales are the most popular strategies for external knowledge commercialization (Henttonen & Lehtimäki 2017, 332).

Outsourcing has proven beneficial for companies by offering cost advantages through all research and development, production, and economies of scale (Gillett 1994, 45 - 46). When companies face resource or capability shortages, they tend to lean towards seeking outsourcing solutions. The widely acknowledged benefits of outsourcing include cost reduction, increased flexibility, the opportunity for firms to concentrate on core competencies, minimized requirements for capital investment, and lowered risks. (Dinu 2015, 103 – 104.) Partnership and collaboration agreements involve two or more separate companies working together on specific business targets. These terms encompass all varieties of inter-organizational cooperation. These cooperations support product marketing, enable economies of scale, and offer various support services. (Henttonen & Lehtimäki 2017, 332.)

The third strategy for collaborative commercialization is licensing. Licensing involves a contractual agreement wherein one company (the licensee) acquires permission to utilize technology, such as patents, trademarks, knowledge of technology, manufacturing, and marketing from external parties which can be a company, organization, or even an individual (the licensor) (Atuahene-Gima 1992, 157). The last two collaborative commercialization strategies refer to asset sales. A knowledge sale occurs when ownership of intellectual property is transferred through the sale of a knowledge asset (Helm, Endres & Hüsig 2019, 330).

Inbound and outbound open innovations are sometimes mentioned by similar terms that external technology commercialization is equivalent to the outbound open innovation and external technology sourcing represents the inbound open innovation. External technology commercialization is not only about knowledge sales but also about partnerships, cooperations, joint ventures, etc. (Helm, Endres & Hüsig 2019, 329 - 330)

It is evident that both inbound (external technology sourcing) and outbound (external technology commercialization) open innovation bring certain advantages to innovating companies. External technology sourcing offers a way to reduce the continuously rising development costs caused by the increasing complexity of products, higher quality demands, and the need for diverse variations. (Helm, Endres & Hüsig 2019, 332.) In another way, external technology commercialization helps minimize wasted resources on irrelevant technologies by transferring or licensing them for additional value, benefiting other firms (Chesbrough 2006).

Firms use external technology commercialization not only to cut sunk costs but also to generate profits through licensing or selling technology. The innovating firms can also gain strategic advantages by accessing external knowledge, fostering internal innovation through new technology combinations, and accelerating the launch of new products to the market. (Helm, Endres & Hüsig 2019, 332.) Moreover, setting industry standards is also defined as a benefit of forming alliances by external technology sourcing or external technology commercialization (Koruna 2004, 488 - 489). Companies may need to actively seek external adopters for their knowledge, as the successful commercialization of their products depends on this adoption (Conner 1995, 218 - 219).

External technology commercialization can also cause disadvantages to companies. First, successful external commercialization of technologies necessitates a thorough assessment of all potential applications, demanding both time and specialized human resources from identifying partners to executing and monitoring agreements (Helm, Endres & Hüsig 2019, 334). Indeed, the diversity of tasks involved in the commercialization process poses one of the main challenges in organizing external knowledge exploitation (Lichtenthaler 2005, 243). Because of this diversity, it requires the commercialization tasks to be handled by specialized employees who are organized into specialized teams navigated by the needs of the company (Dyer et al. 2001, 41 - 42). Second, when the intensity of external technology commercialization increases, it leads to heightened opportunity costs due to an increased probability of innovation sales that may be required domestically later or utilized by competitors (Lichtenthaler 2005, 239). Consequently, the risk of losing future competitive advantages emerges as a significant threat resulting from external technology commercialization. This situation could inadvertently strengthen competition, thereby weakening the firm's own competitive position, even if the technology or knowledge initially appeared irrelevant. (Helm, Endres & Hüsig 2019, 334.) Overemphasizing external technology commercialization might yield short-term profits through licensing revenues but could adversely impact the long-term value provided to customers by diverting focus from their needs (Helm, Endres & Hüsig 2019, 336). This transition from prioritizing customer orientation to focusing solely on profit may undermine the firm's core business, thereby impeding long-term success (Huizingh 2011, 4).

Achieving effective open innovation necessitates a strong emphasis on carefully choosing practices as well as partners (Theyel 2013, 256). It is necessary to obtain alignment among all supply chain stakeholders, who should share a common vision. In many companies, novel ideas are generated by external partners in the company's supply chain. To mitigate this reliance, organizations might implement strategies to internally create products utilizing new materials, components, and technologies. Nevertheless, this approach is not always feasible due to the potential lack of internal skills and expertise within companies. (Zimmermann, DF Ferreira, & Carrizo Moreira 2016, 293.) In other words, the role of supply chain management is undoubtedly essential in new product development process. In the next subchapter, supply chain management and its dimensions are defined to have fundamental understanding about these concepts as well as the practices in large companies.

2.2 Supply chain management practices

2.2.1 Features of supply chain management

Stein and Voehl (l998, 263) define supply chain management as: "The systematic effort to provide integrated management to the supply value chain in order to meet customer needs and expectations, from suppliers of raw materials through manufacturing and on to end-customers.". Simchi-Levi, Kaminsky and Simchi-Levi (2003, 1) define that "Supply chain management is a set of approaches utilized to efficiently integrate suppliers, manufacturers, warehouses, and stores, so that merchandise is produced and distributed at the right quantity, to the right locations, and at the right time, in order to minimize system-wide costs while satisfying service level requirements". Both definitions describe the features and functions of supply chain management in business. However, the definition given by Stein and Voehl (l998) is specific in terms of pointing out explicitly the involvement of different stakeholders in the value chain as well as the flow of the value chain from suppliers to customers. Indeed, supply chain management is viewed as an approach aimed at enhancing competitive performance through the integration of internal organizational functions and their connection with external supply chain partners such as suppliers, customers, and other related parties. (Talib, Rahman & Qureshi 2011, 269).

Supply chain management facilitates a collaborative network of independent entities aiming for efficient operations (Tan 2002, 43). The main objective of supply chain management is “to increase customer satisfaction, market share, and profits for all members of the supply chain network” (Wisner 2003, 5). Purchasing function plays a pivotal role in supply chain management, bridging the gap between supply sources and the organization. Strategic partners within the supply chain must collaborate to enhance manufacturability, benefiting both customers and suppliers. The collective effort focuses on optimizing processes, eliminating redundancies, and enhancing overall efficiency across the supply chain ecosystem. (Tan 2002, 43.)

In many large companies, the supply chain network is viewed as a facilitator of innovations, bringing these innovations to the market (Skippari, Laukkanen & Salo 2017). Meanwhile, some researchers argue that open innovation is merely a new concept of supply chain management (Simchi-Levi & Fine 2010) due to the overlapping of the two concepts. Although there might seem to be similarities between the two concepts, they are significantly different. Open innovation can be seen as “a business model and a paradigm, whereas supply chain management is essentially a tool or component of a system for achieving efficiency in the supply chain” (Badawy 2011, 66). First, supply chain management is structured, planned, and geared toward creating stable networks. Open innovation emphasizes seeking new ideas, products, or services which come from external collaboration and partnerships among various entities. Second, supply chain management is strategically designed for coordinating traditional business functions, prioritizing cost reduction and efficiency by establishing an interconnected system handling the process of moving and storing materials and products from their sources to the final consumption. Meanwhile, open innovation involves unconventional activities centred on creativity, invention, innovation, and differentiation from existing norms. (Badawy 2011, 66.)

Supply chain management is crucial to firms’ performance. Supply chain management practices can be measured by various dimensions. In the next section, different frameworks of dimensions supply chain management practices are exhibited in order to select the most suitable framework for this study.

2.2.2 Dimensions of supply chain management practices

Supply chain management comprises a range of strategies and practices aiming to have efficiently integrated different stakeholders of the supply chain which can be suppliers, customers, distributors to enhance the efficiency of the supply chain, consequently improving performance of a company. This is achieved through a robust and efficient business model. (Chopra & Meindl 2010.) These practices are considered multidimensional, involving both the downstream and upstream facets of the supply chain (Li et al. 2004, 109). Supply chain management practices can enhance a firm's flexibility, which refers to its capability to quickly adjust and react to the changes in business environment (Lenny Koh et al. 2007, 109). Constructing long-term lasting partnerships with suppliers and customers has the potential to boost supply chain flexibility by cultivating mutual understanding and cooperation among the involved partners (Chang et al. 2005, 1126 - 1127; He et al. 2014, 265 - 267). Strengthening partnerships with suppliers and customers enables firms to anticipate information sharing from their partners, leading to improved accuracy in demand forecasting. Additionally, strategic supply chain management planning facilitates resource utilization, optimizing cost savings. Enhanced coordination with external stakeholders such as suppliers or customers is another advantage of supply chain management practices. By forging close partnerships with suppliers, joint innovation for new product development becomes more achievable. (Lenny Koh et al. 2007, 109.) To measure the effectiveness of supply chain management, dimensions are defined and classified by different studies. These different frameworks are exhibited in the Table 1 below.

Table 1 Dimensions of supply chain management practices

Author	Dimensions of supply chain management practices
Tan et al. (2001)	Supply chain integration, Information sharing, Supply chain characteristics, Customer service management, Geographical proximity, JIT capability
Min & Mentzer (2004)	Agreed vision and goals, Information sharing, Risk and award sharing, Cooperation, Process integration, Long-term relationship, Agreed supply chain leadership
Li et al. (2005)	Strategic supplier partnership, Customer relationship, Information sharing, Information quality, Internal lean practices, Postponement
Kumar & Kushwaha (2018)	Supplier collaboration, flexibility with partners, usage of internet, lean production, internal integration, quality management, customer focus

Tan et al. (2002) propose the dimensions of supply chain management practices including supply chain integration, information sharing, supply chain characteristics, customer service management, geographical proximity, and just-in-time capability. In a different view of Min and Mentzer (2004), dimensions of supply chain management practices are agreed vision and goals, information sharing, risk and award sharing, cooperation, process integration, long-term relationship, and agreed supply chain leadership. Kumar and Kushwaha (2018) list out seven dimensions of supply chain management practices, including supplier collaboration, flexibility with partners, usage of internet, lean production, internal integration, quality management, and customer focus. Even though all above-mentioned classification frameworks cover almost all sides of supply chain management, they are not fully in line with the definition of supply chain management by Stein and Voehl (l998, 263) which is mentioned in the previous section and used throughout this study.

In the definition by Stein and Voehl (l998, 12), the supply value chain is emphasized "from suppliers of raw materials through manufacturing to customers". A framework suggested by Li et al. (2004) can describe this flow explicitly. In this framework, the five dimensions encompass upstream (strategic supplier partnership) and downstream (customer relationship) aspects of a supply chain, information flow throughout the supply chain (level of information sharing and quality of information sharing), and internal supply chain process (postponement) (Li et al. 2004, 109). This framework is further extended by including lean practices as the sixth dimension (Li et al. 2005) (Figure 1).

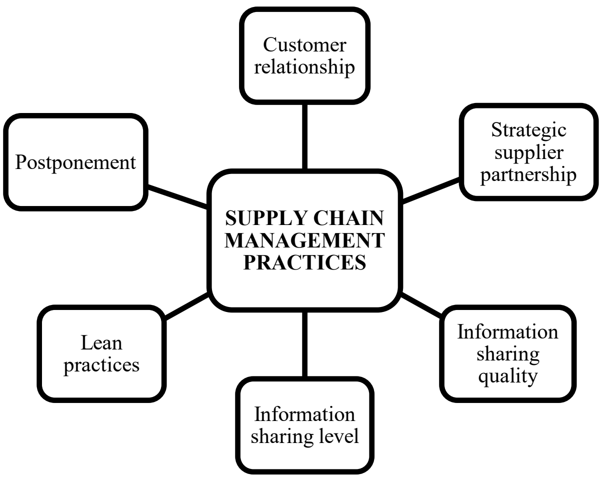

Figure 1 Framework - Dimensions of supply chain management practices (Li et al. 2005)

Strategic supplier partnership refers to the long-term relationships between the organization and its suppliers. Customer relationship encompasses practices related to complaint handling, customer satisfaction, and building long-term relationships with customers. Information sharing entails the communication of information between partners, where quality is determined by accuracy, adequacy, and timeliness. Lean practices involve waste elimination, maintaining low inventory, utilizing small lot sizes, and implementing just-in-time delivery. Postponement refers to the delayed customization of products within the supply chain. (Li et al. 2005, 621.) Although various literature portrays dimensions of supply chain management practices from different perspectives, considering the coverage of proposed dimensions and their relevance to the definition of supply chain management as well as the innovation process, in this study, the framework of Li et al. (2005) will be discussed further in the relationship with the open innovation process. In the next sub-chapter, the impacts of supply chain management practices on the commercialization of open innovation are discussed through the lens of six dimensions of the chosen framework above.

2.3 Impacts of supply chain management practices on the commercialization of open innovation in large companies

This subchapter presents dimensions of supply chain management practices, including strategic supplier partnership, customer relationship, information sharing level, information sharing quality, lean practice, and postponement, as well as their impacts on innovation in general and commercialization in specific. In each section, the definition of dimension is presented first in each section, following by its influences on open innovation. Due to the strong connection between information sharing level and information sharing quality, both dimensions are discussed in the same section throughout this study.

2.3.1 Strategic supplier partnership

2.3.1.1 Defining strategic supplier partnership

The integration of suppliers positively influences a company performance in introducing new products. In situations where buyer-supplier relationships are strategic and trustful, suppliers are inclined to put more effort in technology investment and engage in idea exchange with customers (Arundel et al. 1995). Meanwhile, collaboration on research and development with suppliers shows more significant positive effects on product innovation compared to collaboration with universities. (Un et al. 2010). Jajja et al. (2017, 1067) emphasize that companies with focus on innovation tend to seek suppliers who share the similar visions in innovation, positively contributing to product innovation. In fact, suppliers can actively participate across in new product development process by contributing materials, sharing valuable information, technical expertise, and process knowledge. (He et al. 2014, 262.) They can engage in co-development with manufacturers to create the product or its components together, or even take sole responsibility for specific parts of the product design (Monczka et al. 2000, 52). It is suggested that suppliers can offer significant benefits to develop new products by their knowledge, experience as well as capabilities (He et al. 2014, 262).

Supplier involvement carries distinct objectives within closed and open innovation systems. The differences can be described in the figure 2 which is modified by Lau et al (2018, 26), based on the new product development process by Monczka et al. (2000, 5). In closed innovation, the focus is on cost reduction, quality enhancement, swift delivery, and augmenting functionality within the existing framework (Lau et al. 2018, 26 -27).

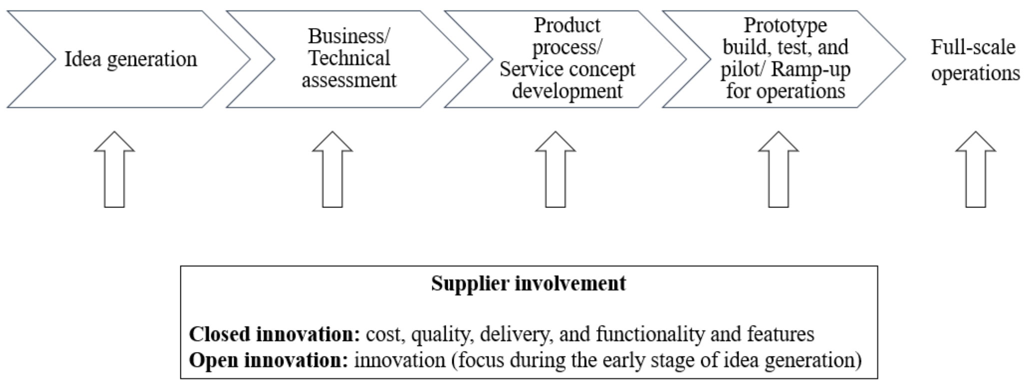

Figure 2 Supply chain - product development framework – (Lau et al. 2018, 26)

Contrastingly, in open innovation, suppliers engage from the inception stage by generating new ideas and providing their technological and market insights to the innovating companies. Consequently, this collaboration allows manufacturers to acquire novel ideas and knowledge for new product development while granting suppliers new purchase orders without facing market uncertainty. The engagement of suppliers should not be viewed only as set of existing ideas; instead, supplier involvement serves the purpose of enhancing operational excellence in closed innovation and plays a crucial role in fostering open innovation. (Lau et al. 2018, 26 -27)

Companies employing an exploration strategy seek partners with complementary capabilities. In contrast, companies implementing an exploitation strategy aim to collaborate with partners who possess comparable technological capabilities. Exploitation demands extensive collaboration, which necessitates significant time to develop, with benefits accruing only after sustained long-term collaboration. (Dittrich & Duysters 2007, 513.) That makes the role partnerships in exploitation strategy similar to strategic supplier partnerships through the lens of supply chain management. According to Li et al. (2004, 109), strategic supplier partnership represents the long-term relationship between the organization and its suppliers. Establishing strategic supplier partnerships enables firms to cooperate more efficiently with suppliers who are committed to jointly ensuring the success of the products that they work on (Li et al. 2005, 621). Strategic supplier selection is not only about their existing technology but also about their capability to innovate future technologies; these advancements can offer benefits across different phases, from product development to commercialization, for the company (Ellram 1990, 13).

2.3.1.2 Impacts of strategic supplier partnership on the commercialization of open innovation

Involving suppliers early in the development of new products can maximize the advantages gained from their expertise in engineering, design, testing, manufacturing, and tooling. Specifically, suppliers can offer insights into the production process necessary for purchased items, optimize design to align with efficient production methods, thereby reducing costs and manufacturing cycle time. They can also provide design and technical knowledge for purchased components or sub-assemblies, anticipate and initiate pre-production activities to shorten the overall development timeline. (Monczka et al. 1993, 39.)

Suppliers are able to introduce new technologies and mitigate risks associated with manufacturing challenges (Ragatz et al. 2002). Integrating suppliers in manufacturing operations can help manufacturers practice better planning, forecasting, inventory management (Wong et al. 2011, 609 – 612). In specific, supplier integration is positively correlated with the improvement of delivery, cost, product quality, and manufacturing flexibility (Dröge, Jayaram & Vickery 2004, 569; Wong et al. 2011, 612; Monczka et al. 2000, 29 - 75). In fact, the foundation for a company to create high-quality products is intensively related to acquiring quality input materials from suppliers. By managing suppliers properly, companies can minimize discrepancies in input materials, ensuring quality specifications and standards are met by suppliers. Based on that, it can positively impact delivery time, product cost, and product quality. (Bonaccorsi & Lipparini 1994, 138.) As suggested by Wong et al. (2011, 609), supplier integration positively impacts production flexibility through the ability to swiftly change production volume, producing customized products, producing a wide range of products by their facility, and the ability to rapidly change product mix. Along with positive influences in manufacturing operations, suppliers can also recommend market expansion strategies aligned with available technologies, benefiting manufacturers. (Monczka et al. 2000, 98). Therefore, company strategic alignment with suppliers is a crucial factor in determining innovation outcomes and competitiveness (Jajja et al. 2017, 1067).

However, the involvement of supplier does not always bring positive effect to innovation. It is suggested that when suppliers participate in engineering tasks, the buyer must allocate time to negotiate, coordinate, control, and monitor to ensure adherence to the buyer-supplier contract, potentially impeding time-to-market performance (Perols, Zimmermann & Kortmann 2013, 163). Involvement with one supplier could potentially create a situation where the purchasing company becomes heavily reliant on the supplier and its technologies (Handfield et al. 1999, 79). Technology is one of deciding factors of bargaining power (Lee & Yan 2019, 563). The dependency in technology decreases bargaining power of buyer (Fabayo 1996, 367). When a supplier has an advantageous position, they might lack motivation to innovate, which can hinder technological progress. It leads to opportunistic behaviour in supplier-buyer relationships. In cases where a company heavily relies on new product development activities of suppliers in the long term, suppliers might hesitate to invest in technology specific to the company or share proprietary technology, fearing dependency and potential lock-in with that supplier (Handfield et al. 1999, 79). In the opposite way, the dependency of supplier on buyer volume degrades surviving ability of suppliers during a crisis when buyer volume suddenly plummets (Huan, Gaoping & Dan 2017, 341; Jiang et al. 2023, 511). Additionally, if suppliers do not align with the goals of innovating companies, it can diminish the likelihood of achieving objectives of company (Ahmadjian & Lincoln 2001, 696 - 697). Therefore, choosing and developing suitable suppliers is very important for innovative firms to achieve innovation goals (Jajja et al. 2017, 1067).

The age of the buyer-supplier relationship influences the extent in which they collaborate on innovation. The depth of supplier engagement and the strength of their relationship significantly affect a buyer's access to supplier technology, which is further influenced by the status of the buyer as a customer. (Ellis et al. 2012.) This point is also justified by the study of Wagner and Bode (2014, 75) that a long partnership between a buyer and a supplier, coupled with the perceived level of cooperation from the buyer, increases the probability that the supplier will share their product innovation. However, when firms seek new technology, long-lasting suppliers are not always able to provide new technology. This may lead to a dilemma to choose between a new partner and a long-term supplier.

Customer is the downstream of firm's supply chain, thus customer relationship is also one of the dimensions of supply chain management practices. In the next section, customer relationship and its impacts on the commercialization of open innovation are presented.

2.3.2 Customer relationship

2.3.2.1 Involvement of customer relationship in innovation

The field of innovation management has extensively explored the involvement of customers in the development process over recent decades. Studies have revealed that numerous commercially significant products or processes originate from innovative users rather than solely from manufacturers. (Piller & Ihl 2009, 8.) Customer relationship encompasses diverse strategies used to address customer complaints, foster long-lasting relationships with customers, and elevate overall customer satisfaction (Li et al., 2005, 621).

Nowadays, the increasing trend of mass customization requires intensive customer involvement in the product innovation process. In particular, mass customization aligns a company's capabilities with the diverse needs of customers through innovative approaches, making customer relationships essential for company growth. (Piller and Ihl 2009, 8)

Based on the level of customer involvement in new product development (framework by Dahan & Hauser 2002), Piller and Ihl (2009, 14) propose three modes, called “Design for, Design with, and Design by customers”. In the design-for-customers mode, products are developed for customers using information collected from various sources like sales feedback or focus groups, with the goal of meeting unfulfilled customer needs. In the design with customers mode, in addition to observing customers' preferences through data analysis, this strategy involves presenting different design options or concepts to customers for their feedback and reactions. In the design-by-customers approach, customers are not merely involved in expressing needs or providing feedback at the start or end of the innovation process; instead, they actively participate in designing or developing their own solutions. Manufacturers either empower customers to design solutions themselves or employ methodologies to efficiently incorporate innovative customer-generated solutions into their company's domain. (Piller & Ihl 2009, 14.)

Based on their level of engagement, customers may take different roles in three stages of open innovation. Accordingly, customers play the role of idea generators, co-creators, testers, and users, in the ideation, development, and commercialization stages respectively. (Vaisnore & Petraite 2011.) Through this iterative process, the most potential ideas are selected from a variety of options for further development (Fuller & Matzler 2007, 381). The new ideas focusing on pinpointing opportunities and generating new and inventive concepts can be contributed by inventors, users, designers, engineers, or even members of other innovative communities (Vaisnore & Petraite 2011, 65). The subsequent phase in the innovation process involves development, wherein customers become active co-creators. Customers can play a role as co-creators or co-designers during the design and engineering stages of new product development. Commercialization is the last phase of open innovation which involves testing and introducing product to the market. In this phase, participants in the process can be testers, end users, or buyers. (Fuller & Matzler 2007, 381.)

2.3.2.2 Impacts of customer relationship on the commercialization of open innovation

Involved in all stages of product innovation, customer integration on new products can bring positive effects to innovation. First, customers often contribute innovative ideas by detailing their requirements and expressing unfulfilled needs (Chesbrough 2003).

Enhanced access to customer-related information is improving the result of innovation endeavours (Piller & Ihl 2009, 3). Furthermore, integrating customers provides valuable understanding about expectations from market and explore potential opportunities, thereby facilitating a responsive approach to meet customer needs by aligning supply with demand (Wong et al. 2011, 609 - 613). Second, along with mass customization trends, customer involvement in new product development enables customized goods to transform customer needs into specific product specifications. In other words, customer integration entails identifying customer needs and adjusting internal operations to fulfil these specific requirements. (Piller & Ihl 2009, 9). Third, engaging customers right from the start of product development aids in clarifying the new product design, thereby reducing the necessity for reworks stemming from misunderstandings in requirements and enhancing time performance during the development stage (Bajaj et al. 2004, 531). Indeed, a tight customer-manufacturer relationship enhances demand accuracy, decreases the time spent on designing and production planning, as well as reduces obsolete inventory, fostering better responsiveness to the needs of customers (He et al. 2014, 261). Last but not least, customer is also viewed as a key stakeholder in diffusing new products to market (Chesbrough 2003) in which the references by a customer or a customer group are important to gain acceptance from other customers for new products (Slater & Mohr 2006, 28).

However, some other studies debate that customer involvement in innovation may also bring side effects to the company. If the new product is overly tailored to the needs of one single customer group, it may result in overall negative performance in innovation (Bonner & Walker, 2004). Customers sometimes prefer familiar products, urging manufacturers to avoid innovation, as new products often demand new resources from customers, potentially wasting their existing resources (Lau et al. 2010, 771). Relying solely on current customer input might limit firms' capacity to create highly innovative products (He et al. 2014, 265). In other words, it is worth noting that the more customer knowledge heterogeneity, the more novelty that product gets (Bonner & Walker, 2004, 164). Therefore, customer knowledge heterogeneity is an important determinant of product innovation.

Information shared in supply chain plays important role in supply chain management, including information from inside organization and from external partners such as customers or suppliers. In the next section, information sharing, in terms of both quality and level, and its impacts on the commercialization of open innovation are explored in detail.

2.3.3 Information sharing level and information sharing quality

2.3.3.1 Defining information sharing level and information sharing quality

Chesbrough and Bogers (2014, 24) describe the open innovation paradigm "a distributed innovation process that involves purposively managed knowledge flows across the organisational boundary". Open innovation mainly focuses on the knowledge as new technological knowledge acquired via scouting, in-licensing intellectual properties, university research programs, funding startups, collaborating with external stakeholders of the company such as intermediaries, suppliers, and customers, and employing nondisclosure agreements (Chesbrough 2003). Information can be divided into two main types, including information on customer and market needs ("need information"), and information on (technological) solution possibilities ("solution information") (von Hippel 1998, 630). These two types are both important for the innovation process and can be acquired from the network of the innovative company (von Hippel 1998, 630).

From another perspective, supply chain management practices emphasize two other aspects of information management: level of information sharing and information sharing quality (Li et al. 2004, 110). This emphasis is due to that information sharing significantly influences supply chain performance, impacting both overall costs and service levels. Enhancing information sharing boosts the collaboration across supply chain, allows a smooth flow of materials and finished goods, consequently decreasing the cost in stock management. (Zhao et al. 2002.)

Information sharing level is defined as "the extent to which critical and proprietary information is communicated to one's supply chain partner", while information sharing quality "refers to the accuracy, timeliness, adequacy, and credibility of information exchanged" (Li et al. 2005, 622). By sharing information, supply chain partners can also understand end customer needs better, making them more responsive to any change in the market (Li et al. 2005, 621). Information sharing is an essential factor of a productive supply chain by accelerating the information flow, reducing the time taken to respond to customer requirements, promoting better cooperation, and allowing to share risks and benefits to related parties (Li & Lin 2006, 1641). Therefore, flexibility throughout the whole supply chain can be obtained by information sharing (Kokins, Straujuma, & Lapiņa 2021, 1637).

2.3.3.2 Impacts of information sharing on the commercialization of open innovation

Information sharing allows firms to gain advantageous skills and foster collaborative problem-solving efforts, enhancing understanding of available opportunities in innovation (Kulangara, Jackson, & Prater 2016, 1609). Internal information sharing within firms is important not only in ideation but also in the application of novel ideas, leading to the improvements of innovative capabilities (Subramaniam & Youndt 2005, 457). Information sharing can help firms obtain knowledge about technology and the market comprehensively, understand significant changes in the environment swiftly and accurately, which is often antecedent to innovation (Hambrick 1997; McFadyen & Cannella 2004). Effective information sharing also builds up confidence and coordination of new product development teams which is important for innovation performance (Liu, Chen & Tao 2015, 32).

External information sharing benefits suppliers and buyers when valued information about processes, products, or customers is shared. The exchange of information between a buyer and its suppliers directly influences the innovation capacity of the buying firm. By sharing information, there's an enhanced capacity to develop new products, as it grants access to insights not readily accessible within the company's internal resources. (Kulangara, Jackson, & Prater 2016, 1609.) Trust serves as a crucial filter for evaluating the accuracy and credibility of information obtained from external stakeholders (McEvily & Marcus, 2005). This filtering mechanism enables the buyer to reply on the quality of information supplied by the supplier. Consequently, mutual trust can enhance the frequency of information sharing between the innovating company and its partners, reducing information asymmetry, and thereby enhancing innovation capabilities. Hence, mutual trust facilitates the adoption of new processes and technologies. (Kulangara, Jackson, & Prater 2016, 1610.)

Along with positive impacts, information sharing also has some negative influence on the innovation process. Too much information sharing can hurt the new product development performance. Over-shared information results in a transfer of intricate data within the organization which can sometimes obscure the main message (Day &

Schoemaker 2004). Therefore, excessive internal information sharing may overwhelm team members' ability to process information, potentially hindering team performance (Wegner 1987). For the external information sharing, there is a risk of leaking information. Uncontrolled external knowledge sharing occurs when individuals share vital business knowledge with external partners without considering the confidentiality level of knowledge. If the information-holders do not carefully consider whom to share critical business knowledge with, it may lead to inadvertent knowledge leakage which negatively influences the innovation performance of innovating companies. (Ritala 2018, 1108.)

In summary, information sharing is crucial in establishing a productive supply chain with the involvement of both customers and suppliers. The proper and timely sharing of information in the whole supply chain can accelerate the innovation process.

Lean practice is one of the six dimensions investigated in this study. In the next section, literature about lean practices and its impacts on the commercialization of open innovation are discussed further.

2.3.4 Lean practices

Lean practices involve waste elimination, maintaining low inventory, utilizing small lot sizes, and implementing just-in-time delivery (Lenny Koh et al. 2007, 106). These elements mostly occur in the commercialization stage.

Lean practices stimulate technological advancement by enhancing a company's efficiency in product development. This can be seen through the reduction of new product development time as well as the elimination of wasteful practices during production. (Gerhard et al. 2012.) Implementing lean practices can further innovation by motivating employees to refine and innovate processes to minimize waste, eliminate non-value-adding tasks, introduce novel methods, and foster a spirit of continuous improvement inside organization, thereby enhancing creativity (Bhuiyan & Baghel 2005, 763 - 764). Additionally, lean practices facilitate uninterrupted improvement of the company's processes by identifying and eliminating bottleneck problems. (Melton 2005, 665).

The lean approach is nowadays used beyond manufacturing and extends to management, product and process development. It is directed towards reducing inefficiencies, such as time lost in unproductive meetings, revisiting decisions, and the inability to adapt swiftly to changing circumstances. (Flores et al. 2017.) The alignment between open innovation and the principle of lean thinking is evident, yet this relationship remains unexplored in academic research (Chesbrough & Tucci 2020, 21). Open innovation offers two paths, including outside-in and inside-out processes, for ideas to reach the market. Similar to the lean principles, open innovation promises reduced waste and faster market entry, particularly through the outside-in path. When collaborating externally, innovating firms can begin mid-project, leveraging what partners have already developed, skipping past prior obstacles. This approach saves time and resources, aligning with lean. (Chesbrough & Tucci 2020, 5.)

Applying lean thinking to startup companies, Ries (2011) proposes new concept "Lean startup". Lean startup is an approach which minimizes resources wasted on developing products or product features that might not meet customer needs (Chesbrough & Tucci 2020, 5). Lean startup can be beneficial for open innovation in large companies, emphasizing the dynamic interaction between the two concepts. However, in order to be successfully practiced in large firms, adaptations of lean startup are essential. This adjustment has to be executed on different levels, from innovation processes to business model, organizational culture, and even changing the mindset concerning current and future business models. (Chesbrough & Tucci 2020, 33.)

Not always exhibiting positive impacts on innovation, lean practices also have some negative side effects in which unexpected additional costs, unplanned quality issues and customer dissatisfaction emerge as the common downsides (Mueller & Strzelczak 2014, 171). The overlooked connection between lean practices and the general strategy, coupled with environmental changes, disregarded risks stemming from profitability pressures, can lead to adverse consequences when applying lean practices. Thus, before implementing lean practices, a systematic and rigorous approach should be taken, including careful selection of initiatives aligned with strategic planning and company goals. Monitoring should be equally systematic, with controls in place to ensure alignment with strategic objectives and effective outcomes. (Mueller & Strzelczak 2014, 172.)

Postponement is the last dimension of supply chain management practices. In the next section, literature of postponement as well as its impacts on the commercialization of open innovation are explored in detail.

2.3.5 Postponement

Postponement is "an organizational concept whereby some of the activities in the supply chain are not performed until customer orders are received" (van Hoek 2001, 161). In specific, postponement is the delayed differentiation of products in the supply chain (Lenny Koh et al. 2007, 106). This process involves creating standard or modularized products which are able to be customized swiftly and affordably when customer requirements are determined. Postponement includes adopting targeted inventory strategies to decrease inventory cost, mitigate risks but still ensure that customer requirement and customer service are still met. It is about employing strategies to have the correct inventory, in the appropriate location, and in the suitable form to fulfil needs. (Wadhwa, Bhoon & Chan 2006.) The implementation of postponement allows firms to be flexible by creating different product versions to address evolving customer needs and optimize production planning at the same time (Waller et al. 2000, 136). In research by Boone, Craighead and Hanna (2007, 604) the linking of postponement strategies and uncertainty is revealed. In fact, the variety of postponement strategies depends on the degree of uncertainty and level of product modularization (Yang et al. 2004, 1053). This relationship is illustrated by the Figure 3.

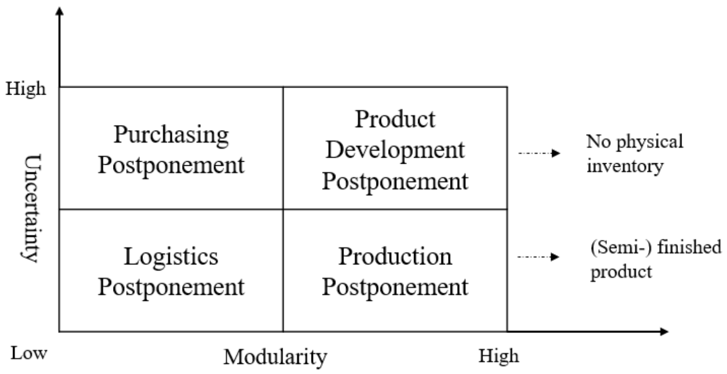

Figure 3 Model for the management of uncertainty through postponement (Yang et al. 2004, 1053)

According to Figure 3, it is suggested that product development postponement and purchasing postponement can be employed to manage situations with a high level of uncertainty, while production postponement and logistics postponement may be utilized to address scenarios with a low level of uncertainty. Additionally, the level of modularity in product development and the production process also significantly influences the selection of various postponement strategies. (Yang et al. 2004, 1053.) Modularity refers to constructing a complex product or process by breaking it down into smaller, independent subsystems that can function together as a finished product (Baldwin & Clark 1997, 86). Accordingly, when high modularity takes place, product development postponement and production postponement can be deployed to deal with the high and low level of uncertainty respectively. (Yang et al. 2004, 1053.) Meanwhile, one of the characteristics of innovation is its high uncertainty (Jalonen 2012) when both demand and supply are not stable, especially during the early phase of innovation. Indeed, postponement is frequently employed in situations of uncertainty, particularly in supply chains dealing with innovative products (Boone, Craighead & Hanna 2007, 604). Therefore, postponement is necessary for innovation.

Even though postponement adds numerous benefits to manufacturing activities, it also exhibits limitations. One of obvious concerns is the lengthen delivery time to customers (Salvador 2008, 7). Furthermore, using standardized components to facilitate mass customization could potentially raise material costs, prompting companies to weigh the advantages of standardization against the extra expenses. The effectiveness of utilizing common components hinges on various factors such as demand uncertainty across different markets, the time required to replenish materials inventory, product life cycle time, and the costs associated with product delivery. When uncertainty, lead time, inventory and stock-shortage costs rise, the advantages of standardization become more apparent. (Feitzinger & Lee 1997, 118). Additionally, implementing postponement demands substantial initial investments and a comprehensive overhaul of the existing business processes which require intensive technical and market knowledge, these reasons are seen as barriers to the adoption of postponement in manufacturing systems. (Wadhwa et al. 2008, 368.)

Based on the reviewed literature of the commercialization of open innovation as well as six dimensions of supply chain management practices, in the next sub-chapter, an initial framework for this study is presented. This framework is generated to provide an overview of theoretical foundation for this study.

2.4 . Initial framework

Supply chain management and open innovation are two concepts that are close to one another. In this subchapter, a theoretical framework is generated based on the reviewed literature. In the Figure 4 (next page), supply chain management practices, throughout six dimensions, impact on the commercialization. The impacts can be positive or negative, demonstrated by contrasting arrows.

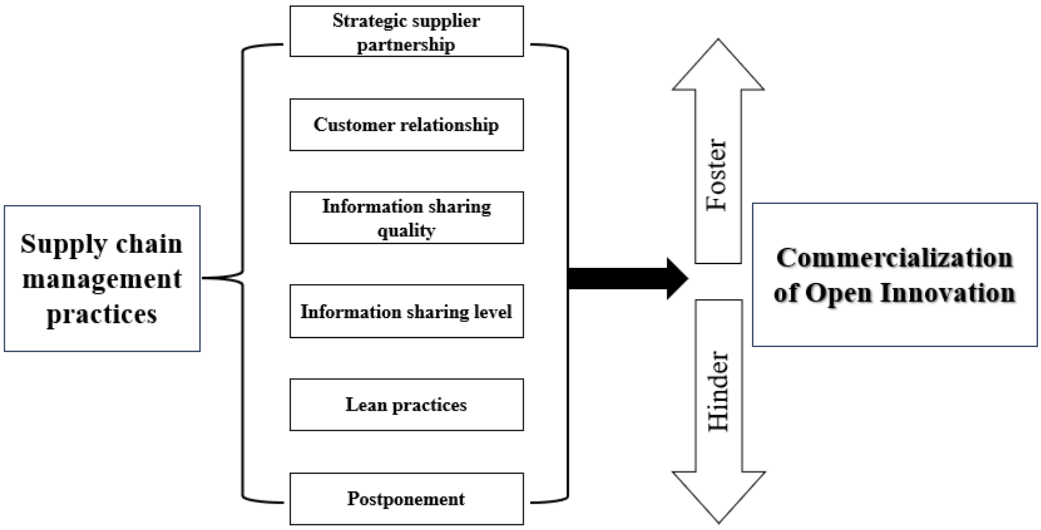

Figure 4 Initial framework of the study

One of the ways in which supply chain management and open innovation intersect is through the creation of collaborative relationships between organizations in the supply chain. Open innovation can be seen as a paradigm where supply chain management plays a very important role. However, the impacts of supply chain management practices in open innovation have not been adequately addressed, particularly in the commercialization stage.

Many studies (Handfield et al. 1999, Lau, Tang & Yam, 2010; Lee et al. 2010; He et al. 2014) discuss the role of different external stakeholders in open innovation but do not have in-depth insights into the influence of strategic supplier partnerships in the innovation process. According to Li et al. (2004, 109), strategic supplier partnership represents the long-term relationship between the organization and suppliers. Companies that prioritize innovation choose their suppliers by assessing their own managerial and technical abilities concerning their desired goals (Kannan & Tan 2006). In addition, these companies also motivate their suppliers to improve their technological and innovative capabilities. These companies collaborate with their suppliers to enhance their technological skills while also allowing them to maintain their technological autonomy.

This leads to well-informed suppliers who can contribute innovative ideas to the partnership. The age of the buyer-supplier relationship is considered one of the key factors in deciding the extent of their cooperation in innovation (Ellis et al 2012; Wagner & Bode 2014). Strategic supplier partnerships can be established when suppliers are able to meet certain requirements from the buying company. In this study, the criteria of being strategic suppliers will be discussed. Strategic partnerships with suppliers allow companies to gain advantages not only from contemporary technical knowledge, manufacturing experiences, insights into the production process, pre-production activities anticipation (Monczka et al. 1993, 39); but also, from their capability to innovate future technologies (Ellram 1990, 13). However, there are also downsides coming from strategic supplier partnerships such as opportunistic behaviours (Handfield et al. 1999), or extra-resources allocation (Perols, Zimmermann & Kortmann 2013). Furthermore, when firms seek new technology, long-lasting suppliers are not always able to provide new technology. Network expansion and external knowledge exploitation, to some extent, have impacts on the relationship between innovating companies and their core suppliers. This may lead to a dilemma to choose between a new partner and a long-term supplier. It remains vague whether these companies tend to source new suppliers and construct a new network serving open innovation, or still prioritize their strategic suppliers to reinforce long-term business cooperation. In this study, both positive and negative impacts of strategic supplier partnerships on the commercialization stage of open innovation will be addressed.

As one of the six dimensions of supply chain management practices, the customer relationship should be investigated, in the context of the commercialization stage of large company open innovation. The involvement of customers is also considered essential for product innovation. The increasing trend of mass customization requires intensive customer involvement in the product innovation process. Specifically, mass customization aligns company capabilities with the customer needs through innovative approaches, making customer relationships becoming essential for company growth (Piller & Ihl 2009, 8). This involvement in each stage of open innovation varies (Vaisnore & Petraite 2011). The effectiveness of customer involvement in innovation has a strong interaction with customer knowledge heterogeneity (Bonner & Walker, 2004) which should be studied more to have in-depth knowledge about the linkage between innovating firms and customer needs in the market.

Customer knowledge heterogeneity is also one of the reasons why postponement is significantly important in supply chain management. Postponement allows innovating companies to develop standardized or adaptable products that can be easily and affordably customized once the real consumer needs are identified (Wadhwa, Bhoon & Chan, 2006). Postponement is highly involved in manufacturing activities which are important to the commercialization stage of open innovation. Even though postponement brings advantages to production, the negative effects should also be addressed in order to get an overview of the impacts of this dimension on open innovation. To practice postponement in manufacturing, it is required innovating firms to get sufficient and accurate information about customer needs and specific requirements for each product, making s tight connection between postponement and customer relationships. This connection and the impacts of postponement in open innovation are discussed further in this study.

The role of information sharing is vitally important in supply chain management as well as open innovation due to the nature of this paradigm is the flow of innovative knowledge. Organizations should regard their information as a strategic asset and secure its smooth flow with minimal delay and misrepresentation (Li et al. 2005, 621). Information disclosure sometimes can be seen as a loss of advantage (Li et al. 2005, 623). However, companies may intentionally manipulate information that could be accessed not only by their competitors but also by suppliers, clients (Mason-Jones & Towill 1997, 138). In open innovation, intellectual property management strategies are also very important, especially in the commercialization stage. Innovating firms tend to be cautious, rarely waiving complete control over emerging knowledge but retaining control over specific usage and application domains (Brunswicker & Chesbrough 2018, 40). Instead of an all-or-nothing approach in intellectual property management, firms have the flexibility to be selective in sharing and retaining control. Selective strategy in managing intellectual property rights is essential in all stages of open innovation and plays a significant role in a project's overall success. (Brunswicker & Chesbrough 2018, 43). It is important to understand how a large company chooses its intellectual property management strategies in the commercialization stage and how these strategies optimize the benefits of open innovation in the company.

Similarly, the role of lean practice in open innovation should be clarified to have a better understanding of how supply chain management practices influence on product innovation process in innovating companies. Lean practice is very important in supply chain management. Recently, lean thinking has been also practiced in management and has become common in innovations of startups with the new approach “lean startup” (Chesbrough & Tucci 2020, 5). However, “lean startup” in large companies has not been paid adequate attention. Chesbrough and Tucci (2020, 5) also argue that “lean startup” can be practiced in large companies with certain adaptations. Whether “lean startup” is practiced in large companies and the adjustment required to be done in order to apply lean thinking in open innovation of large companies are the two main aspects that should be clarified in this study.

By identifying the impacts of each supply chain management practices dimension in large companies' open innovation, this framework can help to expand our understanding of the complex relationships between supply chain management and innovation which contribute to the advancement of knowledge in the fields of supply chain management and open innovation. Based on this theoretical framework, research design is generated and presented in the next chapter.

3 RESEARCH DESIGN

This chapter exhibits an overview of research design which was employed as a framework to find the answers to research questions. Overall, a qualitative methodology was applied in this study. Empirical data was collected by semi-structured interviews and analysed by thematic analysis. Grounded on the research design, trustworthiness of this study was established which is also discussed in this chapter.

3.1 Research approach

Research design is the general plan of how the researcher addresses the research questions (Saunders, Lewis & Thornhill 2009, 136). The selection of a research methodology is influenced by the quality of the research question, the knowledge of the author in a particular situation, and the level of focus on the current event (Yin 2003, 5). Research methodology can be a mono method (qualitative or quantitative) or multiple methods (Saunders, Lewis & Thornhill 2009, 152). In this study, qualitative approach was used to describe and interpret the phenomenon of the research topic.

Quantitative research entails studies to utilize statistical analyses to derive their findings. Key characteristics include formal and systematic measurement, alongside the application of statistical methods. (Marczyk, DeMatteo & Festinger 2010, 17.) Meanwhile, qualitative research dominating the scientific endeavours in social sciences, encompassing business research, is often described in contrast to quantitative research. Indeed, qualitative research approach is regarded with interpretation and understanding. It involves thoroughly gathering information directly from practical situations and interactions with individuals. (Eriksson & Kovalainen 2015, 3 -5.) Aiming to describe, interpret, and translate the meaning behind the phenomena being studied, qualitative research involves a set of methods for understanding and explaining concepts and phenomena through interpretation, rather than simply measuring how often they occur in society (Basias & Pollalis 2018, 96).

Qualitative approach is well suited for this study since the aim of this study is to comprehensively describe how supply chain management practices impact on the commercialization of open innovation in a large company. It requires the author to have a good interaction with the people inside the researched organization to understand the empirical data collected during interviews. (Newman, Benz & Ridenour, 1998, 245.) Therefore, it justifies for selection of the research approach for this study.

Literature review with findings of previous research related to the phenomenon of this study is presented in the previous chapter. Based on the literature review, the research design is developed and described which includes the research questions, research method. Accordingly, data collection and data analysis processes are presented in the next subchapters.

3.2 Data collection

3.2.1 Semi-structured interviews

An interview is a common method for data collection. Utilizing interviews can aid in collecting dependable and pertinent data aligned with your research question and objectives. (Saunders, Lewis & Thornhill 2009, 318). Interviews can exhibit varying levels of formality and structure, ranging from highly formalized and structured interactions with standardized questions for each participant to informal and unstructured conversations. One commonly accepted typology categorizes interviews based on their level of formality and structure, resulting in the following classifications: structured interviews, semi-structured interviews, and unstructured or in-depth interviews. (Saunders, Lewis & Thornhill 2009, 320.) In this study, the semi-structured interview was used as the main tool to collect empirical data.

Standardized interviews are typically utilized for collecting data that undergoes quantitative analysis, such as within a survey-based approach (Saunders, Lewis & Thornhill 2009, 321). On the contrary, non-standardized interviews (semi-structured and in-depth) are employed to gather data that is typically analysed qualitatively (Saunders, Lewis & Thornhill 2009, 321). This study focuses on how supply chain management practices impact the commercialization of open innovation in a large company. Based on that, the study can propose a better understanding of the relationship between open innovation and supply chain management. Semi-structured interviews are useful to collect deeper information based on individual perspectives and practical experiences of interviewees meanwhile interviewer is still able to keep the interview structure well-organized by main questions. In semi-structured interviews, the researcher possesses a set of themes and questions to address, although these may differ across interviews (Saunders, Lewis & Thornhill 2009, 322 - 323). This implies that researcher has the flexibility to exclude certain questions in specific interviews when faced with an organizational context relevant to the research topic. The sequence of questions during the interviews may be adjusted based on the practical progression of the conversation. Furthermore, additional questions can be used during the interviews to explore research questions and objectives, considering specific circumstances within different departments of the researched company. (Saunders, Lewis & Thornhill 2009, 322 – 323.) Thus, the choice of semi-interviews is justified.

The empirical data was collected through semi-structured interviews at a large company. The reasons for researched company selection can be explained as following. First, the chosen company is an industrial machinery company focusing on providing end-to-end solutions and services for the mining industry globally. Furthermore, it operates with the business-to-business model where it has strong relationships with business customers. The company is a well-established business with proactive manufacturing sites, a worldwide supply chain with a massive supplier network. The company is also leading innovation in the operating industry with over 30 locations with R&D, testing or laboratory capabilities. Thus, the company employs many experts in both supply chain management and innovation who have rich knowledge and solid experiences in these fields. Their perspectives on the research topic are great sources for this study.

The semi-structured interview comprised main themes and follow-up questions. The main themes encompassed the core content of the research topic, wherein participants were encouraged to express their opinions freely. Follow-up questions were employed to clarify the main themes or dive deeper into specific topics that arose during the interview. (Kallio et al., 2016, 2960.)

After selecting appropriate form of data collection, interview themes were prepared to collect answers for research questions. An operationalization framework was developed accordingly. This process is presented in detail in the next section.

3.2.2 Operationalization of research

This study is conducted to answer the main research question: How do the supply chain management practices impact the commercialization of open innovation in a large company? To fully find the answers to the main research question, there are three sub-questions that are linked to different themes as listed in the following operationalization framework (Table 2). The interview themes were expected to cover five main aspects: open innovation, commercialization, supply chain management practices, supply chain management practices hindering commercialization, and supply chain management practices fostering commercialization.

Table 2 Operationalization framework

Research question	Sub-questions	Themes	Interview themes
How do the supply chain management practices impact the commercialization of open innovation in a large company?	What are the dimensions of supply chain management practices that influence the Commercialization of Open Innovation in a large company?	Open Innovation	1
		Commercialization	1
		Dimensions of supply chain management practices	1
	How do the supply chain management practices hinder the commercialization of open innovation in a large company?	SCM practices hindering commercialization	1, 2, 4
	How do supply chain management practices foster the Commercialization of Open Innovation in a large company?	SCM practices fostering commercialization	1, 2, 4

According to proposed operationalization framework (Table 2), each sub-question was answered by different themes. Five themes presented above were mapped to have an overview about the impacts of supply chain management practices on the commercialization of open innovation. The first sub-question was covered by three themes. The first theme was to know how open innovation was perceived in informants' organization and its practice in the context of a large company. Following the conversations, more empirical data of the commercialization was provided by interviewees, regarding the practices as well as challenges of commercialization that the researched company was facing. The third theme was the dimensions of supply chain management practices, including strategic supplier partnership, customer relationship, information sharing level, information sharing quality, lean practices, and postponement. In this theme, the practices of those dimensions were focused. In the first three themes, interviewees were mostly asked for their opinions in the context of a large company, however, it was open to discuss the differences between practices in a large company and small and medium-sized companies in which they might have experiences.

Having an initial understanding of different concepts related to the research topic in the first three themes, the last two themes were to describe the impacts of supply chain management practices on the commercialization of open innovation in both negative and positive aspects. The second sub-question was connected to the fourth theme. In this theme, respondents were asked about the downsides of each dimension of supply chain management practices that hindered the commercialization stage of open innovation. This theme also covered six dimensions of supply chain management practices. The last theme aimed to collect data to answer the third sub-question about how supply chain management practices fostered commercialization activities via six dimensions. Following the interviews, participants had the opportunity to bring up matters beyond the predefined themes that they believed were significant to the topic. While the themes were initially defined to address specific sub-questions, responses had the potential to impact other questions and themes. In the next section, the selection of interview participants is presented in detail.

3.2.3 Selection of interview participants

Identifying appropriate participants for the study is crucial. In qualitative research, the process of selecting research participants is purposeful, contrasting with the representative and random approach in quantitative studies. The objective behind participant selection is to gain comprehensive insights, thereby facilitating a better understanding of research topic. (Eriksson & Kovalainen 2015, 53.) In this study, informants who were invited participate the interview were all from the researched company with different responsibilities. The information of interview respondents is presented in the following Table 3. In total, nine interviewees were selected and invited to the interviews. The interviewees were from various departments where directly participated or involved the innovation activities or commercialization activities of the research company. Accordingly, respondents were responsible for both technical function (innovation, technology and engineering) and supply chain function (sourcing, supply and procurement) which ensured empirical data collected coming from experts in both fields of research topic.

Interviewees were expected to own in-depth knowledge and solid practical experiences either in supply chain management or in innovation, so that they could bring broad perspectives to the discussions. Thus, employees who worked in managing positions were suitable for the interviews. The interviewees were also from different level of management from manager to vice president.

Table 3 Conducted interviews

No.	Position	Length (min)	Date
1	Vice President, Innovation	65	10.01.2024
2	Vice president, Technology	55	17.01.2024
3	Vice President, Procurement	50	05.02.2024
4	Director, Strategic Procurement and Quality Supplier	65	12.01.2024
5	Director, Supply and Procurement	60	30.01.2024
6	Director, Strategic Sourcing	50	05.02.2024
7	Senior Manager, Innovation Eco-system	65	26.01.2024
8	Senior Manager, Sourcing	60	12.01.2024
9	Manager, Engineering	65	15.01.2024

All interview respondents were contacted directly by email with brief topic introduction. Individual interviews were used in this study which allow respondents being comfortable to express their perspectives confidentially without concerns about judgment or interference from others. Semi-structured interviews were conducted as informal discussions where interviewees were free to share their views on the research topic. Interviewees were encouraged to share their own perspectives and experiences during the conversations. Due to locations of interviewees as well as the popularity of remote work and virtual meetings after Covid-19, all interviews were run virtually, recorded by Microsoft Teams. All interviews were recorded clearly for analysis purposes. In this study, data collection and management process ensure research integrity which is presented in the next section.

3.2.4 Research integrity

Research ethics, which is crucial in qualitative interviews, are the responsibility of the researcher. This study follows the guidelines of TENK (2019) to ensure ethical principles in research. During collecting, storing, and processing empirical data, researcher ensure research integrity which covers four main aspects. In this research, *personal data* is not collected as the research topic mostly focus on interviewee's perspectives and experiences regarding supply chain management and open innovation. Once participants agreed to participate the interviews by email, the "*informed consent*" were also obtained through written agreement (Appendix 3) which ensured that participants were aware of the aims of this research and their right to voluntarily participate the project and to withdraw their participation at any time without giving reasons (TENK, 2019, 9 – 10). At the same time, Privacy Note (Appendix 4) was sent to participants to ensure the participant understand their privacy rights in this research project.

Confidentiality is kept during the interviews, data analysis and outputs of this research. Accordingly, name of research company, participants as well as the confidential information appeared during interviews were not used in this research. The researcher ensures *integrity and professionalism* by accurately representing information without omission or addition. A data management plan (Appendix 2) was created to ensure all steps of data management were complied.

The data collected following data management plan above were analysed to draw conclusions for this study. In the next subchapter, the process of data analysis is described in detail.

3.3 Data analysis

Qualitative data analysis is a process that describe, classify, and connect phenomena with the concepts of study (Graue 2015, 8). Content analysis is among the various qualitative methods used for analysing data and interpreting its meanings. (Saunders, Lewis & Thornhill 2009, 266).

Thematic analysis is described as "a method for identifying, analysing, and reporting patterns (themes) within data" (Braun & Clarke 2006, 79). The objective of conducting a theme analysis is to identify, examine, and ultimately present the key themes found in the data. (Braun & Clarke 2006, 77-82). In this study, data analysis was conducted using thematic analysis to achieve concise and profound description of the phenomenon being investigated. Theme analysis of transcribed interviews enables a profound exploration of the research topic, exceeding the depth attainable through quantitative analysis. This method grants flexibility and interpretation during data analysis but necessitates careful execution, emphasizing transparency, to instil confidence in the resulting findings. (Castleberry & Nolen 2018, 808.). Therefore, it justifies the choice of thematic analysis in this study.

The data analysis of this study followed the process proposed by Braun & Clarke (2006, 87) as below figure:

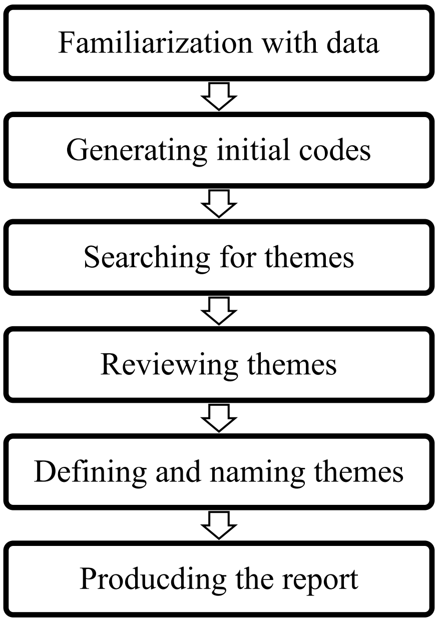

Figure 5 Phases of thematic analysis (adapted from Braun & Clarke, 2006, 87)

Researcher first familiarized with the collected data. In this phase, the collected data was transcribed from recorded video files to text by Microsoft Teams. The transcribed files were in Word documents. In this step, researcher also highlighted important points which were potential for coding. Those points would be revisited in later phases.

In the second phase, the informative sentences of conversations were identified in word file. Informative sentences in the word file were moved to an excel file, equivalating to 72 Word-pages. Based on operationalization framework, data in the excel file was organized by five categories: open innovation, commercialization, supply chain management practices, supply chain management practices hindering commercialization, and supply chain management practices fostering commercialization. Researcher initiated the coding process by systematically identifying and categorizing noteworthy aspects of the data throughout the whole dataset, gathering relevant data for every code. In the next phase, the general codes were generated. At this point, researcher focused on coding the data thoroughly and extensively, including also less conventional themes. When the data was coded, researcher started organizing and combining codes into possible themes. (Braun & Clarke 2006, 88–89.)

In the fourth step, researcher verified whether the themes were applicable based on extracts which were coded and the whole data transcribed, leading to create a thematic "map" that depicted the analysis. Based on the initial framework and the coded empirical data, researcher generated two main themes, including commercialization challenges and the aspects impacted by supply chain management practices (Table 4). Then, it was involved continuous analysis to fine-tune each theme and the main points conveyed by the analysis, resulting in comprehensible names for each theme (Braun & Clarke 2006, 88–89.).

Table 4 Coded themes

Theme	**Codes**
Commercialization challenges	Resources efficiency
	Scales of economy
	Value chain understanding
	Information sharing management
	Customer trust
	Market acceptance
Aspects impacted by supply chain management practices	Cost controlling
	Operations efficiency
	Technology improvement
	Quality of partnership
	Capacity flexibility
	Time-to-market
	Decision-making process
	Fulfilment of customer needs

Finally, researcher carefully selected outstanding extracts, conducts a final analysis of these chosen extracts, related the findings to the research questions and compared with existing studies, and generated a report summarizing the analysis. (Braun & Clarke, 2006, 87 - 93).

Based on practical research design described above, the evaluation of this study is presented in the next sub-chapter. In particular, trustworthiness of this study as well as its limitations are described.

3.4 Evaluation of the study

Trustworthiness of a study reflects the confidence in the data, interpretation, and methodologies utilized to ensure quality of the research (Pilot & Beck, 2014). This study is evaluated by criteria proposed by Lincoln and Guba (1985) which is widely acknowledged by many qualitative researchers. These criteria consist of credibility, dependability, confirmability, and transferability.

Credibility is the most crucial criterion to evaluate the trustworthiness of a study (Polit & Beck, 2014). Credibility ensures that the research is deemed credible by discerning readers and addresses the alignment between the researcher's portrayal and the perspective of the respondents (Lincoln & Guba 1985, 296). As discussed by Patton (1999), the credibility aspect in qualitative research is influenced by three interconnected inquiry elements. Firstly, it hinges on the rigorous use of techniques and methods to collect high-quality data, which are then subject to meticulous analysis with attention to validity, reliability, and triangulation. Secondly, the credibility of the researcher is crucial, influenced by factors such as their training, experience, track record, status. Lastly, credibility is associated with a philosophical commitment to the value of qualitative inquiry, embracing an inherent appreciation for naturalistic investigation, qualitative methodologies, inductive analysis, purposeful sampling, and holistic thinking. (Patton 1999, 1190.) In this study, an initial framework is constructed with solid theoretical foundation which is presented in chapter two. Open innovation and supply chain management are the two widely researched topics with rich theoretical sources. The databases for selected sources are also considered reliable. Thus, the theoretical background for this study is credible. However, due to the restraints of time and resources, not all existing literature regarding the research topic are comprised in the literature review, but the most related studies. Furthermore, the empirical data was collected and analysed following research methodology carefully to ensure that empirical results are trustworthy. The interviews were conducted carefully from building operationalization framework, identifying interview themes based on the framework, developing interview questions, and finally conducting interviews. The interviews were recorded and transcribed carefully before analysis process started. In the analysis process, data was coded and mapped with main themes in order to find the answers for research questions. This process ensures that all findings are presented carefully in the study.

Dependability in research pertains to the consistency of data over time and across different study conditions (Polit & Beck, 2014). It is similar to reliability in quantitative research, the assessment of stability of conditions varies depending on nature of the study. (Connelly, 2016, 435). This study emphasized reliability by offering a comprehensive and detailed research methodology as well as interview protocol. The extensive data collected from nine interviews conducted at the management level, along with substantial transcription material, promote the credibility of the study.

Confirmability refers to the neutrality and consistency of findings, indicating their repeatability (Polit & Beck, 2014). Qualitative researcher maintains comprehensive records of their decision-making processes and analysis throughout the study. These practices help prevent biases arising from perspective of one individual in the research. (Connelly, 2016, 435). In this study, all of nine interviews were conducted virtually but with recordings and then transcribed.

Transferability, which pertains to the extent to which research results can be useful in different settings, distinguishes itself from other aspects of research by leaving the determination of applicability to the readers themselves (Polit & Beck, 2014). Qualitative researchers prioritize the narratives of the participants, acknowledging that these stories do not represent the experiences of everyone. To enhance the transferability of their study, researchers provide a comprehensive and detailed account of the context, location, and individuals involved. They also ensure transparency concerning the analysis process and the reliability of the study. (Connelly, 2016, 435.) The aim of this study is to examine the impacts of supply chain management practices on commercialization of open innovation. Therefore, the focus is the phenomenon of research topic, but not the company itself. However, each industry has its own characteristics which also influences the perspective of interviewees on the research topic. Thus, the transferability of this study is also limited. Furthermore, identities of interviewees were anonymized which encouraged interviewees to speak more openly, enhancing credibility of the study. However, it also restrained the evaluation of research findings' applicability which might lead to a decrease in transferability. The empirical findings can theoretically contribute to literature of open innovation and supply chain management. These key findings will be presented in the next chapter.

4 IMPACTS OF SUPPLY CHAIN MANAGEMENT PRACTICES ON COMMERCIALIZATION

This chapter shows the empirical data of this study which aims to explain the practices of commercialization of open innovation in a large company and how supply chain management practices foster and hinder this stage of open innovation. According to this purpose, three sub-questions are answered: (1) What are the dimensions of supply chain management practices that influence the Commercialization of Open Innovation in a large company? (2) How do the supply chain management practices hinder the commercialization of open innovation in a large company? (3) How do supply chain management practices foster the Commercialization of Open Innovation in a large company? By analysing the collected data from semi-structured interviews, this chapter provides the results of this study. First, commercialization of open innovation and supply chain management practices in a large company are presented, then following by the impacts of supply chain management practices which are discussed in both positive and negative sides.

4.1 Commercialization of open innovation and supply chain management practices in a large company

4.1.1 Open innovation practices

Open innovation is the first subtheme of this study, addressing the perceptions of respondents in open innovation and how it is practiced in a large company. To understand the practical viewpoint of open innovation, the interviewees were first asked to define innovation.

Innovation is one of the key factors for every company to survive and develop in highly competitive business environment nowadays (Pilav-Velić & Marjanovic 2016). From different angles of view, innovation was defined diversely. Innovation is to "create something new which does not exist, or it may be also related to the improvement of the existing" as defined by Vice President, Technology. From a perspective of customer value, innovation can be "something that brings new values to the customers or new ways of doing things" (Senior Manager, Sourcing). Emphasizing the long-term effects, Senior Manager of Innovation ECO-System addressed that innovation was "the capabilities to survive in the future competition. It is not about the next quarters or annual target; the innovations help us stay alive in the future competition". Grounded on the different definitions proposed by respondents, the focuses of innovation are *novelty*, *value offering*, and *future competitiveness*.

Following innovation, respondents were asked to define open innovation. With the aim of collecting diversified viewpoints on the research topic, the interview participants were from both technical departments and supply chain management departments. According to the results of interviews, the term "open innovation" was widely used in technical departments rather than supply chain management side. In details, Vice President of Technology defined that open innovation was "something which was not done in silos, it is *utilizing different stakeholders*, not only R&D but also supply chain, salesman, and customers" which was rather close to the definition of open innovation proposed by Chesbrough (2003). Open innovation could be practiced with several different companies, starting from when one company came up with an idea, but they could not bring the whole offering to the market. Therefore, a group of companies would build up the idea into a new product together. (Vice President, Innovation.) According to the Vice President of Innovation, an *ecosystem* of innovation might be formed based on the practice of open innovation through the cooperation between the innovating company and its stakeholders. This is an interesting point which demonstrates a solid connection between open innovation and firm's network. Innovation can be developed within firm's networks (Aarikka-Stenroos, Sandberg & Lehtimäki 2014, 365) but at the same time networks for innovation can be formed through the practice of open innovation.

While most of respondents who were responsible for technical functions could generally define the concept open innovation, the supply chain management respondents were relatively new to this terminology. However, explained by interviewer about concept of open innovation, the supply chain management respondents were aware that open innovation was, by nature, practiced in their supply chain, but not specifically called open innovation. In general, open innovation was happening in the researched company without an official term to describe it organization-widely.

Even though open innovation was practiced in the company, it was also seen as a *problematic concept* when it came to *intellectual property* perspective (Senior Manager, Innovation Eco-system). This viewpoint was also supported by Vice President of Innovation, mentioning that open innovation could work well if only intellectual property rules were well-developed.

"We form an ecosystem. That ecosystem has well clearly defined targets and objectives, but also very well-defined ownership background. We own through the system anything that we developed together which is governed by an agreement, depending on that who is doing what is defined." (Vice President, Innovation)

Above perspective practically illustrates the reviewed literature (López & Roberts 2002; Laursen & Salter 2006b, Brunswicker & Chesbrough 2018) that large firms pay tremendous attention on intellectual properties and tend to protect their intellectual properties in open innovation. This phenomenon can be explained by two main reasons. First, it was contributed by the *characteristics of industry* (Manager, Engineering). The operating industry of the researched company required intensive investment on equipment and facilities. It led to a historically quite slow-paced innovation spirit in which customers were not eagerly joining to the newest solution or technology. The informant also additionally exemplified that their customers were in remote places, consequently they were hesitant to change their machines or equipment. If they added some very advanced products, there would be always a risk of failure. Without an immediate remedy, that failure might even affect the whole production plant. Second, competitive edge was also seen as the reason why the innovating company preferred to protect their intellectual properties from leaking to other players in the field. (Manager, Engineering.)

Concerning the intellectual property management, an informant stated that when it came to a discussion, the ideation had already well done, and they did not see themselves in doing ideation with others too frequently (Vice President, Innovation). Therefore, open innovation in the company was mostly practiced from the development to commercialization stage.

Due to characteristics of industry, innovation in the research company requires very in-depth knowledge. Most of innovations happened for some materials of finished products (Manager, Engineering) which demanded expertise and profound knowledge in products and its components (Vice President, Innovation). Therefore, suppliers and customers were the actively joining in the innovation process of the company. These cooperations usually take place from development to commercialization. In contrast, the high requirement of intensive knowledge about the operating industry hinders the participation of other stakeholders such as academia or universities in early stage of open innovation process. Furthermore, as mentioned by Vice President of Innovation, cooperated ideation might still happen, but the company had to spend much more time on the legal aspect of intellectual property management before further stages. It is also considered one of the reasons impeding the joining of external stakeholders in ideation stage of open innovation. In the next section, the empirical data of commercialization and its challenges are presented.

4.1.2 Commercialization and its challenges

Commercialization strategy selection is dependent on the resources of innovating companies as well as company goals on specific project. In house production, licensing, outsourcing are all applied in commercialization of the researched company. However, most of the activities are done in house since the company possessed experienced personnel, different branches which can be deployed, and it also reduces the possibility of information leak:

> *"We have own foundries and plants. So, we try to utilize our own supply chain as much as possible, but of course we have also external suppliers. When it is about new innovations and it may be sensitive to disclose new solutions, therefore we try to utilize our internal supply chain as much as possible."* (Vice President, Technology)

This practice shows the tendency of researched company in choosing commercialization strategies. Even though external commercialization takes place, it is exploited as assisting tool to enhance the productivity of in-house commercialization which is accordance with the notion (Lichtenthaler 2005) that companies view the external commercialization as a proactive part of their overall business strategy. In one hand, they tend to take advantage of external commercialization to remedy the shortages of internal commercialization. In the other hand, the company acknowledges that external commercialization also requires dedicated resources (Helm, Endres & Hüsig 2019), whereas internal resources should be employed in commercialization to mitigate information leak. Furthermore, an appropriate approach with the focus on in-house commercialization can also reduce the negative impacts on long-term value provided to customers by diverting focus on customer needs (Helm, Endres & Hüsig 2019).

As stated by informant, the commercialization strategy selection was also determined by the technology readiness levels. The term "technology readiness levels" has been used in NASA (National Aeronautics and Space Administration) and first defined by Mankins (1995, 1) that Technology Readiness Levels (TRLs) are “a systematic metric/ measurement system that supports assessments of the maturity of a particular technology and the consistent comparison of maturity between different types of technology”. Later, technology readiness level is widely applied other industries (Olechowski et al. 2020, 395). In the researched company, engaging with low technology readiness level projects, they mostly worked on their own. Heading towards the higher technology readiness level projects, they then started collaborating more with the customers to pilot and improve the technologies, products, and processes that they had developed. (Senior Manager, Innovation Eco-system). This is in line with other research (Benitez et al. 2022, 101; Glenn Richey et al. 2009, 47) that the higher technology readiness level, the more likely of collaboration with external stakeholders.

Commercialization of innovation in the large company is facing many challenges as addressed by the informants. The challenges of commercialization are mainly related to operating market, customers, information management and supply management. These challenges are listed and categorized in different themes as the Table 5.

Table 5 Challenges of commercialization

Quote from respondents	Challenges
- *I think one of the biggest challenges of this industry is the conservativeness, so they would like to do things as they have been doing in the past and then when we try to commercialize something, pilot and get the first installations in place, so that is the problem. How to get the first reference?* (Senior Manager, Innovation Eco-system) - *It is the acceptance from the market, I guess that is the challenge and we have also not done dealing with that challenge too often because we are on inside thoughts.* (Director, Strategic Procurement and Supplier Quality)	Market acceptance
- *Resource efficiency requirements and this kind of things becomes difficult when you develop products and standardized them to some extent to be able to commercialize them on practical scale.* (Senior Manager, Innovation Eco-system) - *If we think from the financial perspective, so we have good funding instruments for low TRL work, but the higher we go on to your level is the more difficult it becomes. So how to get the funding for implementing something in real life, that is one of the challenges.* (Senior Manager, Innovation Eco-system) - *In the beginning that if something new, it is typically a relatively low volume. How to get that to kind of mass scale production rather than prototyping. Then it might need investments from the company. The supplier is producing new parts, so it needs investments and then it is a question of who does the investment.* (Director, Strategic Procurement and Supplier Quality)	Resources efficiency
- *One of the challenges is that how to get enough reliable information to be able to do something. And for me this is a kind of an issue that you need to have trust and good customer relationship in place to be able to achieve something.* (Senior Manager, Innovation Eco-system)	Customer trust

Quote from respondents	Challenges
- *If we sell out solutions to the customer, then we could offer what they would get it for free when they are applying or buying our products and making contracts with us. So, by that way, they could ensure that they will have the new solutions first in the market in the future.* (Vice President, Technology)	
- *Do we have enough volumes to make it make it profitable, even though that it's a good product, but also the producer wants their say what they are not giving up any profit margins to make it. Then there is us in the between the final customers and producers, how we could increase the market on our behalf.* (Senior Manager, Sourcing)	Scale of economy
- *I think in the in the later phase we are just thinking about that how it suits the market and so on. We should take that to the previous steps, like in the ideation phase already. So, take different stakeholders in that communication and conversations and think about this.* (Vice President, Technology)	Value chain understanding
- *I guess then it is kind of comes back to intellectual property questions. Always it is something that supplier can or is probably willing to extend them and offer it to some other customers as well. That's something that needs to be accurate.* (Director, Strategic Procurement and Supplier Quality)	Information sharing management

In summary, the challenges of commercialization relate to two main aspects. First, the company concerned how to diffuse its new products. It can be seen by the concerns of market acceptance, value chain understanding, and customer trust stated by informants. Second, improving operations efficiency was also a focus when it came to commercialization. The attentions of informants were mostly paid to the challenges in improving resources efficiency, information sharing management, and exploiting scale of economy which help enhance operations results.

Grounded on categorized challenges in table 5, the impacts of supply chain management practices are exhibited and analysed in the two sub-chapters 4.2 and 4.3. Before going to the impacts, the practices of supply chain management in the interviewed company are presented in the next section to obtain basic understanding of supply chain management practices and its dimensions.

4.1.3 Supply chain management practices

Supply chain management and open innovation has a tight relationship. Indeed, supply chain management and open innovation go hand in hand (Manager, Engineering). Supply chain management can be the origins of new idea in open innovation (Director, Strategic Procurement and Supplier Quality). During the collaboration with suppliers, the new idea for innovation may be originated from suppliers who own in-depth technical knowledge about their fields which can be overlooked by large companies (Monczka et al. 2000; He et al. 2014; Jajja et al. 2017). According to another informant, supply chain management could be also seen as a key stakeholder of open innovation to deal with difficulties in commercialization stage (Vice President, Technology). In other words, with the support of supply chain management, open innovation can handle difficulties when it goes from ideas into new products.

To have the ground for further understanding about the impact of supply chain management practices on commercialization of open innovation, the practices of strategic supplier partnership, customer relationship, level of information sharing, information sharing quality, lean practices and postponement are described in this section respectively.

4.1.3.1 Strategic supplier partnership

Strategic supplier partnership is a familiar term to the respondents. Identifying and developing the right suppliers is crucial in obtaining innovation goals (Jajja et al. 2017). To have better understanding about the impacts of strategic supplier partnerships on commercialization of open innovation, the definition of strategic supplier and the criteria of how the researched company classifies supplier partnerships are explored first.

Unlike the proposed definition of strategic supplier partnership in the study of Li et al. (2005) which emphasizes the age of relationship between suppliers and organization, in the investigated company, strategic supplier is the “high-end top-notch suppliers that are really very eager to give us the best service they can” (Manager, Engineering), or “the top on pyramid of suppliers that we are having. They are always in the in the top of the technology” (Senior Manager, Sourcing). In the strategic supplier partnership, buyer and supplier are sharing the information, expecting innovation, new ideas (Senior Manager, Sourcing). Most of informant focused on the technology capabilities of supplier rather than a long-term relationship between the company and its suppliers which is not align with other studies (Ellis et al. 2012; Wagner & Bode 2014) that age of the buyer-supplier relationship influences the extent in which they collaborate on innovation.

The company has its own standards to classify partnership with suppliers. As described by informants, suppliers must fulfil different criteria to become strategic partners with the research company. These criteria are as illustrated in Figure 6 (next page). First, the supplier must be legally and financially eligible to cooperate with the buying company.

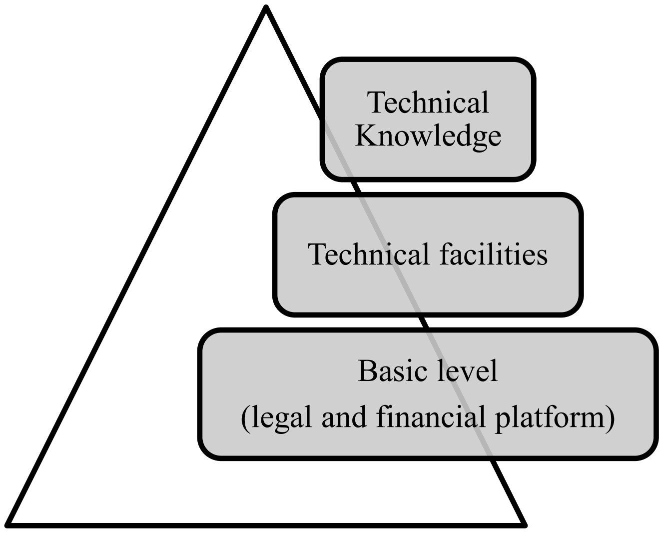

Figure 6 Supplier partnership - classifying criteria

In other words, the basic level is the prerequisite for any established partnership. It is the necessary conditions to become a regular supplier with the researched company. In this level, suppliers are required to be a legal entity with full financial ability to be able to cooperate in long term (Vice President, Innovation). When it comes to strategics partnership, suppliers are expected to meet higher levels which mostly involve technology. In facts, the strategic partnership is decided by the level of technology dependency of the researched company on its suppliers (Senior Manager, Sourcing).

> *"The next level is the technical level: the quality of what they are supplying and what type of activity can they make to us, depending on what type of equipment they have. Then we have the knowledge expect as well, so some supplier may actually sit on a lot of process knowledge I mean what is needed for our specific application. Then they are taking the step out of suppliers. They could be a knowledge supplier as a consultant."* (Vice President, Innovation)

The technical level comprises first the technical facilities or how advanced supplier machine and equipment are, which ensure that suppliers can meet the requirements of technology to manufacture parts or products with new technologies. Indeed, examining manufacturing facilities of suppliers is crucial for comprehending their technological capacities (Ellram 1990, 13). This allows a direct assessment of their size, equipment status, operational context, and overall operational understanding. Strategic supplier selection is not only about their existing technology but also about their capability to innovate future technologies. (Ellram 1990, 13.) Technical level also requires the technical knowledge from manpower of suppliers which allow those suppliers to become consultants in their specific technology fields when new product development is needed.

4.1.3.2 Customer relationship

As described by informants, customer relationships in the researched company were well organized with management system (Senior manager, Sourcing). There is also a customer relationship categorizing system in the researched company in which the big customers are managed by key account managers.

> *"I think the biggest customers are handled by certain key account [...] and they will take some special care about those and maybe we have some kind of customer categorization within our company, let's say key customers are taken more care of than some smaller and occasional customers." (Vice President, Technology)*

Besides the direct sales team, the company was also selling its products through dealers which caused the challenges in communication. When information was not collected directly but through a third party, there was a possibility that customer information would be misleading and perceived incorrectly. (Senior Manager, Innovation Eco-system.)

From supply chain management perspectives, information sharing is important for supply chain operations. Customer is one of the origins of information which are essential for the product management (Chesbrough 2003; Bajaj et al. 2004; Piller & Ihl 2009; He et al. 2014) and supply chain management (Li et al. 2005). Another challenge in customer relationship management is how the information coming from the end customers is flowing further in the supply chain for the product management level and supply chains level (Senior Manager, Sourcing)

Customer relationship is very important for company development. As stated by Vice President of Innovation, customer was the one who validated and bought the new products, so they were extremely vital for the company in both technical and commercial points of view. Therefore, the customer involvement in innovation in the researched company is explicitly taken place and in line with the previous studies where customer involvement is emphasized in innovation (Fuller & Matzler 2007; Vaisnore & Petraite 2011). However, not all customers are involved in innovation activities of the company.

As stated by informant, the company collaborated with a few key customers for innovation but not all of customers (Vice President, Innovation). This may lead to different impacts on commercialization which are discussed in later sub-chapters.

4.1.3.3 Information sharing

Information sharing plays a critical role in supply chain management by promoting coordination and collaboration (Li & Lin 2006), enhancing flexibility (Kokins, Straujuma & Lapiņa 2021) and efficiency (Li et al. 2005) across the entire supply chain of organization. As expressed by respondents, the level of information sharing in the researched company are dependent on two main factors. First, organizational structure of the company can influence the flow of information and the level of information communicated internally.

> *The challenge is that how we have organized the information, so it is usually regarding quite a lot of work or knowing the right people to ask about. That comes from the organizational structure challenges that how we organized our data and information in our company.* (Senior Manager, Sourcing)

Second, the confidentiality is also seen as deciding factor in the level of information sharing. Indeed, while sharing information is necessary for operations, the large company must also information security. Information is strategic assets and inappropriate information disclosure can be seen as a loss of advantages (Li et al. 2005). In line with these perspectives, respondent also explained that information might be a driving the value of the company, therefore a firewall to protect information is needed for their eco-system promoting innovation (Vice President, Innovation). Non-Disclosure Agreement (NDA), as expressed by respondents, was used as a tool to avoid unnecessary public information sharing:

> *We have to have an NDA in place before we can start to talk about the weather.* (Director, Strategic Procurement and Supplier Quality).

The quality of information sharing was also concerned by respondents with the focus on transparency, timeliness, and engagement of information. As addressed by informant, information should be transparent and available to all relevant stakeholders, but the transparency and availability of information were dependent on effort and resources that they could invest in (Senior Manager, Sourcing). *Engagement* and *interactivity* were also viewed as the factors that influenced information sharing quality, especially in communication with customers.

> *Accordingly, we have been a little bit too shy in promoting of our new solutions and upcoming solutions and I think that some of our competitors are more active on that. So, if we are launching some very interesting new product, we should make a big noise now about that on the market.* (Vice President, Technology)

The engagement and interactivity should be considered when information shared. This shows that the innovating company is proactive in problem-solving, creating trust during communication with customers or suppliers.

4.1.3.4 Lean practice

Lean practice is a well-known concept in nowadays business. It is applied in many companies, especially large companies. Therefore, most of the respondent were able to define this concept and those definitions were in line with the definition proposed in previous studies (Lewis 2000; Hines, Holweg & Rich 2004; Lenny Koh et al. 2007). In general, lean practice is "to reduce the waste or non-value adding processes, reduce complexity in supply chain" (Senior Manager, Sourcing). Lean practice can help company save money, be more efficient and better in quality (Manager, Engineer). Lean practice also plays an important role in reporting and decision-making process:

> *We want to make it lean in a way it is organized and taken care of in terms of decisions and reporting as much as we can. There is a tendency if you do not have a lean process, the failures keep going on, and just consume resources. But in reality, they should have been killed because the target setting for them has not been reached and there is no hope to get them to reach that either.* (Vice President, Innovation)

Lean is not only practiced in manufacturing (Vice President, Innovation). As described by company innovation process, lean practice is practiced in all stages of innovation. Lean is not only applied in innovation to make decision making process and reporting process efficient, but also a tool to terminate projects which are not forecasted unsuccessfully. In other words, lean practices in innovation reduce the waste of resources on unsuccessful ideas.

4.1.3.5 Postponement

Unlike other supply chain management practice dimensions, the concept of postponement is not familiar with interview respondents. Most of the respondents could not define postponement in supply chain management. However, when interviewers explained the concept of postponement, respondents could relate to similar terminology in engineering which is product modularization (Manager, Engineering) or product standardization (Senior Manager, Innovation Eco-system). This supports previous study (Yang et al, 2004) stating that postponement has tight connection with product modularization.

As described by company process of product modularization, a module needs to fulfil technical requirements and driven by company specific strategy which adapted the model by Treacy and Wiersema (2007) as in Figure 7.

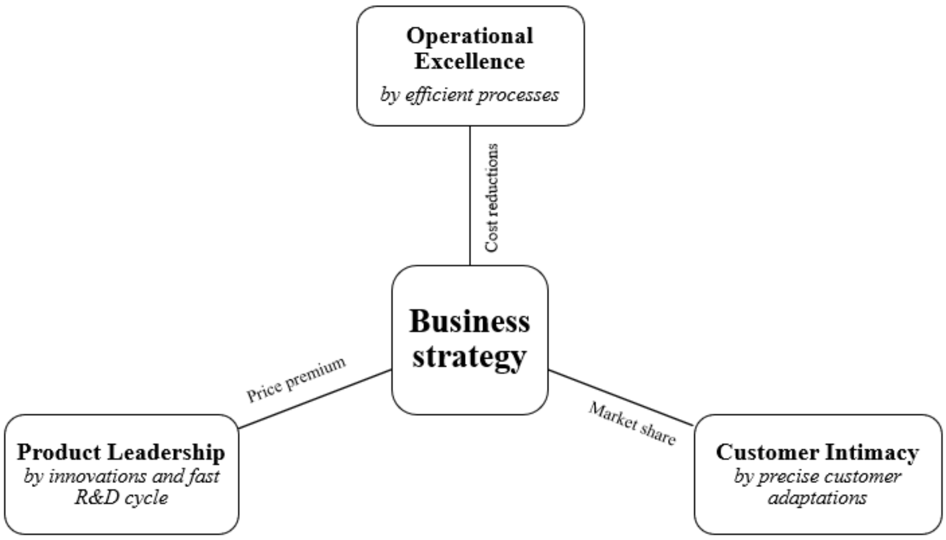

Figure 7 Business strategy of the researched company (adapted model from Treacy & Wiersema 2007)

In this model, company strategy is the integration of three different factors, including operational excellence, product leadership and customer intimacy (Treacy & Wiersema 2007). Operational excellence by nature is the efficiency of processes in supply chain management in terms of quality and cost management. Product leadership is navigated by innovation activities and fast R&D (research and development) cycle. Customer intimacy is managed by precise customer adaptations. Having said that postponement or product modularization, product standardization in the researched company have a tight relationship with customer relationship management:

> *Basically, all the product or projects where we are working, they are somehow customer specific cases. We have a lot of kind of standard structures […] We are supplying the products which are what the customers are needing and wanting, so usually which has been kind of conceptualized or developed together with the customers. (Vice President, Innovation)*

Indeed, the product modularization is derived from specific customer needs which are varying from customer to customer. To gain knowledge about customized products, company must manage customer relationships effectively.

An overview of commercialization of open innovation has been presented. The next sub-chapter describes how supply chain management practices hinder the commercialization of open innovation in the researched company via the six dimensions.

4.2 Supply chain management practices hindering commercialization of open innovation

Even though supply chain management is considered an effective tool to increase the efficiency of commercialization, it also brings obstacles to new products' commercialization. In this sub-chapter, the empirical data of how supply chain management practices impede commercialization are explored. The informants were asked to describe the downsides of supply chain management practices in commercialization, via the lens of six dimensions including strategic supplier partnership, customer relationship, information sharing level, information sharing quality, lean practices and postponement in five sections respectively.

4.2.1 Strategic supplier partnership hindering commercialization

Strategic suppliers are important for the development of the company as well as the product innovation, especially in commercialization stage when the involvement of suppliers is significant in production activities. However, strategic supplier partnership is not always a positive factor accelerating commercialization, it also has negative impacts on commercialization of open innovation.

First, over reliance on strategic supplier can ***reduce the possibility to use the available options***. This is in line with previous study (Hanfield et al. 1999) that being tied with a strategic supplier can potentially lock buyer to the supplier and its technologies. Therefore, choosing the right supplier initially becomes crucial, as the buying company must predict whether the supplier will continue to lead in technology (Hanfield et al. 1999, 79).

> *Sometimes there is reluctance in thinking the other suppliers because the product managers kind of immediately start thinking that it is a lot of work hours that we need to do if we want to change that component or part to something else. We just work like we have been working with them for ages. We do not think anything else. We do not think outside the box and that big that remains to be a standard way of working with those suppliers. (Senior Manager, Innovation Eco-system)*

When the company was stuck in the one solution, the supply chains might be vulnerable in crisis (Senior Manager, Sourcing). Furthermore, reliance on technology of a strategic supplier caused ***difficulty in cost controlling*** for the supply (Senior Manager, Sourcing). Indeed, the dependency on technology make buyer losing their advantage in dealing cost with their supplier (Fabayo 1996).

Second, strategic supplier partnership can cause the ***dependency and subjectivity in cooperation***. It is also suggested in the study of Handfield et al. (1999) that opportunistic behaviour can happen. As explained by informant, when business cooperation has become routine, the company and strategic suppliers might take that cooperation for granted which sometimes caused mistakes (Manager, Engineering). Furthermore, there was also the risk that if the innovating company expected too much from suppliers, they might not do their own work very clearly and not well prepare for the collaboration work. The changes in strategic suppliers could lead to a crisis in cooperation if the company was too reliant on the partnership. In small and medium sized suppliers where certain people were usually charge of all tasks related to a specific customer, if the key individuals in those suppliers left their company, human risk always emerged in collaboration work, especially in tasks requiring intensive technical knowledge. (Manager, Engineering.)

Third, production volume is a challenge in commercialization of open innovation. In the very first phase of commercialization, small volume is inevitable which can discourage suppliers, especially small and medium-sized suppliers.

> *I think it is mainly on them on the load on demand point of view. Keep the promise that we have given them, that we need this amount of your capacity for these new products in the future and if it happens that we are not selling that new product as we planned, then we have a problem with the supplier most probably.* (Vice President, Technology)

In the study of Handfield et al. (1999, 79), the overreliance of buyer on suppliers is emphasized as the side effect of supplier-buyer relationship when suppliers gain advantageous position. It also has the reversed effect that the reliance of suppliers on buyer volume diminishes their ability to survive during crisis when buyer's volume suddenly declines (Huan, Gaoping & Dan 2017; Jiang et al. 2023). In a case that strategic suppliers are too ***dependent on innovating company volume***, when the business of innovating company goes down, those suppliers will be in trouble due to the plummet in their sales volume. This dependency requires the large company to find the solution to keep their suppliers alive, especially when these suppliers are holding exclusive technologies. (Director, Strategic Procurement and Supplier Quality.)

Fourth, collaborating with small and medium-sized suppliers can lead ***the risk of losing technology competitiveness*** as those suppliers can be acquired by competitors. As explained by informant, if it was a very small partner, they could be acquired by other competitors. Therefore, it should be covered by licensing, buying the technologies or owning equity in those suppliers. (Vice President, Innovation.)

4.2.2 Customer relationship hindering commercialization

In business-to-business market, the reference from customer is very important. Due to the characteristics of operating industry where customers are hesitant to try new products, it is not easy to persuade customers using new products.

> *Usually for the first customers, we have to persuade them to do some prototyping work with us and that is kind of scary word if you are a customer. Not very many customers are eager to do that because there are so many risks.* (Manager, Engineering)

During the collaboration between innovating company and its customers, there might be a risk that the ***information of new products may be leaked*** to some other players in the industry especially when the innovating company is not usually the only supplier of customers. Therefore, innovating company need to be careful with communication that they are not revealing too much of confidential information before the proper intellectual property protection is in place. (Vice President, Technology.)

Innovating company also needs to be careful, avoiding the situation that the new product is the ***problem solver for one specific custome***r. It is easy to fall into the trap that innovating company solves one specific problem which make one customer satisfied, but consumes a lot of money, effort, and human resources on that solution. (Vice President, Innovation.)

To reduce the possibility to commercialize customer specific solution, standardization to some extent is necessary. This is typically the problematic part that innovating company is required to have the trust in place so that customers are willing to share the data as well as their problems or challenges (Senior Manager, Innovation Eco-system). The diversity of customer data should be emphasized to enhance the standardization of new products. Grounded on that information, new products can be continuously improved. The relationship between customer relationships and postponement is also illustrated by the importance of standardization to mitigate the risk of commercializing customer specific solutions.

Even though product standardization is encouraged to be practiced, improving the efficiency of supply chain as well as productivity of commercialization, the ***customized products*** are still required by customers which may cause the difficulties in supply chain management for commercialization.

> *The customers are basically our foundation, where all the innovations, ideas or needs drive from. So, I would say customer should be the main focus point how we develop the open innovation concept but of course we also need to keep it secured when something specific for certain customers and how it then impacts in overall our supply chains and companies, which usually not so easy as we have a specific pattern in overall.* (Senior Manager, Sourcing)

Collaboration with customers always requires effective communication. However, in reality, the organizational structure of a large company causes difficulties in internal communication. As explained by informant, it was rather difficult to keep updated about who was managing their customers since people changed all the time. Even though the informant understood that they have the key customer managers, site account managers, etc., but it was not easy to get information of contemporary person-in-charge. Because they were only working with domestic customers but also international customers. (Senior Manager, Innovation Eco-system)

Not only in internal communications, customers themselves are also struggling with information management. As described by respondent, this problem is also caused by the organizational structure of customers, especially customers who are large companies. Specifically, respondent explained:

> *Typically, the problem at the customer is that different kind of information sets needed for the development are owned actually by different functions of their organization. And those functions are not either discussing together. It is very typical that they do not even know who owns the data at their organization and are they even collecting any data concerning that specific area.* (Senior Manager, Innovation Eco-system)

The downsides of information management in customer relationships are also discussed further in the next section about information sharing quality and information sharing level.

4.2.3 Information sharing hindering commercialization

Big companies tend to be siloed in departments (Tett 2015). This is in line with informant's perspective. An informant exemplified that their organization was split by technologies and also split by business lines who were responsible for certain technologies. They were so occupied by their daily business that it was difficult to find time for discussing with the other departments. But whenever it came to customer problems, it could not be solved with one business line technology only and it was required to be a combination of different equipment from different business lines. (Senior Manager, Innovation Eco-system). Therefore, the complexity of *organizational structure* in big company may cause the ***silo mentality***. With this silo mentality, information cannot be shared with the right level which hinders commercialization efforts as valuable insights and knowledge are not diffused properly across the organization.

> *For external stakeholders, I would say that we are quite strict on what we are sharing, how we are sharing, avoiding kind of public information sharing platforms for the other companies related topics.* (Senior Manager, Sourcing)

Inappropriate level of information shared to external stakeholders can decelerate commercialization of new products. As explained by respondent, if too much information was shared to customers, they might be able to fix the problem without innovating company expertise or they might take further steps with other competitors (Senior Manager, Innovation Eco-system). Therefore, it is risky that over-shared information can lead to the situation of ***losing competitive advantage*** in commercialization.

> *If we are too early giving these ideas to the markets, probably some people who are clever enough they are picking up these ideas and trying to make it faster than us.* (Director, Supply and Procurement)

Indeed, the leak of crucial information can lead to a situation that competitors who own competitiveness in facilities to take advantage of the leaked idea and introduce it first to the market (Dahlander & Gann 2010). How to share information internally and share enough information to external stakeholders but still keep the confidentiality in mind was the most concern of respondents. Even though confidentiality education was provided in the research company, it was still in general level. Accordingly, the company provided training courses regarding code of conduct, information security policy, etc., but those trainings were general, did not address daily issues which might be faced by information holders. (Senior Manager, Innovation Eco-system.)

4.2.4 Lean practices hindering commercialization

As stated by Vice President of Innovation, lean practices were always good from management perspective. In previous study, unexpected additional cost is described as a downside of lean practices (Mueller & Strzelczak 2014). From the new product development process of the researched company as well as other internal processes learned by interviewers, lean is omnipresence. Lean is likely accepted as an obvious norm in the researched company. This may explain the reason why the additional cost was neglected by respondents.

Most of the concerns in interviews were about the adoption of lean in the company. From execution point of view by other respondents, people sometimes practice lean without knowledge about that concept:

> *Sometimes, people or companies decide that we start to use lean, and they try to force the lean culture. It is just starting to use all sort of lean tools and methodologies without really telling or convincing or teaching people what does that mean. Then people are following in principles without understanding why we are doing this, so they are also not buying it. It is used to being done for the reason of being asked to do all of that.* (Director, Strategic Procurement and Supplier Quality)

This is an additional point to previous literature which emphasizes the downside of lean based on its implementation in firms that the mismatch between lean practices and the overall strategy, coupled with environmental changes, disregarded risks stemming from profitability pressures, can lead to adverse consequences when applying lean practices (Mueller & Strzelczak 2014). Beside the harmony between company's strategy and lean approach, the education of lean is necessary to ensure proper execution.

Training should be provided to the employee to get the full ownership of lean practice in daily work. Lean is not a totally new concept in the interviewed company. However, there is always the risk that people do not understand the full concept of lean but only see different tools with difficult Asian language (Vice President, Technology). The main problem is how they could find out the best practices utilizing lean in commercialization and how they can communicate and train people to have a proper perception of lean (Vice President, Technology). Furthermore, a consensus approach should be taken, including careful selection of initiatives aligned with strategic planning and company goals. Monitoring should be equally systematic, with controls in place to ensure alignment with strategic objectives and effective outcomes. (Mueller & Strzelczak 2014)

4.2.5 Postponement hindering commercialization

Postponement, perceived as product standardization or product modularization in the interviewed company, is crucial for commercialization where manufacturing activities mainly happens. However, postponement also bring disadvantages to commercialization.

The obvious disadvantage of postponement is the ***lengthen delivery time to customer*** (Salvador 2008). This is also mentioned by a respondent:

> *It (postponement) is something that is difficult in the sense that we need to be able to do the timing correct.* (Director, Strategic Procurement and Supplier Quality)

However, another respondent stated a different viewpoint that:

> *We are working to be more standard as we can. Because if you can stand there, you can be faster, you don't need to be designing every time a different product. it will be helping in the lead time.* (Vice President, Procurement)

Considering the timing of new product commercialization, both perspectives are explainable. In the early phase of commercialization when product standardization is still constructed, it takes time for the innovating company to complete the product standardization process which leads to the delay to market for first launches. When it comes to later phases of commercialization, product standardization enables a shorter lead time by simplifying manufacturing processes and exploiting available stock of common parts.

Product standardization ***requires intensive knowledge about the product***, and it should be taken into account from the earlier stage of open innovation. This is accordance with previous study that implementing postponement demands substantial initial investments and a comprehensive overhaul of the existing business processes which require intensive technical and market knowledge (Wadhwa et al. 2008). Otherwise, when it reaches the commercialization, new products cannot meet requirements of customers. This point is addressed by Senior Manager of Innovation Eco-system:

> *It depends how experienced people working with the product development are, because some business lines have very long traditions and they have a lot of knowledge about the customer cases, customer challenges, customer needs. And they also very much understand what kind of buying strategies, our customers have an and they have a have a good knowledge in place too.*
>
> *But then in some cases, when the people are not that experienced, so they typically start developing their ideas further without any understanding about their customer segments, about the needs of different customer segments and so on. And when they have this kind of a thinking in place, it very easily leads to a*

> *situation that when you are heading towards the commercialization, so you suddenly find yourself in a situation that you have a product that fits pretty much for everyone, but it's not good for anyone.* (Senior Manager, Innovation Ecosystem)

Therefore, lacking experience and customer knowledge can be attributed for standardized products which "***fit pretty much for everyone, but it's not good for anyone***". It leads to a failed project and directly affects the sales volume as well as credibility of innovating company.

The drawbacks coming from six dimensions of supply chain management practices have been described. The next sub-chapter explores how supply chain management practices foster the commercialization of open innovation in the researched company via the six dimensions.

4.3 Supply chain management practices fostering commercialization of open innovation

In this sub-chapter, the empirical data of how supply chain management practices accelerate commercialization are discussed. The informants were asked to describe the benefits of supply chain management practices in commercialization, via the lens of six dimensions including strategic supplier partnership, customer relationship, information sharing level, information sharing quality, lean practices, and postponement in five sections respectively.

4.3.1 Strategic supplier partnership fostering commercialization

Strategic suppliers play an essential role in commercialization of new products. As agreed by respondents, the strategic supplier partnerships foster commercialization activities through several different ways. First, informant addressed that strategic suppliers could be considered a solution for ***capacity building***. It is in accordance with prior study (Wong et al. 2011) that suppliers can assist manufacturers in quickly changing manufacturing volume.

> *But when we have for example like capacity constraints, we might move some more standard products to external suppliers, so that we can keep the intellectual property in house and manufacture those ourselves. We need to make sure that*

we have the right amount of capacity available for the new product before it is launched. (Vice President, Technology)

To become a strategic supplier, they meet all requirements of technology to be technically capable of producing the products developed by innovating companies. With the technical capability and production capacity, strategic suppliers are the reliable partners to produce not only the newly developed products but also the other old products, so that the company can save its production capacity for new products.

Second, strategic suppliers, especially which are small and medium-sized enterprises can assist innovating company in ***improving technology*** in specific fields where they expertise in (Monczka et al. 1993; Monczka et al. 2000; He et al. 2014). Indeed, the large company usually possesses overall picture about the new products, however, when it comes to detail component with specific technology, they might seek for assistance from suppliers who are more knowledgeable about that technology.

SMEs they are usually experts in a specific technology. Meanwhile, we are having understanding about a bigger picture. Usually, we are not knowing necessarily all the details. (Senior Manager, Sourcing)

Third, the participation of strategic suppliers in commercialization can be advantageous in ***cost reduction*** strategies of the innovating company. Indeed, cost reduction is one of the benefits of supplier integration that supplier can positively impact cost reduction by providing valuable information, technical expertise, and process knowledge (He et al. 2014) to reduce the defect rate of products, mitigate engineering changes, standardize components (Bonaccorsi & Lipparini 1994; Dröge, Jayaram & Vickery 2004)

One strategy is being used sometimes that we are asking for cost reductions, and they say we cannot, we cannot do any cost reduction with current design, and it has been always produced like this. But then we can pressure, push them or challenge them that we need reductions so that they provide us cost saving ideas. So just bring us new ideas and then we can figure out together. (Director, Strategic Procurement and Supplier Quality)

During the commercialization stage, cost reduction is necessary and can be viewed as an effective method to reduce the product price, increase market share, and gain more profit. However, when it comes to a newly established supplier partnership, the innovating company usually face difficulties in bargaining price for newly launched products with small volume. In this scenario, strategic suppliers are able to provide the cost saving ideas based on their experience in technology which can eventually lead to a cost-saving solution.

Fourth, the strategic supplier partnership, built on trust and common goals, can help the company in ***improving their operations efficiency*** in commercialization stage:

> *I think strategic suppliers are giving us better documentation or reporting. In some certain suppliers, they are ashamed to admit they made a mistake somewhere, and then we hear about it very late.* (Manager, Engineering)

According to Director of Strategic Procurement and Supplier Quality, strategic partnership also means that the buying company spends much more time with strategic suppliers on daily cooperation. It is understandable that strategic suppliers are more likely to have better understanding about the process of buying company rather than regular suppliers. Therefore, they are better in reporting or documentation as stated by Engineering Manager above. The trust between the innovating company and strategic supplier makes them more comfortable and willing to admit mistakes than regular suppliers.

Strategic supplier partnerships also ***provoke the competitiveness among suppliers***. As explained by an informant, the company would like to develop its suppliers by creating competition between those suppliers. In doing so, suppliers are able to improve their abilities and capabilities to provide a better service for the company.

> *It comes down to how many strategic suppliers do we have. We need to have a number of them, and we'd like also to develop competition within our strategic suppliers. I mean we want the develop them as the same way as we develop ourselves because they are big part of our success going forward as well.* (Vice President, Innovation)

An informant claimed that strategic partnerships with suppliers were where they wanted to collaborate with their suppliers to be able to respond to customer needs and answer their challenges (Senior Manager, Innovation Eco-system). This is an interesting point and linked with a finding in study of He et al. (2000) that supplier integration indirectly enhances customer integration by the mediating role of production flexibility.

4.3.2 Customer relationship fostering commercialization

The role of customer in innovation is significantly important as studied by previous studies (Chesbrough 2003; Piller & Ihl 2009; Wong et al. 2011; He et al. 2014). As explained by a respondent, if the innovating company does not have the customer relationship in place, it is difficult to know how technologies survive in the real operations, the bottlenecks, typical challenges that the customers are facing in their daily work, as well as customer needs in the future. In the very first stage of innovation, the innovating company should identify those customers who are potential to get involved. The company should get those customers on board from the very beginning, but not at the very last stages of the process. (Senior Manager, Innovation Eco-system.)

Not only in ideation and development stages, but customer relationship is also essential in commercializing new products. Firstly, customers are the ***key to defuse the new product in the market***. This is in line with the prior research (Slater & Mohr 2006) about the importance of customer references in new product launch. In the business-to-business market, the references from certain customers are crucial to enhance the reputation and credibility of innovating company, leading to higher volume in sales of new products. As stated by respondents, the references from big customers were essential for other customers in considering new products:

> *I think the open innovation is a good topic for this one and maybe we can ask approach certain key customers beforehand, even when we are going to commercialize something that would it be something for you to try. […] Would you like to make a free trial lesson example before we launch it? That gave us feedback about the performance, so I think that is quite important. When we think about the commercialization, if we have some references already before the launch from certain big customers, that's very important for the other customers.* (Vice President, Technology)

Communication with customers is a mean to provide information of new product value chain to the market:

We need to explain and prove why he should buy from us. What is unique with us and what can we offer that nobody else can offer? What is the benefit we can give him on the value chain service, let's say commitment and long-term development. We have market area who are daily based communicating with the customers for technical information, commercial information. (Vice President, Innovation)

Secondly, customers also make a significant ***contribution to continuous improvement of new products*** based on their practical experience with those products. This is in line with other studies (Chesbrough 2003; Piller and Ihl 2009) that customer can contribute to product innovation by expressing their requirements and unmet needs which reflect market expectations. As explained by Senior Manager of Innovation Eco-system, having conversations in place were the key in innovation with customer. It was not only customers sharing the information, but two-way communication where the company and customers shared, discussed about the results, and decided the next steps together. Through the frequent conversations, trust can be built between customers and the company. With the trust, customers were willing to share their information about their challenges which can be useful for product improvement:

We don't need to persuade them if we are responding to the challenges that they have presented to us. (Senior Manager of Innovation Eco-system.)

Thirdly, as described by informant, ***product standardization*** was a need in commercialization stage of open innovation. Product standardization can be a good tool in saving cost and increasing supply chain efficiency (Waller et al. 2000) which mostly happens with the customer involvements as stated by informant:

You need to standardize to some extent, but when we talk about these systemic challenges, so we really need to be able to understand and answer the question that how this work in the customers operating context and answering those questions on our own is impossible. There is a must to collaborate more with customers. (Senior Manager, Innovation Eco-system)

With the involvement of customers, the innovating company can obtain practical information about how products are used in real contexts which is vitally important for product standardization process. Information in general is essential for product development. In the next section, the positive impacts of information sharing on commercialization are discussed further.

4.3.3 Information sharing fostering commercialization

As agreed among informants, information sharing was vitally important in commercialization. First, customers owned the knowledge and information about their desired products and the research company had expertise in maximizing efficiency of processes (company product to provide plant solutions) for customers. The right information sharing level was the key to ***accelerating collaboration and cooperation with customers*.** (Vice President, Innovation.)

Information security firewall was a part of the innovation Eco-system structure of the company and intellectual properties management policies could be an efficient tool to regulate the level of information sharing in the company, as stated by informant:

> *We have rules and policies that how we treat the trade secret, everything we do. Sometimes we can give stakeholders a license. We can also license from somebody else, but it's well defined in the in our policies.* (Vice President, Innovation)

However, it is not always good to practice an absolute protection on intellectual properties. Even though large firms tend to focus on intellectual properties protection when innovation projects progress to later phases including development and commercialization (Brunswicker & Chesbrough 2018), revealing knowledge or technology to external stakeholders can bring benefits to the innovating company (von Hippel 2005; Henkel 2006) such as new product diffusion to market or production cost reduction. Therefore, selective approaches in intellectual property management are necessary for commercialization:

> *If we are developing something new, of course we are trying to patent it and not get the patterns in place so that we have the IPR [...] It is important to understand that you don't always need to patent everything to do our own* (Director, Sourcing)

Based on the rules and policies of intellectual properties management, the company can make the right decision in ***choosing appropriate commercialization strategies*** which can motivate external partners in proactively joining the innovation process of the company.

By choosing suitable communication channels, the level of information sharing can ***foster collaboration with suppliers*** in commercialization. According to respondents, depending on characteristics of information, the communication channels were varied suitably. For instance, for the basic information such as quotations, they mostly communicated by email, but it was necessary to visit supplier sites and have face-to-face meetings for important innovation topics (Director, Strategic Procurement and Supplier Quality.)

Along with information sharing, quality of information is vitally important to new product development process. Without qualified information, company could not start developing anything (Senior Manager, Innovation Eco-system). Information should be transparent and available to all relevant stakeholders (Senior Manager, Sourcing). The timeliness and accuracy of information can ***accelerate the operations*** in commercialization stage. As exemplified by an informant, the company had recently changed its organizational structure in which every new project would have a logistics team. This logistics team would play coordinating roles with customers to ensure that information of order, delivery, etc. could be communicated with customers accurately and timely. They were also doing very frequent follow-ups and reporting back to product managers. (Manager, Engineer.) This exemplifies that when information sharing quality is improved, company can receive better input information from customer which lead to better forecasting, inventory, delivery, quality control, increasing flexibility of supply chain serving innovation. Conclusively, the improvement of information sharing can lead to more effective operations activities.

4.3.4 Lean practices fostering commercialization

Lean is an effective tool to reduce waste in production activities (Lenny Koh et al. 2007; Flores et al. 2017). As stated by informant, there were always lean practices within the work of supply chain management (Vice President, Innovation). This opinion was also supported by Senior Manager of Sourcing:

> *When I'm working in the supply chain, we are also creating the efficiency by making it more lean to have straightforward supply chains. We try to improve*

> *all the time as we are following quite closely how we are performing in our organization. (*Senior Manager, Sourcing)

Indeed, lean practices involve waste elimination, maintaining low inventory, utilizing small lot sizes, and implementing just-in-time delivery (Lenny Koh et al. 2007) which mostly happens in manufacturing activities of commercialization stage. The implementation of lean in supply chain can enhance the efficiency of operations and increase the flexibility of supply chain (Flores et al. 2017) which make firms more adaptive with changing environment.

By the reduction of perceived product development time and the elimination of wasteful practices during production, lean practices stimulate technological advancement in commercialization (Gerhard et al. 2012). This viewpoint is also supported by the practices at researched company. Identified by a respondent, there were many things to do with lean. Lean was to do continuous improvements in the quality of the data, supplier, technology that the company needed, as well as to reduce or eliminate not value adding processes. (Senior Manager, Sourcing.) Lean could also be useful in scheduling and following up on the progress (Manager, Engineering). With that being said, lean practices play a role in ***enhancing operations efficiency*** which is a crucial part of commercialization. Lean practices should be applied not only in the innovation process but also in daily tasks. In doing so, employees can ***save time for other innovation activities*** rather than solely focusing on routine tasks. This perspective was proposed by Manager of Engineering:

> *I think everything starts from where we have our products well defined, well designed, well modularized in our systems and once they are there, we have much more time for innovating and developing those predigested modules.* (Manager, Engineering)

The implementation of lean practices can foster a culture of continuous improvement, thereby facilitating creativity (Bhuiyan & Baghel 2005). This point can be understood that when applying lean practices in previous projects, it not only saves time for the innovation activities, but also promotes the culture of lean in the future projects.

As mentioned in section 4.2.3, the silo mentality was one of the reasons that information sharing did not take place properly in the company. As suggested by informant, lean practices might be useful in *improving silo mentality* which was caused by the complexity of organizational structure in big company. However, that was a suggested solution brainstormed during the interview, necessarily being verified in the future studies.

To apply lean practices successfully in commercialization, it requires top-down exercises, so the management needs to have the ownership first and understand its benefits as well as pitfalls. If there is no mindset in the management of the lean practices, lean practice cannot really be implemented in the operational level (Vice President, Technology.)

4.3.5 Postponement fostering commercialization

Postponement is useful in manufacturing activities, especially procurement and production planning which happen during commercialization stage of open innovation. Postponement allows innovating companies to develop standardized or adaptable products that can be easily and affordably customized once the real consumer needs are identified (Wadhwa, Bhoon & Chan 2006). In the manufacturing companies as the researched company, these activities significantly involve designing bill of materials.

As exemplified by respondent, it was a typical challenge if there were so many bills of materials comprising many materials serving different customers. It may be easy for production planning to decide upon from which point the production line can start to use the new bill of materials for new customer requirements. However, from procurement perspectives, the new bill of materials required the demands for hundreds different items. If procurement team poorly managed it, company might face obsolete parts which were not needed anymore. (Director, Strategic Procurement and Supplier Quality.) With the assistance of postponement where product standardization process is applied, company can reduce the waste of obsolete materials, cost of inventory but still meet the production plan effectively. Thus, postponement can be considered an effective tool for ***enhancing efficiency of procurement and planning*** as well as ***reducing waste in supply chain***.

> *The more we can standardize, it would make our processes and practices much simpler.* (Vice President, Technology)

In example of bill of materials verifies the viewpoint (Waller et al. 2000) that the implementation of postponement allows firms to be flexible by creating different product versions to address evolving customer needs and optimize production planning at the same time. This is important during the uncertainty of early product life cycle when forecasting is difficult.

Postponement in projects with different customer-specific requirements allows project workers to gain experiences with the new product development:

> *I would say this is a good example that within the projects with different kind of customer specific, we are learning quite a lot of new things such as giving the ideas, feedback openly, all the needed stakeholders. So that in incoming projects we have these ideas available if needed.* (Senior Manager, Sourcing)

According to Senior Manager of Sourcing, by postponement, innovating company also ***learns from old projects*** which has similarities with the new project and take the good practicalities to the new one which partially accelerates the practice of commercialization for new products.

Postponement is also seen as a practical method to ***prevent the newly developed products from becoming customer specific solutions***. When most of the literature focuses on the benefits of reducing inventory cost, mitigating risks (Wadhwa, Bhoon & Chan 2006), increasing flexibility (Waller et al. 2000). This is a notable point explained by respondent:

> *If we do not have the kind of modular thinking in place, so it might be difficult to apply the same for the other customers. So, I think the key is to have the modular thinking in place that what are the necessary bits and pieces that you need anyway independent of your deliver this to customer one, two or three.* (Senior Manager, Innovation Eco-system)

Informants expressed that product standardization was to some extent needed as they were not supposed to maintain a customer-specific solution. The product standardization practices obviously required customers involvement. The shared ideas from numerous customers or their production data were useful to understand the extent of variations and the challenges customers were facing in their certain contexts. (Senior Manager, Innovation Eco-system.) It reduces the possibility that new products become customer specific solution when the innovating company try to productize and commercialize their ideas by thorough collaboration between departments:

> *Product standardization also require thorough collaboration between the people who typically are responsible for the commercialization and people who start working on R&D with the very first ideas of what they are willing to develop. So that to get the mindset in place already from the very beginning, that we cannot serve all of our customers and we need to start thinking from the very beginning that what might be the most potential customers that we are designing for. Work more together with the commercialization people to understand the kind of importance of segmentation and importance of understanding the needs of those customers who most probably will anyway buy the product from ourselves. So, it would simplify the R&D work as well if we understand what is actually needed and we do not even try to find answers for everyone's problems.* (Senior Manager, Innovation Eco-system)

The above point also emphasizes the linkage between postponement and customer relationships. Indeed, product standardization process in postponement can only happen with the involvement of customers. The contribution of practical experience and needs from different customers navigate the product standardization on the right track. At the same time, product standardization can also be advantageous for customers:

> *I take it (postponement) more positive because if the parts are more standardized, it's easy for the customer also. They know or they can replace it with the part number. They don't have to really always get into engineering phase. Also, with the spare parts and the service availability, they can keep the stock.* (Director, Supply and Procurement)

This angle of view is novel compared to the previous studies (Waller et al. 2000; Wadhwa, Bhoon & Chan 2006; Lenny Koh et al. 2007; Boone, Craighead & Hanna 2007) which investigate the effects of postponement from only the viewpoints of manufacturers. In practice, the application of product standardization also allows customers to buy and stock spare parts to replace the broken parts of products. It is not always required engineering involvement if the error happens, making the repairing process simpler. This ***facilitates a smooth aftersales service*** which can be seen as a competitive advantage in commercialization.

Postponement with product modularization can also ***reduce the logistics cost*** for the company. As described by Manager of Engineering, products of the researched company were huge in size. With modularization, the company could break it down in small modules and deliver to the customers which was more efficient and logistics cost-saving.

Findings from the collected empirical data have been presented in this chapter. In the next chapter, the conclusion of this study is presented with theoretical contribution, managerial implications as well as limitations and some suggestions for future research.

5 CONCLUSIONS

In this chapter, theoretical contribution, managerial implications, limitations and suggestions for future research are presented respectively. Based on the empirical findings, compared with the reviewed literature, theoretical framework is revised accordingly in the subchapter of theoretical contribution. In this subchapter, summaries of empirical findings are also presented to draw conclusions. Next, some implications for management are suggested to enhance the effectiveness of commercialization by exploiting supply chain management practices. Finally, limitations of this study are discussed, following by some possible topic for future research.

5.1 Theoretical contribution

Open innovation happens when the innovation activities take place with the participation of external stakeholders (Chesbrough 2003; Grassman & Enkel 2004; Brunswicker & Chesbrough 2018). Meanwhile, supply chain management involves and integrates different stakeholders in value chain in order to meet customer needs (Stein & Voehl l998, 263). Even though there are similarities between the two concepts, there are certain impacts of supply chain management practices on open innovation which are investigated in this study. This study examined the multifaceted impacts of supply chain management practices on the commercialization of open innovation. Strategic supplier partnership, customer relationship management, information sharing quality, information sharing level, lean practices, and postponement strategies are the six dimensions of supply chain management practices that directly influence commercialization activities of open innovation and have been discussed throughout this study.

Open innovation has been widely practiced in large companies (Chesbrough 2003) as company innovation strategies have become more open and reliant on outside information (Laursen & Salter 2006a). However, the adoption level of open innovation in large companies varies, depending on the operating industry (Chesbrough & Brunswicker 2013, 6). Among external stakeholders, suppliers, customers, and universities emerge as the most popular partners selected by large firms in open innovation (Brunswicker & Chesbrough 2018, 41; Cooper & Edgett 2008, 3; Zynga 2018, 22). Empirical data of this study supports the viewpoint that the adoption of open innovation is dependent on industry characteristics. In particular, the researched company operates in mining industry, which is slow-paced in innovation compared to high-tech industries, making open innovation not widely applied, especially in ideation stage. The participations of external stakeholders, who are mostly suppliers or customers, take place in from development stage onwards. The involvements of universities or academic institutions in the investigated company are also constrained. This is owing to the industry characteristics which require in-depth and intensive knowledge in product and its components, making customers and suppliers well-suited for innovation process rather than universities or academic institutions.

When participating in open innovation, companies typically maintain a certain degree of control over intellectual properties. As innovation projects progress to later phase, companies tend to retain control over these properties (Brunswicker & Chesbrough 2018, 38-43). In this study, the empirical results show that open innovation is regarded as a “problematic concept” when it comes to intellectual property management. In line with the findings of Brunswicker and Chesbrough (2018) stating that companies tend to exhibit full protection on their intellectual properties to keep their technology advantages in the market.

There are different strategies of commercialization, including in-house and five external commercialization strategies (licensing, outsourcing, partnership and collaboration knowledge sales, divestment of company units). (Henttonen & Lehtimäki 2017, 332). External commercialization strategies are practiced proactively as a part of overall business strategy nowadays (Lichtenthaler 2005). The result of this study shows researched company adopts both in-house commercialization and external commercialization (licensing and outsourcing). There are two main factors that influence the selection of commercialization strategies. First, it is the company resources. Company is inclined to deploy its own resources before externalizing its new products. Second, choosing commercialization strategies is also dependent on technology readiness levels that the higher technology readiness levels, the more likely external commercialization strategies is chosen (Glenn Richey et al. 2009, 47; Benitez et al. 2022, 101).

This study examines the impacts of supply chain management practices on commercialization of open innovation via the lens of six dimensions. In other words, the investigation focuses on how supply chain management practices hinder and foster commercialization of open innovation in a large company and the relationship between those dimensions in supply chain. Overall, the empirical data addresses both negative and positive impacts. Accordingly, the research framework is updated and revised as Figure 8.

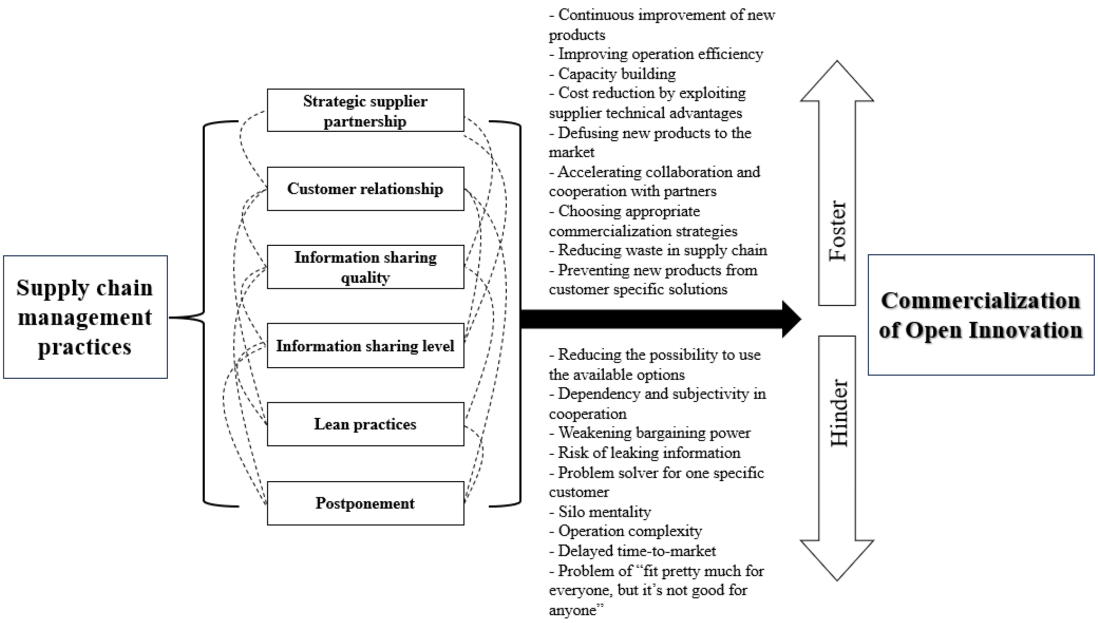

Figure 8 Revised framework.

The figure describes that supply chain management practices are constituted by six main dimensions. These dimensions are mutually connected to each other by dash lines. Thus, it can also be seen that the impacts of supply chain management practices are combined effects as shown in fully black arrow. The arrows with contrasting directions demonstrate that supply chain management practices can hinder or foster commercialization depending on different impacts described upper or lower the full-black arrow. Overall, the impacts of supply chain management practices are summarized in Table 6 (next page). In this table, six dimensions of supply chain management practices are listed with their impacts on the commercialization of open innovation. These impacts include both negative and positive aspects, illustrating how supply chain management practices hinder and foster commercialization. The fostering effects also contribute to partially resolve the commercialization challenges which have been summarized in the Table 5 (section 4.1.2) of this study. This connection is highlighted in last two grey columns of table 6.

Table 6 Summary of impacts of supply chain management practices on commercialization

Dimension of SCM practices	Impacts of SCM practices on commercialization		Commercialization challenges
	Hindering effects	Fostering effects	
Strategic supplier partnership	Reducing the possibility to use the available options	Improving technology	Resources efficiency
	Dependency and subjectivity in cooperation	Improving operation efficiency	Resources efficiency
	Inappropriate production volume	Capacity building	Resources efficiency Scale of economy
	Weakening bargaining power	Cost reduction by exploiting supplier technical advantages	Resources efficiency
	Risk of losing technology competitiveness if supplier acquired	Provoking the competitiveness among suppliers	
Customer relationship	Risk of leaking new product information	Defusing new products to the market	Market acceptance Scale of economy Understanding of value chain
	Customer-specific problem solver	Contribution to continuous improvement of new products	
	Customized production leads to operations complexity	Accelerating product standardization	Scale of economy
Information sharing level & quality	Silo mentality	Accelerating collaboration and cooperation with customers and supplier	Information sharing management Customer trust
		Choosing appropriate commercialization strategies	Resources efficiency
	Losing technical competitive advantage	Enhancing operations efficiency	Resources efficiency
Lean practices	Misconception	Enhancing operations efficiency	Resources efficiency
		Reduce waste in supply chain	Resources efficiency
	Mismatch between lean practices and overall strategy	Saving time for other innovation activities	Resources efficiency
Postponement	Problem of "fit pretty much for everyone, but it's not good for anyone"	Preventing new products from customer specific solutions	Scale of economy
	Delayed time to market	Enhancing efficiency of procurement and planning	Resources efficiency
	Requires intensive knowledge about the product	Reducing the logistics cost	Resources efficiency
		Facilitating a smooth aftersales service	Customer trust Market acceptance
		Reducing waste in supply chain	Resources efficiency

Long-term relationship between buyer and supplier is a factor contributing to the establishment of *strategic supplier partnership* (Li et al. 2005) since prolonged partnership, combined with the perceived level of cooperation from the buyer, increases the likelihood that the suppliers will share innovation ideas to customers (Wagner & Bode 2014). However, the empirical results of this study show that technology is the deciding factor for strategic supplier partnership establishment, including technical facilities and technical knowledge. Strategic suppliers are expected to be also technical consultants in innovation of the buying company. The involvement of strategic suppliers brings positive effects to commercialization such as expanding market (Monczka et al. 2000) and enhancing productivity in operations (Wong et al. 2011, 609 – 612) by improving delivery, production cost, production quality and production flexibility (Bonaccorsi & Lipparini 1994, 138; Dröge, Jayaram & Vickery 2004, 569; Wong et al. 2011, 612). The results of this study are in line with previous studies. Indeed, strategic supplier partnership can foster commercialization buy providing flexible capacity expansion, consulting technology improvement based on the fields they expertise in which probably leads to cost reduction. The involvement of strategic supplier in commercialization also improves operations efficiency of buying company by the trust and compatible processes between buyer and supplier. Additionally, strategic supplier partnerships provoke competition among suppliers, keeping suppliers moving forwards. These positive impacts partially help company deal with the challenges in commercialization about resources efficiency and scale of economy. However, strategic supplier partnerships also exhibit downsides which hinder commercialization such as reducing the possibility to use the available options, causing dependency and subjectivity in cooperation, dependency on sole buyer volume, weakening bargaining power. These downsides are in accordance with the findings of previous studies (Handfield et al. 1999; Huan, Gaoping & Dan 2017; Jiang et al. 2023). The empirical data of this study also mentions that strategic supplier need align with buyer goals to eventually meet customer needs which is similar with the findings of He et al. (2014, 266) that the involvement of supplier is indirectly influence the integration of customer in new product development via manufacturing flexibility.

Customer relationship is one of dimension investigated in this study. The empirical results show that customer relationship has both positive and negative impacts on commercialization of open innovation. Customers are the key to defuse the new product in the market by their references in the business-to-business market. They also contribute to the continuous improvement of new products based on their practical experiences in using new products. The positive impacts of customer relationship found in this study are in accordance with prior research (Chesbrough 2003; Slater & Mohr 2006; Piller & Ihl

2009) about the role of customers in the idea diffusion and technical assistance of innovation. By these positive effects, customer relationship accelerates commercialization by dealing with the challenges of commercialization discussed by informants, comprising market acceptance, scale of economy, diffusing value chain. Beside positive effects, customer relationship practices also hinder commercialization when new products information leaks to competitor, customer information make the innovation become problem solver for one specific customer. These findings support previous studies (Bonner & Walker 2004; He et al. 2014) that customer knowledge heterogeneity should be focused during innovation. Customer relationship is considered important factor in product standardization. By customer knowledge heterogeneity, company can standardize their products which meet customer needs and simplify production activities. Therefore, customer relationship influences postponement where product standardization is an essential tool.

Information sharing level combined with *information sharing quality* are examined in this study. Information sharing is the key factor in supply chain. Accelerating the information flow, reducing the time taken to respond to customer requirements, promoting better coordination and collaboration between supply chain partners (Li et al. 2005, 621; Li & Lin 2006, 1641) are the benefits of information sharing, consequently enhancing supply chain flexibility (Kokins, Straujuma, & Lapiņa 2021, 1637). This is supported by empirical results of this study that information sharing enhances operations efficiency by quality of information shared. By managing the level of information shared to external stakeholders, large company can choose suitable commercialization strategies. Accelerating collaboration and cooperation with customers and suppliers is also seen as a good effect of information sharing on commercialization. In the meantime, it also shows the connection between information sharing and customers, suppliers. However, managing information sharing inappropriately can cause negative impacts on commercialization. First, over-shared information is the root of leaking crucial information to competitors which make company losing its competitive advantages in the market. Second, complexity in organizational structure of large company leads to silo mentality which hinders information sharing properly withing organizations, thus degrading operations efficiency in commercialization stage. In the empirical data, there is a noticeable example about the change in organizational structure of project team which leads to more efficient in information sharing. This can exemplify how organizational structure influences the efficiency of information sharing in large companies, also partially explaining connection between silo-mentality and information sharing.

Lean practices generate advantageous effects on commercialization as this study data shown. Lean practices enhance operations efficiency in commercialization by improving quality of data, supplier and technology used in large company, as well as eliminating non-valued adding processes. Consequently, company can save time for other innovation activities. The findings of this study support previous research (Flores et al. 2017; Chesbrough & Tucci 2020) stating that that lean approach minimizes resources wasted on developing products or product features that might not meet customer needs. When it comes to the downsides of this dimension, most of the concerns is on the implementation of lean that people sometimes practice lean without correct understanding about this concept. The data suggests that training should be provided to ensure that people have accurate understanding about lean and are able to apply it properly in their tasks. In the previous literature (Mueller & Strzelczak 2014), additional cost is described as a negative effect of lean. However, this point was not mentioned by respondents during interview which can be explained that lean is not a new concept and has been practiced as a necessarily ubiquitous standard in the company's processes. Consequently, the presence of lean is accepted as a norm where "extra" cost is necessarily default. In this study, lean is also suggested as possibly effective method to remove silo mentality from information sharing. However, this is just a suggestion by respondent, should be verified in future research.

The empirical results of this study, in line with prior studies, show that *postponement* foster commercialization by dealing with uncertainty of new products when demand is not stable (Yang et al. 2004, 1061), preventing new products from customer specific solutions, enhancing efficiency of procurement and planning, reducing waste in supply chain (Hsuan-Mikkola & Skjøtt-Larsen 2004, 357), and reducing logistics cost. Empirical data of this study also reveals a new point that postponement also benefits customers by enhancing aftersales service. In specific, the application of product standardization also enables customers to easily replace the broken parts of products by spare parts which are standardized and commonly stocked by innovating company. The replacement process is simpler as it requires engineering involvement. Delaying time-to-market for new products is probably the first thought of many respondents in this study. Interestingly, postponement can both lengthen and shorten lead time in different contexts. Indeed, in infancy of commercialization, it takes time for the innovating company to complete the product standardization process which leads to the delay to market for first launches. However, when commercialization is mature, product standardization enables a shorter lead time by simplifying manufacturing processes and exploiting available stock of common parts. Furthermore, standardizing products requires intensive knowledge about the product and market (Wadhwa et al. 2008) and may create problem of new products "fit pretty much for everyone, but it's not good for anyone.

Overall, supply chain management practices exhibit both positive and negative impacts on commercialization. The investigated impacts mostly focus on operations efficiency, cost controlling, capacity flexibility, time-to-market, decision-making process, technology improvement and fulfilment of customer needs. Taking advantages from the positive impacts of supply chain management practices, company can deal with the challenges of commercialization regarding resource efficiency, scales of economy, value chain understanding, information sharing management, customer trust and market acceptance.

5.2 Managerial implications

Open innovation is widely practiced in large companies and supply chain management plays an important role in it. This study provides insight into the impacts of supply chain management practices on commercialization stage of open innovation. By six dimension contributing supply chain management practices, these impacts were investigated and described in detail, including both benefits and downsides. Based on this, large companies' management could have overall picture regarding the connection between supply chain management and open innovation as well as the effects stemming from each dimension to commercialization.

Depending on operating industry of innovating companies, the involvement of external stakeholders in open innovation process varies. Large companies in industries which is slow-paced in innovation should collaborate more with external stakeholders such as universities or academic institutions for novel ideas, especially in early stages of innovation. Choosing appropriate commercialization strategies is crucial for large companies in new product development. Even though protecting intellectual properties is top priority, large companies should consider a flexible approach to manage their intellectual property to obtain high productivity in commercialization.

Large companies' management can take advantages of strategic suppliers to foster commercialization of open innovation. However, management team should also pay attention to all potential of new technologies offered by other suppliers, avoid overreliance on strategic suppliers in technology which partially maintains bargaining power for large companies. Customer knowledge is one of key factors open innovation. Management team of large companies should carefully collect and filter suitable knowledge to avoid developing customer-specific solution into new products. In other words, customer knowledge heterogeneity should be taken into account in innovation.

Large companies are facing silo mentality which hinders information sharing properly within organizations, degrading operations efficiency in commercialization stage. Therefore, management team should be aware of the silo mentality issue and seek for appropriate solutions. Lean practices can be considered a potential solution for this problem as suggested by interviewee in this study. Postponement is an effective tool to deal with uncertainty of innovation where demand is to stable. Management team can take advantage of product standardization but at the same time should be careful to avoid the situation that products fit everyone, but they are not good for anyone.

5.3 Limitations and suggestions for further research

With justified research design and credible empirical data, this study provides theoretical contribution and managerial implications to open innovation and supply chain management topics. This can be considered successful in frame of research purposes stated in the beginning of this study. However, this study also has limitations.

Firstly, the research was conducted with qualitative method in which data was collected by semi-structured interviewed and analysed by thematic analysis. Even though its findings reflect practical knowledge and perspectives of interviewees in mining industry about the research topic, a generic conclusion about the whole industry cannot be generated. Secondly, this study investigates the research topic in a large Finnish company when almost interviewees are in Finland. Although the company operates globally, cultural factors can affect respondents' points of view in the research topic. Thus, this leads to a possible topic for future research about cultural factors as a mediating role in the impact of supply chain management practices on open innovation.

Based on the study results, some other topics regarding supply chain management and open innovation are possible to be discussed in future research. Silo mentality is one of the obstacles in information sharing in large companies. One of informant suggested that lean practices can be applied to reduce the impact of silo mentality on information sharing. This can be a possible topic for further discussion in the future. As presented in empirical findings, technology is a key factor in establishing strategic partnerships with suppliers. This is a different viewpoint from the literature by Li et al. (2005). It would be potential to continue to study further about the role of technology advancement in choosing strategic suppliers for innovating company. Furthermore, the role of technology readiness levels in choosing appropriate commercialization strategies is also possible to researched further. Last but not least, very little attention is paid to the role of lean practices on open innovation. This point is also consensus with a study by Chesbrough and Tucci (2020). Thus, it can be seen as an interesting topic for future research.

6 SUMMARY

Open innovation is widely practiced in large companies which own competitiveness in resources. Meanwhile, supply chain management is an essential tool to obtain the efficiency in supply chain. The two concepts have tight connections to each other where supply chain management practices can hinder or foster the innovation process, especially in commercialization stage. This study is conducted to answer the main research question: *How do the supply chain management practices impact the commercialization of open innovation in a large company?* To find the answer for this question, semi-structured interviews are conducted in this study.

Nine interviews were conducted to collect empirical data from participants who owned solid knowledge and practical experiences in a large Finnish mining company. The collected data was collected by semi-structured interview which covered the practices of commercialization of open innovation, how supply chain management practices hinder and foster commercialization of open innovation in a large company. The data was collected, coded and analysed following data management plan, ensuring trustworthiness of the study.

With six dimensions of supply chain management practices, the impacts of supply chain management are examined throughout the flow of value chain, encompassing upstream (strategic supplier partnerships), information flow (information sharing level, information sharing quality), internal supply chain process (postponement), lean practices, and downstream (customer relationships). Strategic supplier partnerships allow firms to improve their technology, operations efficiency, build up flexible production capability, reduce cost by exploiting supplier's technical advantages, as well as provoke the competitiveness among suppliers. Beside the positive impacts, strategic supplier partnership may reduce the possibility to use available options of technology, increase dependency and subjectivity in cooperation, and weaken bargaining power of buyer. Customer relationships also influence commercialization positively and negatively. Customer relationships play an important role in new products diffusion, continuous improvement of the new products, accelerating product standardization; whereas the risk of leaking new product information, problem-solver for one specific customer and operations complexity are the downsides of customer partnerships in commercialization.

Information sharing quality and level are considered the deciding factors in choosing appropriate commercialization strategies for open innovation. Information sharing also accelerates the operations and foster collaboration with external stakeholders such as suppliers and customers. However, overshared information can lead to information leak, making firms losing technical competitive advantage. Lean is a concept that many people view as always positive. In this study, lean practices can be seen as an effective tool to enhance operations efficiency, therefore saving time for other innovation activities. The most concern about lean practices is the misconception which lead to practicing without proper understanding. The last dimension of supply chain management practices is postponement which prevents developing new products from customer-specific solutions, improving efficiency of procurement and planning and reduce waste in supply chain. However, postponement may delay the time-to-market for new products and cause the problem of standardized products which fit many customers but is not good for any.

Overall, the study contributes to the literature about both supply chain management, commercialization of open innovation as well as the cross disciplinary interaction between the two concepts. Based on the empirical findings, managerial implications guide manager in large companies to exploit different dimensions of supply chain management to serve commercialization activities of open innovation. This study also proposes several possible topics for future research in the related fields.

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APPENDICES

Appendix 1 - Interview Questions

Background questions

- Could you give a brief introduction of yourself as well as your professional background and current position?
- How would you describe yourself as a manager?
- What does the word innovation mean to you? How is it perceived in your organization?

Theme 1 – Commercialization of Open Innovation

- In your opinion, what does open innovation mean?
- How would you describe open innovation practices in your company?
- What are the most popular strategies in the commercialization of innovation in your company? Why?
- What are the main challenges in the commercialization of open innovation?
- Which factors do you think could foster the commercialization of open innovation?
- In your opinion, how would you describe the relationship between supply chain management and open innovation?

Theme 2: Dimensions of supply chain management practices

- What are the main advantages and challenges of supply chain management in a large company?
- In your opinion, what are the dimensions of supply chain management practices?

Strategic supplier partnership

- What is your understanding of the strategic supplier partnership concept?
- What are the criteria for categorizing partnerships with suppliers in your company?
- What are the challenges in strategic supplier management?

Customer relationship

- How would you describe customer relationship management in your company? Any challenges?

Information Sharing

- How would you describe information sharing within your company and to external stakeholders?

Lean practice

- In your opinion, what does lean practice mean?
- How would you describe lean practice in your company?

Postponement

- What does postponement mean in manufacturing?
- How would you describe postponement practice in your company?
- How do you describe the relationship between customer relationship and postponement in the commercialization of open innovation?

Theme 3 – SCM practices hindering the commercialization of open innovation

- What are the downsides of strategic supplier partnership management to the commercialization of open innovation?
- What are the negative impacts of customer relationship management on the commercialization of open innovation?
- In both level and quality aspects, what are the negative impacts of information sharing on the commercialization of open innovation?
- What are the negative impacts of lean practice on the commercialization of open innovation?
- What are the downsides that postponement may impact the commercialization of open innovation?

Theme 4 – SCM practices fostering commercialization of open innovation.

- How can your company manage strategic supplier partnerships to foster the commercialization of open innovation?
- How can your company manage customer relationships to foster the commercialization of open innovation?
- In terms of level, how can your company manage internal and external information sharing to foster the commercialization of open innovation?
- In terms of quality, how can your company manage internal and external information sharing to foster the commercialization of open innovation?
- How can your company manage lean practice to foster the commercialization of open innovation?

- How can your company manage postponement to foster the commercialization of open innovation?

Reflections

- In your opinion, among the six dimensions of SCM practices (strategic supplier partnership, customer relationship, lean practice, information sharing quality, information sharing level, postponement) which dimensions are the most crucial to open innovation?
- What are the major challenges in managing a supply chain serving open innovation?
- In your opinion, what are the most important competencies to deal with these challenges?
- If you have anything, please feel free to share.

Appendix 2 – Data Management Plan

Plan Overview

A Data Management Plan created using DMPTuuli

Title: Impacts of Supply Chain Management practices on the Commercialization of Open Innovation in a large company

Creator: Thi Diem Phuc Tran

Affiliation: University of Turku

Template: General data management plan - University of Turku

Project abstract:
Semi-structured interviews are conducted to understand the impacts of supply chain management practices on the commercialization of open innovation in a large company.

ID: 24537

Start date: 01-01-2024

End date: 15-04-2024

Last modified: 13-04-2024

Impacts of Supply Chain Management practices on the Commercialization of Open Innovation in a large company

1. General description of the data

1.1 What kinds of data is your research based on? What data will be collected, produced or reused? What file formats will the data be in? Additionally, give a rough estimate of the size of the data produced and collected.

Semi-structured interviews with experts in the researched company are conducted and recorded. The collected data will be transcribed in text. The content of interviews is the perspectives of interviewees regarding impacts of supply chain management practices on the commercialization of open innovation in a large company. The interviews are 50 - 65 minutes long.

1.2 How will the consistency and quality of data be controlled?

Consistency and quality of data are ensured by using an interview protocol.

2. Ethical and legal compliance

2.1 What legal issues are related to your data management? (For example, GDPR and other legislation affecting data processing.)

Question not answered

2.2 How will you manage the rights of the data you use, produce and share?

Data is protected by a separate privacy notice

3. Documentation and metadata

How will you document your data in order to make it findable, accessible, interoperable and re-usable for you and others? What kind of metadata standards, README files or other documentation will you use to help others to understand and use your data?

Data will not be shared to third parties

4. Storage and backup during the research project

4.1 Where will your data be stored, and how will the data be backed up?

Data is stored in the researcher's private laptop. Backups are uploaded to private cloud of researcher. All data will be dismantled after the research is completed (latest on 31 Jul 2024)

4.2 Who will be responsible for controlling access to your data, and how will secured access be controlled?

The researcher takes responsibility in controlling access to the data. No third parties have access to the data stored in researcher's laptop and cloud.

5. Opening, publishing and archiving the data after the research project

5.1 What part of the data can be made openly available or published? Where and when will the data, or its metadata, be made available?

Excepting the findings of the research, data will not be available for any third parties

5.2 Where will data with long-term value be preserved, and for how long?

Data will not be stored after the research is completed

6. Data management responsibilities and resources

6.1 Who (for example role, position, and institution) will be responsible for data management?

Thi Diem Phuc Tran, student, Turku School of Economics

6.2 What resources will be required for your data management procedures to ensure that the data can be opened and preserved according to FAIR principles (Findable, Accessible, Interoperable, Re-usable)?

Data will not be stored after the research is completed

Appendix 3 – Privacy Notice

1. Name of the research	Impacts of Supply Chain Management practices on the Commercialization of Open Innovation in a large company
2. Data controller of the research	Thi Diem Phuc Tran, +358 414931416 thidiemphuc.t.tran@utu.fi
3. Contact person	Thi Diem Phuc Tran, +358 414931416 thidiemphuc.t.tran@utu.fi
4. Purpose of processing personal data	The research collects data to have understanding about the impacts of supply chain management practices on the commercialization of open innovation in a large company.
5. Legal basis for processing personal data	The EU General Data Protection Regulation, Article 6 Section 1(a): the data subject has given consent to the processing of his or her personal data for one or more specific purposes.
6. Processed personal data	The following information is collected and stored during in the research: Name, email address, position, perspectives on the research topic.
7. Sources of personal data	The data will not be disclosed to any third parties
8. Transfers or disclosures of data outside the EU or the European Economic Area	The data will not be transferred or disclosed outside EU or the European Economic Area
9. Processing of personal data after the research has ended	Data is stored in the researcher's private laptop. Backups are uploaded to private cloud of researcher. All data will be dismantled after the research is completed (latest on 31 Jul 2024)
10. Rights of the data subject	Rights of the data subject follow the EU General Data Protection Regulation. Specifically, the data subject has the right to access their registered data

	(Article 15) which is stored and controlled by Data Controller; the right to rectification of their data; the right to erasure of their data (Article 17). The subject of data also has the right to restrict (Article 18) and object (Article 21) to the processing of data.
11. Automated decision-making or profiling.	The data processing does not include automatic decision-making or profiling.

Appendix 4 – Informed Consent Form

INFORMED CONSENT FORM for Participants

Impacts of Supply Chain Management practices on the Commercialization of Open Innovation in a large company

I have read and understood the research topic received by email and I voluntarily consent to participate in this project.

☐ YES ☐ NO

I understand that my participation is voluntary and that I have the right to withdraw at any time without giving any reason.

☐ YES ☐ NO

I agree to this interview being audio-recorded.

☐ YES ☐ NO

I agree to this interview being video-recorded.

☐ YES ☐ NO

I agree to be identified in the following way in the research outputs:

- Pseudonym *(e.g: alternative code shown in the research outputs instead of personal identifiers)*

☐ YES ☐ NO

- Impersonal attribution *(e.g: by profession: worker, student, etc)*

☐ YES ☐ NO

Date	Participant's name	Signature
……………………	……………………………………..	………………………………..