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SPEEDING UP THE DELIVERY PROCESS THROUGH KNOWLEDGE TRANSFER IN ENGINEER TO ORDER CONTEXTS

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ABSTRACT

Ahsan Mahmood: Speeding Up the Delivery Process Through Knowledge Transfer in Engineer to Order Contexts
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In engineering to order (ETO) companies, short lead times are regarded as a source of competitive advantage for businesses. After a customer order has been received, the production of ETO products either starts from scratch or adjusts according to customer specifications. When delivering ETO products, significantly longer processing times are one of the primary reasons for the slowness of the delivery process due to their high degree of engineering complexity. Hence, to decrease the processing time of engineering activities from the delivery process, the timely availability of complex information to engineering functions regarding customer specifications is necessary. However, to obtain such complex information from the customers upfront requires strong technical competencies. One of the most important strategies for enhancing technical knowledge is to ensure easy access to knowledge sources.

Thus, the objective of the thesis is to speed up the delivery process of ETO products through the knowledge transfer approach. The study is done for a company whose product demands a timely availability of information related to customer specifications for speeding up its delivery process. This study is performed from the perspective of a complex organizational system (COS), considering the viewpoint of complex ETO products. To fulfill the objective and develop a theory in the research field, the thesis aims at answering what are the different requirements and the related knowledge transfer techniques for speeding up the delivery process of ETO products.

The empirical data was primarily collected through existing material that includes documentation available in the company's intranet pages, and qualitative interviews with employees at the case company. The literature review together with the empirical results was used to propose and validate the theoretical framework and examine the feasibility and effectiveness of its implementation.

The results show that knowledge transfer can prove to be an important tool for speeding up the delivery process of ETO products. The findings also indicate that in ETO companies, the role of sales function becomes highly crucial to ensure timely availability of customer specifications to engineering teams. Hence, suitable knowledge transfer techniques should also be employed to increase the technical knowledge of the salespeople when attempting to reduce the processing time of ETO products. Even though there are certain limitations attached to the results of the thesis, the study provides a theoretical framework for speeding up the delivery process of ETO products through knowledge transfer. This might be an insightful examination for academics and practitioners interested in the topic.

Keywords: Engineer to Order, Engineer to Order Products, Knowledge Transfer, Knowledge Transfer Techniques, Delivery Process, Delivery Speed

PREFACE

While pursuing my master's studies, I was presented with a very interesting opportunity to work in a start-up environment for a Finnish technology service provider where I was supposed to investigate the causes behind the slowness of the delivery process of the company's product. The aim was to propose possible solutions and also participate in the implementation of these solutions for speeding up the delivery process of the case company. This problem seemed extremely interesting to me, and I decided to convert this opportunity into a master thesis.

I would like to greatly thank Professor Miia Martinsuo and Associate Professor Tuomas Ahola for the support and guidance throughout the process of writing this thesis. Without their support, the completion of my thesis would not have been possible. In addition, I would like to express my most sincere gratitude to the management of the case company, and especially to Mr. Markku Haapakoski, who helped me a great deal in the introductory phase and was also assisting and accompanying me in the inter-city travelling during the interviews phase.

I would like to thank all my friends, acquaintances, and faculty at Tampere University who contributed to my experience while studying in Finland. Finally, I cannot forget to mention my beloved parents, sister, and wife who always prayed for me and were there to push me and support me during my master studies, and especially during the thesis writing process.

Tampere, 09 May 2020

Ahsan Mahmood

CONTENTS

LIST OF ABBREVIATIONS

3PL	Third Party Logistics
ATO	Assemble to Order
B2B	Business to Business
B2C	Business to Consumer
COS	Complex Organizational System
DAC	Digital Automation Cloud
DC	Data Center
ERP	Enterprise Resource Planning
ETO	Engineer to Order
HR	Human Resource
IoT	Internet of Things
KPI	Key Performance Indicator
MTS	Make to Stock

1. INTRODUCTION

1.1 Background

In engineering to order (ETO) companies, short lead times are regarded as a source of competitive advantage for businesses (Konijnendijk, 1994; Bozarth & Chapman, 1996). After a customer order has been received, the production of ETO products either starts from scratch or adjusts according to customer specifications (Amaro et al., 1999). Therefore, the engineering processes cause a substantial increase in delivery lead times (Little et al., 2000). Such a scenario can easily decrease the rate of production output and hence, it can make it difficult for a company to fulfill and capture customer orders and demand.

As a result, for a business to grow, companies should not only invent quality innovations and technologies, but they must also focus on the improvement of internal business processes that are responsible for delivering the technology to the end customer. In an ETO company, the changes in customer specifications with each order cause a change in information that flows within business processes. Lack of visibility to the information which is necessary to make decisions to ensure a smooth running of a process can significantly limit the ability of a business to scale up (Pal Singh Toor & Dhir, 2011). However, in business processes, information sharing and visibility becomes relevant only after the right information has been created.

In ETO products, variation in customer specifications with each order trigger a change in the knowledge required to generate the information which will be shared later with the actors involved in the delivery process. Hence, in an ETO company, the absence of knowledge for information creation can be the root cause of the slowness of the delivery process since the information shared will be either missing or incorrect. Thus, the role of knowledge management becomes extremely crucial in such environments to increase the efficiency and pace of delivery processes. Numerous studies have been conducted in theoretical terms which either showed the importance of knowledge transfer or identified the key factors for facilitating or impeding the knowledge management processes (see, e.g., Ren et al., 2019; Korbi & Chouki, 2017; Goh, 2002). However, there is a shortage of studies where the impact of knowledge transfer techniques on internal business processes have been measured in quantitative terms.

Hence, this thesis studies the role of knowledge transfer in speeding up the delivery process in engineering to order products. This research is carried out in cooperation with a technology service provider that delivers private wireless network to enterprises for enabling large internet of things (IoT) applications. The case company is part of a complex organizational system (COS) because it is surrounded by an extensive network of stakeholders whose activities are dependent on each other (Wadhawan, 2009). In such systems, the behavior of the network is not determined by a single company, but it is decided by the actions of the partners (Silva & Guerrini, 2018). As a result, such complex systems can contribute greatly to escalating the engineering complexity of the ETO products, hence, making such offerings even more complex. Due to high engineering complexity of the case company's product, it is experiencing significantly longer processing times in the delivery process. Hence, to decrease the processing time of engineering activities from the case company's delivery process, the timely availability of complex information to engineering functions regarding customer specifications is necessary. However, to obtain such complex information from the customers upfront requires strong technical competencies. One of the most important strategies for enhancing technical knowledge is to ensure easy access to knowledge sources.

1.2 Objective

The research focuses on speeding up the delivery process of the ETO products for a company that is part of a complex system. It concentrates on the role of knowledge management techniques for reducing the delivery lead time, particularly in business to business (B2B) cooperation. Thus, the objective of the thesis is:

> *To speed up the delivery process of ETO products by utilizing knowledge transfer approach*

The objective of the thesis is broken down into the following research questions:

1. *What are the different requirements of ETO products for speeding up their delivery process?*
2. *What kind of knowledge transfer techniques can be utilized for speeding up the delivery process of ETO products?*

In the case project, the researcher participated in streamlining the existing delivery process of the company by utilizing knowledge transfer techniques, and as a result, attempted to speed up the process. The participation enabled the gathering of empirical data by providing access to the company premises.

1.3 Scope of the Thesis

This thesis focuses on improving the delivery lead time through knowledge transfer to better satisfy the enterprise customers. Therefore, only the B2B sector is part of the scope of this study, and the consumer market domain is excluded from the thesis. Furthermore, the thesis only concentrates on speeding up the delivery process of ETO offerings, and thus, the other type of offerings such as assemble to order (ATO) and make to stock (MTS) are out of the scope of this research. In addition, this study takes the perspective of a single company involved in the telecommunication sector, hence, a broader analysis from multiple case companies and industrial sectors is not part of the thesis.

1.4 Structure of the Thesis

The thesis is divided into six chapters, and the content of the next chapters is as follows:

Chapter 2 focuses on the literature review. The first part concentrates on defining the general characteristics and management principles of COS. Following the first section, characteristics of ETO environments and the delivery process of ETO products are studied in detail. After covering the concept of ETO products, various factors for enabling intra-organizational knowledge transfer are examined and the theoretical framework is formed. The literature is reviewed to achieve a comprehensive understanding of the main topic of the study and to build a theoretical foundation for the empirical section.

Chapter 3 concentrates on the research methodology. The methods of the thesis consist of existing material and qualitative interviews. This chapter describes the research strategy of the thesis and provides a general overview of the research and data collection process. Finally, it explains the way of analyzing the gathered data.

Chapter 4 presents the results. It contains the results of a single case study and the related analysis. It describes the case company and its product. Then, it explains the delivery process of the company. In the end, it describes the requirements and the related knowledge transfer techniques for speeding up the delivery process of the case company's product.

Chapter 5 is about discussion where it examines how the results are linked to prior studies. It shows the overlaps and main differences between the results of the case study and the literature review regarding the requirements and knowledge transfer techniques for speeding up the delivery process of ETO products. It also responds to the research questions and the objective of the thesis.

Chapter 6 presents the conclusions. It reviews the academic contribution of the thesis where it makes a linkage between knowledge transfer and delivery speed of ETO products. In addition, it explains the practical implications and limitations of the study, and also gives directions for future research.

2. LITERATURE REVIEW

2.1 Defining Complex Organizational System

Since this thesis examines the delivery process environment of ETO products from the perspective of COS, it is essential to provide the reader with a basic understanding regarding this concept. According to Capra (1983), a complex organization is not seen as a machine made up of various individual parts, but such an organization is identified as one being whose parts are interrelated with each other. Likewise, Regine & Lewin (2000) state that complex systems are formed by several actors where the behavior of each actor affects others. As a result, even a small variation in inputs can cause a considerable change in the system output (Dooley & Van de Ven, 1999).

According to Nayak & Waterson (2019), a large number of elements are required for a system to be termed as complex. However, the number of elements cannot determine alone whether a system is complex or not. The agents present under a complex system must have complex interactions and are tightly woven together (Cilliers, 1998; Kirlik, 2011).

Rangachari (2008) mentions three distinctive properties of COS – first, it is defined by the relationships and connections among agents. Second, complex systems are self-organizing in nature, and this self-organization happens through the interactions among various elements of the system. Last, a complex system's trajectory is unknowable because it is impossible to forecast the pattern of behavior of such a system. Due to these properties, complex systems possess the quality of non-linearity. Therefore, changes in communication between individual agents result in disproportionate changes in the system output which are difficult to predict (Silva & Guerrini, 2018).

Anderson & McDaniel (2000) provide some prescriptions for managing complex systems. They state that relationship building, diversifying, and creating a learning organization can facilitate a great deal in the management of COS. First, relationship building means to realize the importance of interactions and connections among elements. Second, diversification is the process of encouraging learning and innovation through dialogues and interactions among people with different backgrounds. Last, processes and mechanisms should be designed in such a manner that they stimulate learning and exchange of knowledge, and hence, lead to the creation of a learning organization.

In the light of the prescriptions mentioned by Anderson & McDaniel (2000), Nayak & Waterson (2019) further state that superiors should communicate direct orders to employees in the form of training manuals and training sessions. In addition, they must also provide the employees with a full understanding of the job and its possible links to the other jobs within the same system. The characteristics and principles for managing COS mentioned in the existing literature are summarized in the following figure.

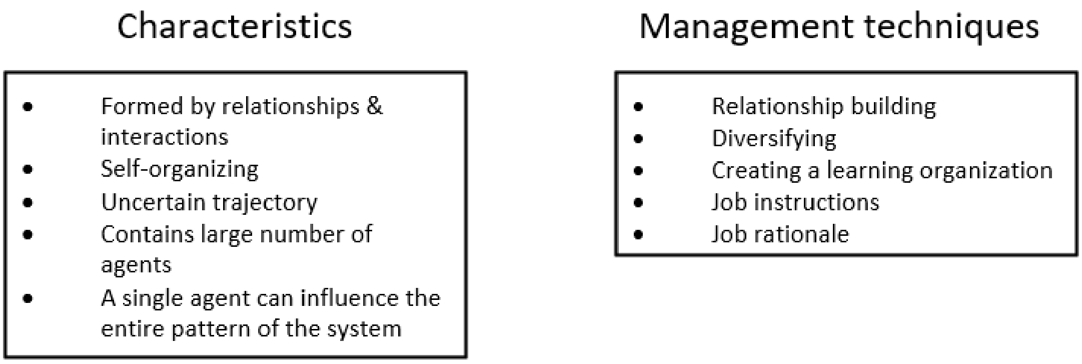

Figure 1. Characteristics & techniques for managing COS (Adopted from Dooley & Van de Ven, 1999; Nayak & Waterson, 2019; Cilliers, 1998; Kirlik, 2011; Rangachari, 2008; Silva & Guerrini, 2018; Anderson & McDaniel, 2000)

The characteristics shown in the figure are demonstrating the attributes of a typical ETO environment where a change in interaction with a customer can result in a significant change in the final product architecture and specifications (Amaro et al., 1999; Little et al., 2000). Such a change easily influences the entire delivery process, and therefore, it can disturb the pattern of the whole system. Moreover, it is extremely difficult to predict what kind of changes will be done to the product with each customer order. This exhibits the property of uncertain trajectory which is one of the primary features of COS. This means that the COS environment can induce unexpected variations in a product offered within the system, hence, the concept of ETO becomes highly relevant in such cases. The next section focuses more on this concept and presents several requirements of ETO products in speeding up the delivery process.

2.2 Delivery Process in Engineer to Order Manufacturing

2.2.1 Characteristics of Engineer to Order Products

Since this thesis focuses on speeding up the delivery process of ETO products, it is necessary to provide the reader with a general overview of the characteristics of ETO products in the light of existing literature. In B2B networks, ETO companies offer a low volume of highly customizable products that are developed in order to exactly satisfy the needs of a specific customer (Wortmann et al., 1997). Due to the customization aspect, some degree of engineering work is required to adjust to the changing customer requirements. The inclusion of engineering work has a direct impact on delivery lead time (Konijnendijk, 1994). The primary reason for longer delivery lead time in ETO companies is that most of the activities are performed after receiving the customer order (Amaro et al., 1999).

The challenge for ETO companies in B2B cooperation is to deliver high-quality products with diverse customer needs in highly uncertain environments (Stavrulaki and Davis, 2010). Another challenge is that high technical knowledge is required from all the actors involved in the delivery of an ETO product (Caron & Fiore, 1995; Gosling et al., 2015) since, in B2B situations, products are extremely technology-intensive. Besides, the occurrence of delays caused by the engineering processes is a major problem for ETO companies (Hicks et al., 2001). Such delays increase the delivery lead time, and they usually happen due to poor coordination among the participants in dealing with specific requirements and product changes (Caron and Fiore, 1995).

According to Pandit & Zhu (2007), ETO strategy is suitable for highly customized and non-repetitive products. Due to high customization and low level of repetitiveness, the production outputs of ETO companies are significantly low as compared to MTS and ATO strategies (Tu, 2000). Furthermore, the management of ETO offerings involves both non-physical and physical stages (Wikner & Rudberg, 2005; Gosling & Naim, 2009). The non-physical stage comprises of tendering, engineering, and design phases. Whereas, the physical stage consists of manufacturing, assembly, and installation. More specifically, the ETO strategy includes a high degree of uncertainty in terms of product architecture, customer demand, and process lead times (Wikner & Rudberg, 2005). The following table shows a recap of the distinctive characteristics of the ETO products in a B2B environment as emerged from the present literature.

Table 1. Typical characteristics of ETO products.

Characteristics	Description	Authors
Core competencies	Design, assembly, and engineering	Wikner & Rudberg, 2005; Gosling & Naim, 2009
Competitive advantage	High technical knowledge	Caron & Fiore, 1995; Gosling et al., 2015
Production volume	Small volume	Tu, 2000
Product customization	High	Wortmann et al., 1997; Pandit & Zhu, 2007
Replenishment	Purchasing is done according to the customer order	Gosling & Naim, 2009
Demand forecasting	Low accuracy	Wikner & Rudberg, 2005
Risks	Coordination and delays	Hicks et al., 2001; Caron and Fiore, 1995
Process lead time	High	Wikner & Rudberg, 2005

The characteristics shown in the table are the reflection of ETO companies which are part of a B2B network. It is evident from Table 1 that to reduce process lead time of the ETO products, a company needs to take measures which not only improve coordination among the participants but also increase their technical knowledge. These are the only characteristics on which a company influences whereas the rest of the attributes are essentially unchangeable.

2.2.2 Lead Time and Delivery Speed in Manufacturing Processes

According to Lamming (1996), time is one of the most essential indicators of logistics and distribution processes. From a market perspective, delivery speed is the time consumed from customer order receipt to final delivery (Handfield & Pannesi, 1992). Reduction of delivery lead time can not only decrease the cost of poor quality, but it can also result in better customer satisfaction (Nabhani & Shokri, 2009). Arnheiter & Maleyoff (2005) further state that by achieving faster delivery, companies can enhance their competitiveness greatly. As a result, delivery speed has become a key requirement for competitive differentiation and increased profitability (Chan et al., 2002).

According to Handfield & Pannesi (1992), the two major causes for not being able to meet the requested customer lead time are the existence of backlog of previous orders and excessive processing times. These two scenarios are shown in the figure below.

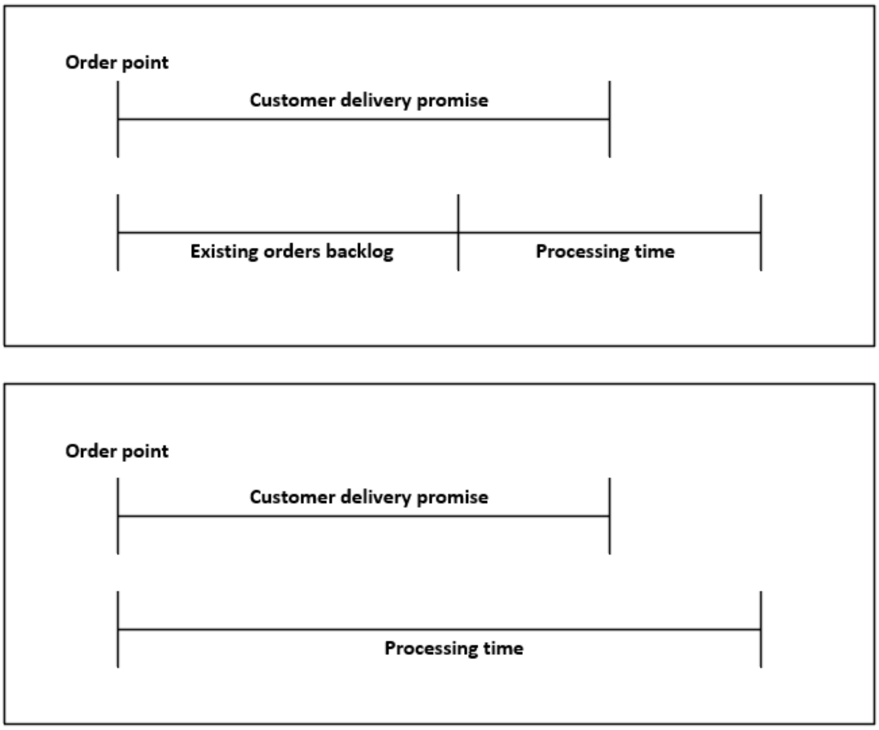

Figure 2. Causes of failure to meet requested delivery lead time (Adopted from Handfield & Pannesi, 1992).

The first scenario shows that although the processing lead time is less than the customer lead time, due to the existing orders backlog, the delivery time becomes greater than the requested lead time. Similarly, in the second situation, even though there is no existing backlog, the excessive length of the processing time leads to failure in meeting the promised delivery lead time. Both of these cases either directly or indirectly decrease the delivery speed, and therefore, result in longer lead times. Furthermore, in their case study, Handfield & Pannesi (1992) generalized the completion of a delivery cycle and stated that it ends when the product is transferred to the shipping department since the operations department does not take responsibility for delivery after this point. However, the case company of this thesis has a completely different approach to the measurement of the delivery cycle. It uses an end-to-end approach and measures the delivery process from the registration of customer order to the transfer of product to the final customer. Therefore, strategies for speeding up the delivery process might vary with the reference point a company is using.

Based on this discussion, it can be assumed that the delivery lead time is an essential indicator of the delivery speed. Since this thesis deals with the delivery speed of ETO products, the primary source for slowing down the delivery process might originate from significantly longer processing times due to high customization aspects (Wortmann et al., 1997; Pandit & Zhu, 2007). Therefore, the next section explains different requirements for speeding up the delivery process of ETO products in more detail.

2.2.3 Speeding Up the Delivery Process of Engineer to Order Products

After gaining an understanding of the general characteristics of ETO products, it is essential to mention the requirements which can speed-up the delivery process of ETO products. The aim of all the requirements mentioned in the existing literature is to decrease the processing times since this is the bottleneck phase in the delivery of ETO products. According to Willner et al. (2016), standardizing and automating the ETO delivery chain can substantially decrease its delivery lead time. Since ETO products are highly customizable and non-standard, it might be a useful strategy to reduce the customization aspect as much as possible in order to cut time from engineering activities. In other terms, standardization enables the reduction of engineering complexity which means, the less the engineering complexity, the more it will be possible to automate the delivery processes. However, in the case of high engineering complexity, it will be extremely complicated to perform automation since more flexible processes are required to feed the complex engineering environments. In line with this idea, Wacker & Treleven (1986) considers the standardization of product structures as a prerequisite to enable automation.

Nevertheless, Willner et al. (2016) also state the possible challenges of performing standardization and automation of ETO products. They mentioned four different types of ETO environments and related to the degree of standardization and automation possible in each ETO type. Figure 3 shows the types of ETO products and the level of standardization and automation possible in them.

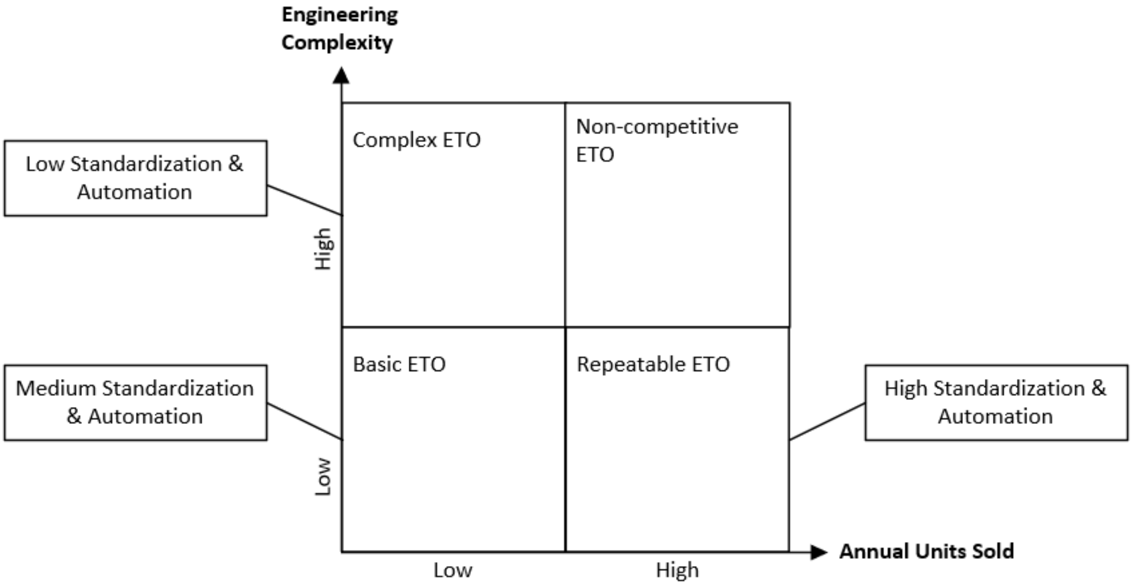

Figure 3. Archetypes of ETO environments (Adopted from Willner et al., 2016).

As the figure shows, the types are categorized based on engineering complexity and production volume in the form of 2 x 2 matrix. First, complex ETO products have a high degree of complexity, and they are mostly ordered in low volumes. Hence, this type of ETO products perfectly corresponds to the definition of ETO mostly used in the existing literature (e.g. Hicks et al., 2001; Gosling and Naim, 2009). Ideal examples of complex ETO products are ships and nuclear plants. In such cases, it might be difficult to perform standardization and automation since they are engineered according to precise customer specifications and as a result, a great deal of engineering effort is required. Nevertheless, standardization and automation remain essential requirements for speeding up the delivery process of ETO products regardless of their types.

Second, basic ETO products are ordered in low volumes, but they possess a low degree of engineering complexity. Such ETO products require low engineering effort since only part of the product needs to be customized according to customer order and only a few modules are affected by engineering. Therefore, in the case of basic ETO, medium standardization and automation are possible and lead times generally vary from medium to high depending upon the degree of customization. Moreover, the production volumes are most often low because the market size of basic ETO products is usually small (Willner et al., 2016).

Third, repeatable ETO products are ordered in high volumes and contain low engineering complexity. Examples of repeatable ETO products can be elevators and buses. Alderman & Thwaites (2001) regard repeatable ETO also as customized MTO products. Like basic ETO, this type of ETO product is also developed as an MTO product which is later on modified according to customer requirements. Hence, due to low complexity, high production volume, and repetitive nature, a high level of standardization and automation is possible. As a result, lead times, in this case, can vary from short to medium.

Last, non-competitive ETO products are ordered in high volumes and possess a high degree of engineering complexity. Such products are very rare, and they almost do not exist. Utterback & Abernathy (1975) suggest that non-competitive ETO products appear only in certain exceptional cases when, for example, a pioneering company is part of a market which is expanding rapidly, and a dominant design has to be established yet.

Since complex ETO products comprise of high engineering complexity and low sales volume, it might be an extremely rare scenario where the delivery process is slowed down due to the existing backlog of orders since the number of units sold of complex ETO products is generally very low. As a result, the only factor left behind a slower delivery speed is the length of processing times. However, in the case of repeatable and non-competitive ETOs, the delivery speed might also be decreased by the orders backlog because these ETO products are sold in high volumes. In basic ETO products, delivery speed should not be an issue since both the factors, engineering complexity, and units sold are low. These scenarios are presented in Figure 4.

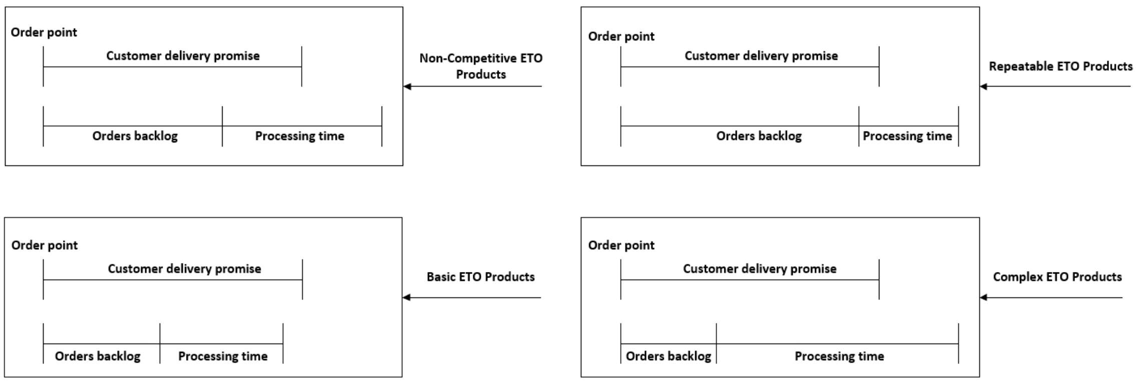

Figure 4. Causes of delivery speed slowness based on ETO archetypes.

As shown in the figure above, in the case of non-competitive ETOs, the delivery speed is slowed down by both existing order backlog and processing time equally since these ETO products have not only high engineering complexity but also have high production volume. When it comes to repeatable ETOs, the processing times are significantly shorter because of their low engineering complexity, however, due to the high selling volume, the delivery lead time is increased by high order backlog. In the case of basic ETOs, due to low volume and engineering complexity, delivery speed is at a good level. In complex ETOs, the main culprit behind the slowness of the delivery process is longer processing time whereas the role of orders backlog is rather insignificant. Although processing time plays a crucial role in the majority of the ETO products, in complex ETOs, its role becomes even more important in increasing the delivery speed.

Mello et al. (2015) emphasized the need for close coordination and knowledge sharing between internal stakeholders when attempting to speed up the delivery process of complex ETO offerings. According to Malone & Crowston (1994), coordination is “the act of managing dependencies between entities and the joint effort of entities working together towards mutually defined goals.” Thompson (1967) further states that coordination becomes even more crucial in the case of complex organizations. In COS, business functions are highly interdependent, hence, the higher the interdependence, the higher the need for coordination.

On the other hand, in ETO supply chains, two business functions require absolute knowledge sharing practices: engineering and production (Hicks et al., 2000). Conversely, Konijnendijk (1994) stresses the coordination of marketing and production by stating that these functions are particularly interdependent, and therefore, they should be overlapped to improve delivery speed in ETO companies. The idea behind functional coordination is to ensure the availability of complex technical information that the ETO products possess. Moreover, Mello et al. (2015) not only specified the need for knowledge transfer between business functions, but they also highlighted several other factors that can either slow-down or speed-up the delivery of complex ETO products. They performed their research by studying six cases of shipbuilding projects and came up with five factors for reducing the delivery lead time.

First, the integration and overlapping between engineering and production should be efficient in order to achieve faster delivery. Second, in very large projects, coordination becomes extremely challenging, however, relatively smaller ETO projects are easier to coordinate. Hence, the size of an ETO project is another important factor in influencing the delivery lead time. Third, those ETO products which have never been tested before, meaning that the maturity of their design/technology is at a lower level, their delivery process is considerably longer than those solutions which have a higher maturity level. Fourth, the frequency of changes in customer order is another important factor in increasing the delivery lead time. The occurrence of changes disrupts the production process, and as a result, it slows down the delivery speed. Last, a lack of technical competency is also a major cause of slowing down the delivery process. If the engineering team has less capability of adjusting technical specifications according to customer order changes, the entire delivery process can come to a halt. The following table summarizes the requirements for speeding up the delivery process of ETO products.

Table 2. Requirements for speeding up the delivery process of ETO products (Adopted from Willner et al., 2016; Mello et al., 2015; Hicks et al., 2000; Thompson, 1967; Konijnendijk, 1994).

Requirements
High technical competence
Knowledge sharing between engineering & production
knowledge sharing between marketing & production
Standardization & automation
Low to moderate changes in customer order
Projects of smaller size
High maturity of design/technology

It is essential to point out here that the requirements mentioned in Table 2 focus on reducing the processing time of the ETO delivery process. As shown in the table, knowledge sharing is one of the most essential requirements for speeding up the ETO delivery process. Hence, the next section focuses on the organizational knowledge transfer techniques, however, the goal is to discuss knowledge management only at the intra-organizational level to match the scope of this thesis.

2.3 Knowledge Transfer and Delivery Speed

2.3.1 Knowledge and Knowledge Transfer

According to DeFillippi et al. (2006), knowledge facilitates an organization to make better decisions and to compete better. Hence, knowledge acts as a basis for increasing the competitive advantage of a company. Chen (1996) states that companies that lack knowledge capabilities always underperform their competitors. Therefore, in today's competitive business landscape, organizations need to source knowledge from various sources. According to Von Krogh et al. (2001), knowledge is created within companies with the help of explication, scrutiny, and the sharing of tacit knowledge on a collective basis.

In the existing literature, two types of knowledge are mentioned – explicit knowledge and tacit knowledge. Explicit knowledge is easier to communicate and store, and it is available readily through various platforms such as publications, informal discussions, web, and operating manuals (Schartinger et al., 2002). On the other hand, tacit knowledge is stickier and more difficult to transfer, and it is the one that plays a crucial role in providing a company with a competitive advantage (Grant, 1996). However, the transfer of tacit knowledge is a gradual process, and it is done through demonstration and learning by doing (Roberts, 2000; Arrow, 1974). This means that it is triggered through questions, discussions, trainings, and reflective thoughts.

When it comes to the communication of knowledge either explicit or tacit, it is done through the process of knowledge transfer. According to Christensen (2003), "Knowledge transfer is about identifying (accessible) knowledge that already exists, acquiring it and subsequently applying this knowledge to develop new ideas or enhance the existing ideas to make a process/action faster, better or safer than they would have otherwise been." Hence, this thesis focuses on the concept of knowledge transfer presented by Christensen since the goal of this study is to make the delivery process faster by applying knowledge transfer techniques.

Knowledge can be transferred by reading written materials, listening to others, and experimentation (Ranjan & Gera, 2012). DeFillippi et al. (2009) state that explicit and tacit knowledge often exist simultaneously. Since tacit knowledge is the basis for providing long-term value, modern organizations induct most of their resources in acquiring it to make their work-force competitive. Individuals gain tacit knowledge by applying explicit knowledge continuously (Cohen et al., 1996). However, based on the explicit-tacit dimension, Nonaka & Takeuchi (1995) categorized knowledge transfer in four forms, i.e. internalization, socialization, externalization, and combination.

First, internalization is the conversion of explicit knowledge into tacit form by learning through the imitation of documented tasks. Second, socialization is when tacit knowledge is passed to others in a tacit form with the help of team meetings and discussions. Third, externalization is the transfer of tacit knowledge to explicit, and this is done, for example, via theories and concepts. Last, the combination means when explicit knowledge is transferred into explicit form through written and verbal material, e-mails, and reports, etc.

According to Seaton (2002), before implementing the actual knowledge transfer process, it is highly essential to acquire knowledge about how to transfer knowledge. Hence, after gaining basic insights regarding knowledge and knowledge transfer, it is important to explain the factors that can enable the intra-organizational knowledge transfer.

2.3.2 Intra-Organizational Knowledge Transfer Techniques

In their study, O'Dell & Grayson (1999) presented several examples from case-studies that suggest that knowledge transfer can bring about various benefits to an organization. However, certain techniques need to be followed to encourage effective knowledge transfer within a company. One of those techniques is the use of technology to facilitate knowledge sharing (Goh, 2002). The deployment of information technology tools is still regarded as one of the beneficial methods to facilitate intra-organizational knowledge transfer (Goh, 2002). In an interview, John Browne – CEO of BP told that his company utilized a virtual team network in order to reduce the size and distance between different business units which eventually allowed for active knowledge sharing between the internal stakeholders. However, Goh (2002) states that the absence of motivation and willingness to share knowledge can easily harm the efforts of facilitating it through the use of technology. In the case of BP, the behavior of internal staff was a major factor in the success of knowledge transfer through the use of information technology.

Therefore, organizational culture is another critical factor for encouraging internal knowledge transfer (Riege, 2007; Goh, 2002). Organizational culture has many dimensions, but the one which is absolutely necessary to promote internal knowledge transfer is cooperation and collaboration (Morris & Snell, 2011; Morris & Snell, 2014). This means that knowledge transfer requires individuals or groups to work together and share knowledge for mutual benefits. Hence, the internal knowledge transfer process will fail if employees are showing strong resistance to mutual cooperation. In order to encourage mutual cooperation, Fey & Furu (2008) proposed to provide monetary compensation to employees for conducting knowledge sharing practices.

Furthermore, according to Nonaka (1994), the type of organizational structure also plays an important role in the transfer of knowledge in an organization. Strict hierarchical structures that work in their silos restrict the smooth flow of knowledge. As a result, it is essential to develop horizontal communication flows through the creation of cross-functional interactions.

The competencies of knowledge recipients can also greatly support or hinder the transfer of knowledge (Szulanski, 1996). Due to the recipient's lack of motivation, absorptive and retentive capacities, the knowledge transfer process can suffer a great deal despite the availability and accessibility of knowledge in an organization. Therefore, companies must invest in the training of knowledge recipients so that the relationship between knowledge giver and receiver can be made stronger by developing equivalent skills and knowledge capacities in both the parties. To promote recipients' training, companies should also execute workforce mobility and rotational assignments (Morris & Snell, 2014).

In his study, Riege (2007) presented a comprehensive list of actions that managers can apply to facilitate internal organizational knowledge transfer. He identified three primary barriers to transferring knowledge – people, organizational, and technological. One of the barriers that employees can create is either their perception regarding lack of time to share knowledge or they consider knowledge sharing as an extra amount of work. To overcome such a resistance, managers should acknowledge the time pressures that employees face, and hence, they should allocate a separate time slot for knowledge sharing. In addition, if knowledge transfer activities truly demand extra effort and time, managers must acknowledge the value of employees' commitment and establish a reward system accordingly.

Another source of resistance is the organization itself. There can be a situation where an organization lacks leadership and managerial direction in terms of the communication of potential benefits and value which can come as a result of knowledge transfer practices. To solve such an issue, it is essential to educate managers and leaders by showing examples of how knowledge transfer techniques can make them perform their jobs more efficiently and serve their customers in a better way. Another type of organizational barrier can result from insufficient resources and infrastructure to successfully implement knowledge transfer practices. To counter this barrier, it is important to identify the right people and the type of information and knowledge they need and then, direct the required resources and infrastructure necessary to provide access to knowledge base towards that group. The third type of organizational barrier relates to the problem of communication flows which are confined into certain directions. This issue should be solved by promoting cross-functional communication. There should be no restrictions between hierarchies when it comes to knowledge sharing. This also means that direct contact must be established between knowledge sources and knowledge receivers in order to minimize information distortion.

The technological barrier is another cause of disrupting the knowledge transfer process. First, hindrance is linked to the failure of IT systems to facilitate workflows and internal communication. In order to solve this problem, a company must enhance and integrate its IT infrastructure according to the company's business processes. Moreover, it is also essential to explain to the employees how these tools should be used. Second, the source of a possible technological barrier can result from the reluctance of employees to use IT systems and tools in place. To counter this, appropriate training on new technology should be provided to reduce people's fear of technology change. In addition, it is also necessary to give people enough time to getting familiar with the new applications. The following table lists various internal organizational knowledge transfer techniques, taken from the existing literature, which are necessary to improve internal business processes.

Table 3. Types of intra-organizational knowledge transfer techniques.

Internal Knowledge Transfer Techniques	Authors
Training of knowledge recipients	Szulanski, 1996
Allocation of separate time slot for knowledge sharing	Riege, 2007
Identification of right people and right knowledge	Riege, 2007
Workforce mobility	Morris & Snell, 2014
Enhancement and integration of IT infrastructure	Goh, 2002
Educating managers about the benefits of knowledge transfer	Riege, 2007
Providing incentives for knowledge sharing	Fey & Furu, 2008

The next section presents the framework for speeding up the delivery process of ETO products through the application of knowledge transfer techniques.

2.3.3 Speeding Up the Delivery Process Through Knowledge Transfer

As mentioned in the present literature, in order to speed up the delivery process of ETO products, it is necessary to establish close coordination through knowledge sharing practices across different functions, mainly due to the complexity which the ETO products possess. The primary aim of knowledge sharing is to increase the technical knowledge of the people who are involved in or can impact the delivery process of ETO products. The reason behind is that one of the most essential requirements for speeding up the delivery process of ETO products is to secure high technical competence (Mello et al., 2015). An increase in technical knowledge will ensure the timely availability of complex information which will help to decrease the processing time of the ETO products. Figure 5 shows how knowledge transfer can speed up the delivery process of ETO products.

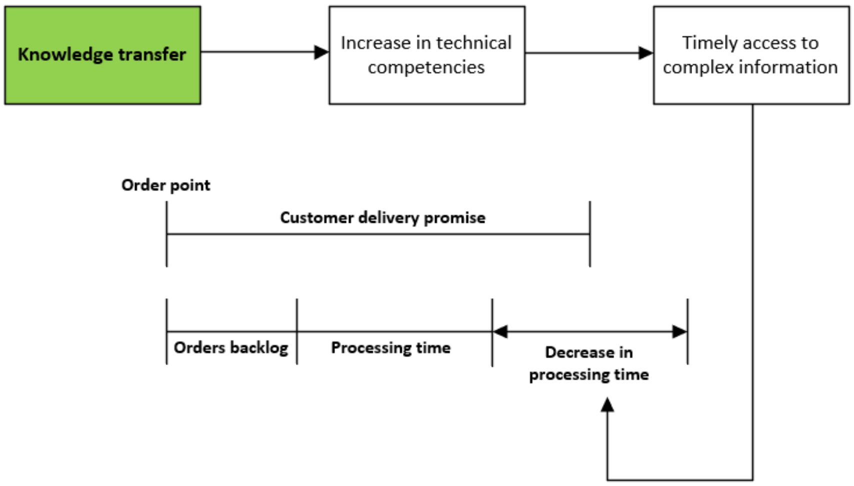

Figure 5. Speeding up the delivery process of ETO products through knowledge transfer.

However, the implementation of the knowledge transfer approach without the right enablers will be ineffective. Hence, knowledge sharing can only be made possible through the employment of a variety of knowledge transfer techniques. As a result, such techniques have a direct impact on the delivery lead time of ETO products. Hence, based on prior studies, Figure 6 illustrates the theoretical framework for speeding up the delivery process of ETO products through a knowledge transfer approach.

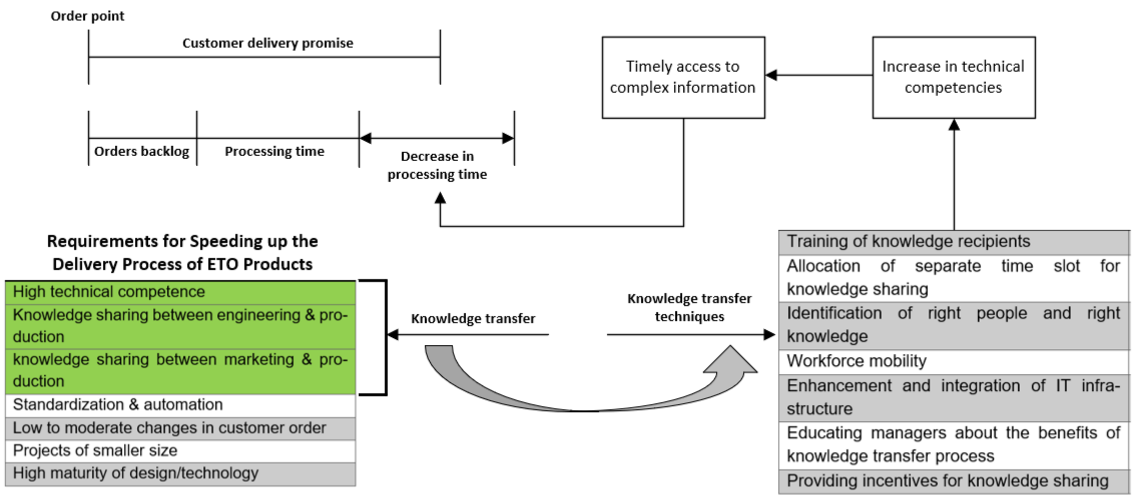

Figure 6. Theoretical framework for speeding up the delivery process of ETO products through knowledge transfer.

As discussed in previous sections, complex ETO products demand plenty of technical competencies to ensure a smooth delivery to customers. When it comes to speeding up the delivery process of complex ETO products, the requirements mentioned in the existing literature, other than knowledge sharing (Hicks et al., 2000; Konijnendijk, 1994) and high technical competence (Mello et al., 2015), might become less effective as compared to other types of ETOs. Due to their high degree of engineering complexity, it might be considerably difficult to achieve high technology maturity, standardization, and reduction in the changes in the customer order. Furthermore, the rest of the requirements, which are not shown in green, are independent of knowledge transfer regardless of the type of ETO products. This means that the knowledge transfer approach is not capable of fulfilling these requirements, and other factors are needed to influence them. Some of those factors have already been discussed in the previous sections.

In a company that is selling an ETO product, there can be a significant variation in the technical competencies between the internal staff and among different business functions. Since the delivery of ETO products requires a heavy cross-functional collaboration, it is necessary to establish a common basic set of technical competencies among functions. Hence, such an imbalance can only be resolved through knowledge exchange that promotes continuous learning and training of the internal stakeholders. In the delivery of ETO products, it is essential to acquire complex information from the customers. Failure to get this information can substantially decrease the speed of the delivery process, hence, to do so, the right amount of technical knowledge is required.

To increase the technical knowledge, the existing literature proposes several knowledge-sharing techniques. These techniques are in the form of trainings, job rotation, identification of suitable knowledge givers, sophisticated IT infrastructure and creating awareness among managers regarding the benefits of knowledge transfer (Szulanski, 1996; Riege, 2007; Morris & Snell, 2014; Goh, 2002). However, the knowledge transfer practices usually demand from knowledge receivers and givers, to invest a significant proportion of their total working time. Hence, the top management must also allocate a separate time slot and reward systems for these activities (Riege, 2007; Fey & Furu, 2008). The application of the framework presented in Figure 6 might assist a company in speeding up the delivery process of its ETO product. This framework is more of a theoretical model, therefore, it needs to be modified and verified with the help of the empirical research. The next section aims to analyze the results of the existing literature and possible research gaps in relation to the research objective of this thesis.

2.4 Critical Analysis of Prior Studies and Research Gaps

The literature review has been targeted to respond to the research questions of this thesis using previous studies done in the area of ETO environments and internal knowledge transfer. Section 2.2.1 focuses on framing the typical characteristics of ETO products. Section 2.2.3 shows different requirements and pre-requisites for speeding up the delivery process of ETO products. Whereas Section 2.3.2 mentions various techniques for promoting intra-organizational knowledge transfer in companies. Hence, it is essential to analyze the previous studies to understand their context, methodology, and possible research gaps concerning the research questions of the thesis. Tables 4 and 5 illustrate the analysis of the response of the prior studies to the research questions of the thesis.

Table 4. Analysis of prior studies about the requirements for speeding up the delivery process of ETO products.

Authors	Research Content	Methodology	Key Findings for Current Study	Research Gaps
Hicks et al., 2000	Role of procurement in improving the performance of ETO manufacturing companies	Multiple case study	Knowledge sharing between engineering & production due to their high interdependence	Perspective from service industry, Coordination of other functions besides engineering & production
Konijnendijk, 1994	Discussing the interdependence of marketing & production in ETO companies	Multiple case study	Knowledge sharing between marketing & production to improve delivery speed	Interdependence of other functions besides marketing & production, Perspective from service industry
Mello et al., 2015	Effect of contingent factors on coordination in ship building projects	Multiple case study	Need for high coordination, Increased overlapping of engineering & production, Less changes in customer order are required, High technical competence	Perspective from service industry, Coordination of other functions besides engineering & production
Willner et al., 2016	Determining the appropriate degree of standardization & automation in ETO manufacturing companies	Multiple case study	Reducing customization & increasing automation	Perspective from service industry, Requirements other than standardization & automation

Table 5. Analysis of prior studies about the types of intra organizational knowledge transfer techniques.

Authors	Research Content	Methodology	Key Findings for Current Study	Research Gaps
Fey & Furu, 2008	Exploring the types of organizational policies which lead to knowledge sharing in multinational units	Structured interviews with general managers of multinational corporations	Compensation program can enable intra organizational knowledge transfer	Viewpoint from ETO environments, Quantitative measurement of the impact of knowledge transfer on internal processes
Goh, 2002	Exploration of key factors for improving knowledge transfer process	Literature review	Cross functional collaboration, Integration of IT infrastructure	Case study, Viewpoint from ETO environments, Quantitative measurement of the impact of knowledge transfer on internal processes
Morris & Snell, 2014	Framework for configuring knowledge assets to overcome mismanagement in an organization	Literature review	Workforce mobility	Case study, Viewpoint from ETO environments, Quantitative measurement of the impact of knowledge transfer on internal processes
Riege, 2007	Actions to remove barriers in internal organizational knowledge transfer	Qualitative interviews with senior managers of multinational corporations	Allocation of separate time slot for knowledge sharing, Identification of right people & right knowledge, Educating managers about the benefits of knowledge sharing	Viewpoint from ETO environments, Quantitative measurement of the impact of knowledge transfer on internal processes
Szulanski, 1996	Finding major reasons for the failure of internal knowledge transfer	Surveys from multinational corporations	Training of knowledge recipients,	Viewpoint from ETO environments, Quantitative measurement of the impact of knowledge transfer on internal processes

In response to the first research question of the thesis which is related to the requirements for speeding up the delivery process of ETO products, Table 5 shows that the results of the existing literature came only from the manufacturing sector. In addition, the results also indicated either the need for standardization & automation or the coordination of production with engineering and/or marketing functions in order to speed up the ETO delivery process. Since this thesis focuses on complex ETO offerings, standardization & automation might not be a suitable requirement (Willner et al., 2016). Hence, it is essential to explore requirements other than standardization & automation. Furthermore, when stressing upon the integration of production with other business functions, it is important to note that in the service sector, production is entirely absent. Therefore, there is a definite need to investigate the types of other functions that might overlap to speed up the delivery process when the production aspect is missing altogether from the internal business processes.

Regarding the response to the second research question about the types of intra-organizational knowledge transfer techniques, Table 6 illustrates that knowledge management literature is very generic in its content. This means that the results of the present literature did not originate from a specific industry or product. In all the prior studies, the industry and/or product context was completely missing. Hence, this thesis aims to direct the knowledge management literature towards a specific industry and product group. Furthermore, in almost every study, it is emphasized in theoretical terms, the importance of knowledge transfer approaches in making the business processes more efficient. However, there is hardly any study conducted which measures the actual impact of knowledge transfer practices on internal processes in a quantitative manner. As a result, this thesis tries to focus on this aspect as well and attempts to calculate the real impact of knowledge management on an organization's business performance.

3. RESEARCH METHODOLOGY

3.1 Research Strategy

This research was done by employing a qualitative case study approach. Yin (2009) states that management research reports are more inclined towards qualitative than quantitative methods. In order to understand how a company can utilize knowledge transfer techniques to speed up the delivery process of an ETO offering, the case study method was considered essential. A case study examines an academically interesting issue in its practical context (Saunders et al., 2009). According to Gummesson (1993), case studies are appropriate when attempting to understand a complex or hidden phenomenon. Yin (2009) further mentions that the most widely used approach for conducting business-related research is the case study method.

The research is based on a single case study design. This may cause uniqueness and artificial conditions surrounding the case (Yin, 2009). However, the rationale for selecting a single case study method is that the case company belongs to the telecommunication sector with a unique product. The research questions of this thesis have been rarely examined before in the industry in which the case company operates.

3.2 Case Company

The case company of the thesis is a Finnish technology service provider that operates in the telecommunication sector. The company, headquartered in Finland, was founded in early 2018 with the aim to provide a digital automation cloud (DAC), which is a private wireless network that brings IoT to enterprises globally. DAC enables them with smart manufacturing, predictive maintenance, remote operations, and machine to machine operations. DAC has been designed as a plug and play platform optimized for low latency and ultra-reliability. The company's target is to sell and develop private plug and play mobile networks as a service to enterprises. DAC provides the capability to activate digital automation applications such as high accuracy, drones, and video analytics which are often required in advanced industrial IoT solutions. The deployment is simple, plug, and play. It requires a combination of recommended hardware and a web-based service portal that enables the user to continuously monitor and manage the solution.

Currently, the company has two different distribution strategies in place. The first strategy is based on the idea of direct selling where the company sells through its own legal entity. This sales model is being used only in the USA and Japanese markets. Presently, the USA market is the most promising one, generating more than 50% of the total revenue. Another distribution strategy that the company follows is related to indirect selling where the company sells via a local partner. This strategy is widely used by the company since it simplifies a variety of issues related to taxation, management of master data, and entering new and/or existing geographical markets.

The business model of the company is quite straightforward. DAC comes with a monthly subscription fee, and it is based on a flexible pay as a customer grows subscription-based service. It starts with low initial investment and scales up as the customer's need to grow or scales down as the need diminishes.

By the end of 2018, the company managed to acquire only 20 customers. However, the year 2019 marked significant growth for the company. At the time of writing, the case company signed deals with nearly 100 new customers belonging to various industrial segments. At present, the company has supplied private networks to over 130 different customers. About 30% of these customers are in the energy generation sector, with around 25% in public services and smart cities, 20% in transportation, 10% in manufacturing, and the remaining 15% is a mix of other verticals.

As the number of customers began to increase, the company started experiences problems in its delivery operations. The case company's delivery process is measured end-to-end. This means that it does not take into account only the pre-configured hardware delivery, but it also includes the final deployment of the network at the customer site. By the summer of 2019, the company noticed a considerable increase in the length of time of its DAC delivery. Earlier, the private wireless network used to be up and running at the customer site within two weeks following the customer order. However, after the expansion of the company's customer base, it started taking on average seven weeks to deliver an up and running private network kit to the end customer. However, customer delivery promise is set between two to four weeks.

As a result, in June 2019, the case company decided to investigate the causes behind the slowness of the delivery process. To accomplish this purpose, the company hired the author of the thesis as a trainee in its digital automation unit. The author reported directly to the head of the services of the company. Through this hiring, the company hoped to streamline its delivery operations based on the findings of the trainee.

3.3 Research Process

The research process was unofficially kicked off in the mid of July 2019 when the author was hired as a trainee in the case company. The primary purpose behind this hiring was to streamline the delivery process of the company. In this phase, the author performed a background study, collecting general information about the company and its offering. The product architecture was also studied in detail as part of the background study. Following the first phase, the interview round began which lasted from the beginning of September till the end of October 2019. During the interviews, a preliminary empirical analysis was also carried out to map the case company's delivery process. At the end of the interviews, the objective of the thesis was formulated. After the formulation of the thesis objective, a literature review was conducted from November 2019 to March 2020.

Following the literature review, some weeks were spent on analyzing all the empirical data collected. During this phase, empirical discussions were also conducted with the case company representatives to analyze the feasibility and effectiveness of the proposed framework. The last few weeks from May to June were dedicated to finalizing and completing the thesis. Figure 7 shows the general overview of the research process of the thesis.

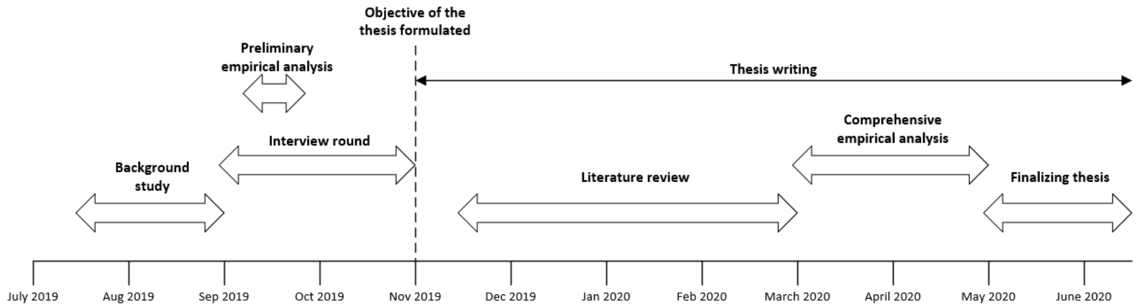

Figure 7. General overview of the research process.

The next section explains the details of the data generation methods employed, and it also illustrates and describes the data gathering process of the thesis.

3.4 Data Collection

One important aspect of doing a case study is selecting the most appropriate data gathering method. According to Gummesson (1993), most common data gathering methods in management research are existing material, questionnaire surveys, interviews, observation, and action science. Data generation methods used in this research are existing material and interviews. First, existing material refers to all kinds of secondary data sources such as books, journals, research reports, computer databases, and photos (Gummesson, 1993). In this thesis, the case company's intranet pages and key performance indicator (KPI) reports were used as a primary source of existing material to collect important information about the company and its product and architecture. The information retrieved from the intranet pages also acted as supporting material in the interview stages.

Second, interviews are one of the most common methods to collect data in the case study research. Interviews are similar to questionnaire surveys, however, they are not standardized and are conducted informally in the form of a conversation (Gummesson, 1993). In this research, informal interviews have been conducted where empirical data was collected through unstructured interviews. The reason for unstructured interviews is that the research questions and literature review of the thesis were formulated as an outcome of the interviews. This means that at the time of interviews, the researcher had no clear objective, and the thesis topic was defined after obtaining the interview results. The detailed information about interviews is illustrated in Table 6.

Table 6. Interviews summary.

	Role	Base Office	Duration
Interviewee 1	Delivery manager	Espoo	50 min
Interviewee 2	Head of services	Tampere	35 min
Interviewee 3	Senior operations specialist	Espoo	45 min
Interviewee 4	Delivery coordinator	Espoo	30 min
Interviewee 5	Senior system specialist	Naperville	60 min
Interviewee 6	Customer project manager	Budapest	30 min
Interviewee 7	Customer project manager	Naperville	40 min
Interviewee 8	Business development manager	Espoo	60 min
Interviewee 9	Business development manager	Sunnyvale	45 min

In total, nine one-to-one interviews were conducted. The content of the interviews focused mainly on the mapping of the delivery process and problems faced in the delivery operations, and possible solutions to fix the issues. The duration of the interviews varied between thirty and sixty minutes with an average of about forty minutes. Almost sixty percent of the interviews were performed using an online meeting platform due to the global spread of the delivery and sales teams. The rest of the interviews were conducted in person. All the interviews were recorded and partly documented in the written form as well. Figure 8 demonstrates the data gathering process and methods of this thesis.

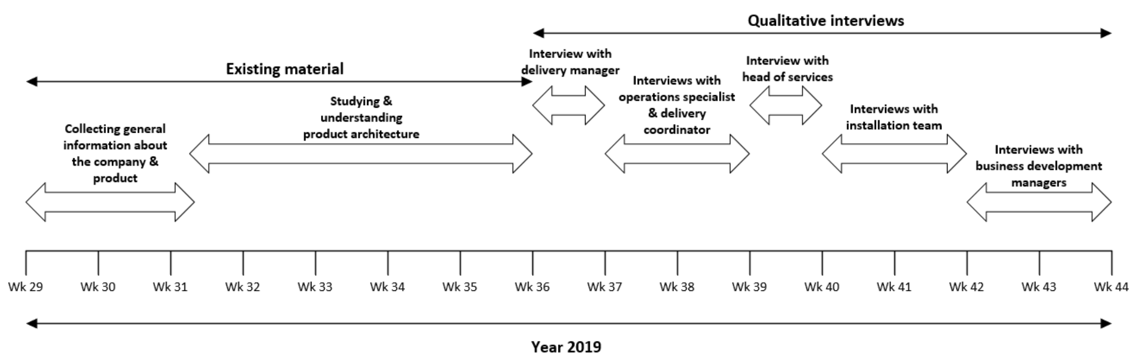

Figure 8. Data gathering process & methods of the thesis.

Since the case company is a start-up, it did not have any defined and documented delivery process. Hence, the first challenge for the author was to map the delivery process at both higher and lower levels. After that, it was possible to look for flaws and root causes for the longer delivery lead times. Mapping was also essential for creating awareness in the delivery team regarding the delivery process so that, each participant can know how his/her work relates to the rest of the delivery process. To fulfill this purpose, an interview with the delivery manager was conducted for drafting the higher-level process and identifying the responsible person/s for carrying out each step within the delivery process. Following the interview with the delivery manager, the researcher went on to interview the senior operations specialist and delivery coordinator. Their interviews assisted the author to document the lower-level steps and the problems they face regularly.

The resultant draft and information were then shared with the head of services to get her inputs and guidelines for going further. On her instructions, the author first arranged an interview with a senior system specialist who is based in the USA, and then two of the customer project managers working in the USA and European markets. All three of them are responsible for managing the final deployments of the private wireless network at the customer site. Interviews with them prove to be very helpful since they pointed out further hiccups in the delivery operations and also proposed possible solutions to eradicate them. Until this point, most of the interviewees blamed the sales and business development team for slowing down the delivery process. Hence, the next obvious choice was to conduct interviews with the business development managers to validate the previous information and to get their point of view on the topic in question.

3.5 Data Analysis

All the recorded interviews were first transcribed by the author himself. Following the transcription, the results were first organized both in the form of flowcharts and a table. The results from the interviews with the delivery manager, delivery coordinator, and senior operations specialist were first converted into process flowcharts using Microsoft Visio in order to map the higher and lower levels of the delivery process. Processes happening inside multiple teams were mapped using swim lanes whereas processes happening inside one business function were graphed using a basic flowchart. After that, results from all the interviews were filtered and relevant information was tabulated. The results were tabulated to categorize the pain points faced by the delivery team, and solutions to mitigate the encountered problems in the delivery process.

After the organization, the results were analyzed to identify which viewpoints should be given more attention and what are the missing aspects. During this stage, academic literature played a supportive role to potentially add a theoretical layer on top of the empirical data. The results were also analyzed to identify the aspects to look at when implementing the proposed solutions. Based on the analysis, a mind map was also constructed to visualize different viewpoints. According to Romlie et al. (2017), the use of mind maps is considered highly relevant when it comes to develop an understanding of a subject matter and to support learning. The mind map provided a good base for giving direction to the thesis and reconfirming its objective.

4. RESULTS

This chapter discusses the relevant results that were acquired through the empirical data gathering process of the thesis. Most of the discussed results are a direct output of the interviews, however, information about the case company's product and delivery KPIs was obtained by reading the KPI reports and documentation available on the company's intranet pages.

4.1 Basic Information about the Company's Product

The aim of the case company's product offering is to provide a private wireless network that brings IoT to enterprises globally. The product architecture consists of three primary hardware components: SRX, Edge Cloud, and Radios. Three of these together make one product kit that is supplied to the end customer. The company's core competency does not lie in the hardware, but it comes with the software which is configured and installed in the edge cloud by the case company's delivery team. All three components – edge cloud, SRX, and radios need to be pre-configured according to customer IP network specifications and radio spectrum before they can be deployed at the customer site. The hardware configurations vary greatly with each customer order since every customer has different network and radio parameters. As a result, the software needs to be tailored according to each customer network requirements. This characteristic makes the case company's offering a typical ETO product because configurations are required to be customized with every order.

As mentioned, the case company's product has three components. First, SRX functions as a router similar to the ones which are installed in today's modern homes for the purpose to supply Wi-Fi. Second, edge cloud acts as the main source of supplying private network. In order for it to do so, it has to be linked to one of the data centers (DCs) of the company that maintains, control, and release the network. Currently, the company uses four datacenters located in the USA, Japan, Denmark, and Finland. Third, radios work as transmitters of the data packets received from the SRX. The number of radios required can vary significantly with each customer case. For larger customer networks and sites, the number of radios needed can vary between five to ten. On the other hand, for smaller networks and sites, even one to three radios are sufficient. For both edge cloud and radios, a connection needs to be established with the SRX router. Figure 9 shows the hardware components and product architecture offered by the case company.

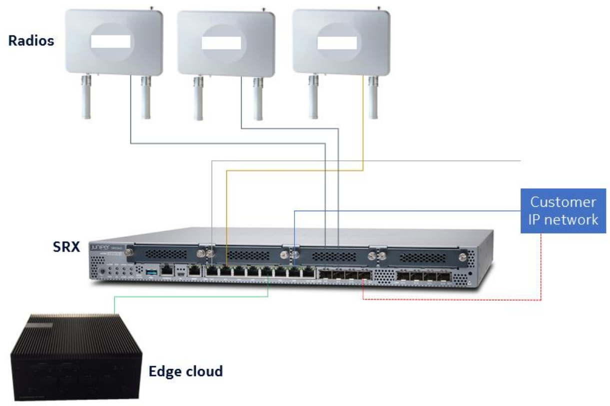

Figure 9. Case company's product and its architecture.

The next section explains the delivery and the configuration processes in more detail.

4.2 Delivery Process of the Case Company

The delivery process of the case company is cross-functional where five different teams are involved: Order management, operations, radio planning, logistics, and installation. The purchasing function is non-existent in the delivery process. The reason is that the customization aspect only exists at the software side whereas the hardware devices remain standard. The delivery manager explains:

"*The purchasing function is almost irrelevant when it comes to the delivery process since the purchasing of hardware components are always done in advance based on the demand forecast.*"

The delivery process is triggered after receiving the customer purchase order. It begins with the registration of customer orders in the enterprise resource planning (ERP) system where a sales order is created by the order management team. Following the creation of sales order, the operations team begins with the configuration of edge cloud and SRX devices. After the SRX and edge cloud is configured, the radio planning team starts configuring the radios. All the configuration files generated for edge, SRX, and radios are also stored in the SharePoint environment for future reference. After all the hardware components are configured, the logistics team takes over the process and carries out the shipment duties where it first packs the hardware and transfers the product to the warehouse facility. Then, the logistics team creates third-party logistics (3PL) requests in the ERP system for notifying the logistics provider that the goods are ready to be shipped. After the goods are picked up by the logistics provider from the warehouse, the logistics team gets the delivery note and tracking information from the logistics provider which is then provided to the installation team and the customer via email. After the hardware reaches the customer, the installation team gets notified through email, and the team starts to perform the final deployment of the hardware at the customer site. After obtaining the customer approval, the delivery is marked 'completed' with the release of the subscription contract to the customer by the order management team. Figure

10 illustrates the delivery process of the company at a higher level and the related information systems used for communication.

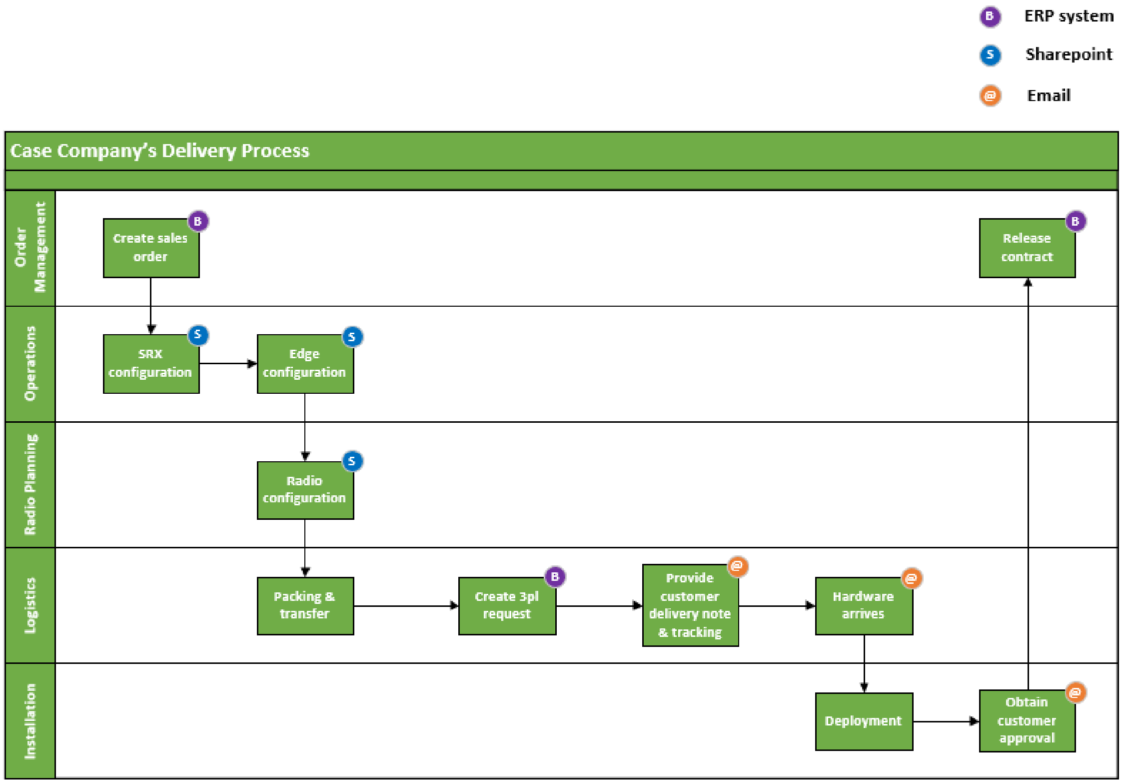

Figure 10. Higher level delivery process of the case company.

Since this thesis deals with the speeding up of the delivery process, it is essential to highlight the delivery KPIs and the current processing times of the relevant steps. Since processes happening inside operations, radio planning, and installation functions are the most business-critical for the case company, it is necessary to mainly focus on these. The operations team comprises of four engineers whereas the radio planning team consists of two persons. Logistics is managed by the delivery manager and delivery coordinator. The installation team has a global presence where in each country, the size of the team varies between two to four persons. Figure 11 shows the related KPIs and processing times associated with the delivery process.

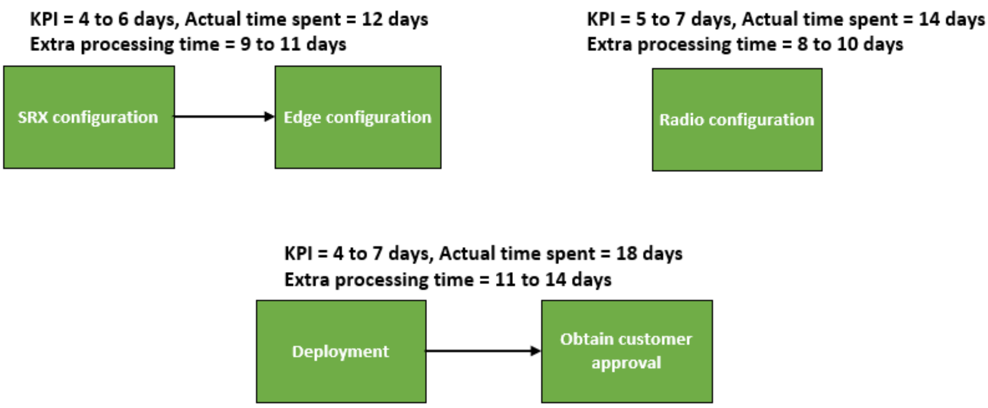

Figure 11. KPIs and processing times of the case company's delivery process.

The KPI limit for the SRX and edge configuration is four to six working days. In the case of the radio configurations, it is up to seven working days. Deployment should be completed within one week after receiving the hardware at the customer site. The KPI target for the entire delivery process is set between two to four weeks, taking into account also the logistics and shipment processes that usually take less than a week. However, currently, it takes approximately seven weeks on average to complete the entire delivery process. As shown in Figure 11, hardware configurations and deployment stages are significantly above the KPI limit and as a result, these steps are the primary contributors to the slowness of the delivery process.

The lower levels of the delivery process mostly happen inside the SRX, edge, and radio configurations since these steps are the primary constituents of the DAC delivery process. To configure SRX and edge, the operations team has to first select the right DC. For the DC selection process, precise coordinates regarding customer location are required. The senior system specialist describes:

"*Currently, there are four different DCs in use – DC 1, DC 3, DC 4, and DC 5. DC 3 and 4 are utilized in the case of North and South America. However, DC 3 has become old, hence, DC 4 is used in most of the cases. DC 1 is reserved for the rest of the world. Also, for simplified cases, DC 1 is being employed although DC 5 is meant to be used for such scenarios.*"

After a DC is selected, the customer account will be created. The senior system specialist explains: *"Before we can begin the actual configuration, the admin and delegate accounts from the customer organization need to be linked to the network for the purpose of adding the respective hardware inventory to these accounts."*

After the customer account has been created, hardware inventory for that account is added to the respective DC. Following the creation of hardware inventory, all the hardware is fused into one group, belonging to the corresponding network.

After the creation of hardware inventory, the operations team finds the created network and connects it to DAC by creating a network profile. Later, the network is activated, and the installation serial number becomes visible to the customer in the customer portal. After the network activation, the actual network configuration begins which is done with a USB stick. Here, first, the SRX router is uploaded and configured, and then, the edge configuration takes place. In order to configure SRX and edge, all the possible information related to customer IP parameters is needed to generate the right configuration files. The operations team member states: *"It is important to note here that the configuration process is not fixed, and hence, it is usually altered flexibly depending upon the case."* Figure 12 shows the SRX and edge configuration processes inside the higher-level delivery process of the case company.

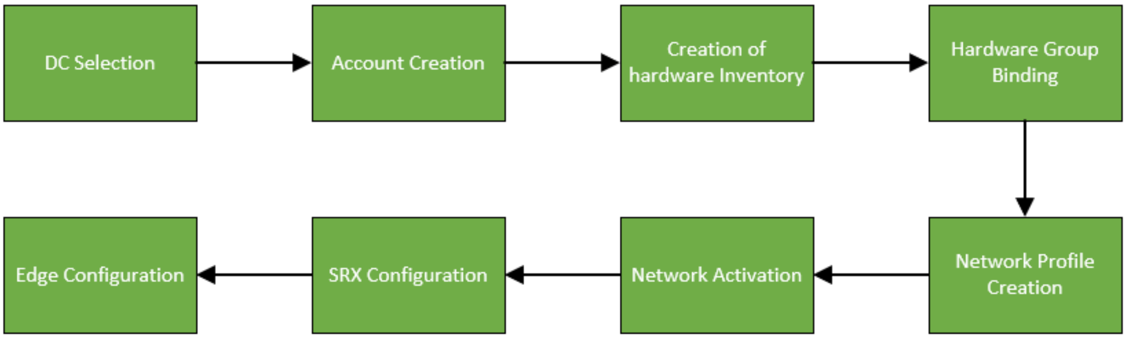

Figure 12. SRX and edge configuration process.

After the configuration process of SRX and edge is finished, the radio configuration process starts. The process begins by picking up the radios from the stock using the hardware id. After that, the radio planning team checks the template containing the configuration files. When the template is ready, the team starts to configure the radios. The team uploads the configuration files from a centralized server such as SharePoint, and then, it changes the radio parameters and downloads the files back to the server to the respective customer radio. The delivery coordinator says:

"In situations when radios cannot be configured due to some problems, the issue is escalated to the solution R&D team."

After finishing the radio configuration, the team tests the software banks of the configured radios by using the speed test site for downlink and uplink testing. Figure 13 exhibits the radio configuration process of the company.

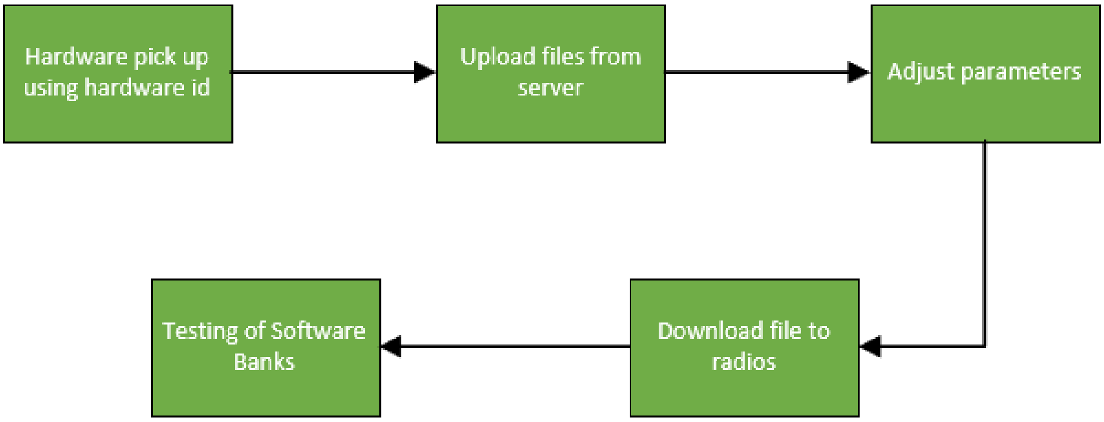

Figure 13. Radio configuration process.

The configuration processes make the overall delivery process significantly complicated due to the involvement of a great deal of technical information. The next section attempts to highlight the requirements of the case company's product in order to speed up its delivery process based on the responses received by the delivery team.

4.3 Requirements for Speeding Up the Delivery Process

The delivery process of the case company has been drastically slowed down due to complicated configuration processes. To perform fast and correct hardware configurations, the delivery team needs to have access to the right information related to the customer's network and radio parameters. These parameters are used for DC selection, account creation, and generation of configuration files which are downloaded to edge cloud and radios. Majority of the interviewees believed that high technical competence is required in order to collect customer-specific parameters for configuring the hardware. As a result, information related to these parameters is obtained by the engineering functions that consist of operations, radio planning, installation, and technical site survey. According to the operations team lead: *"We get the parameters by contacting the customers directly."*

However, according to most of the interviewees, information related to the customer specific parameters must be given to the delivery team by sales and business development since it is the only function that is in direct contact with the customers upfront. The head of service explains: *"The information related to network and radio parameters must come from sales guys because they are the only ones who are in direct contact with the end customers. It is not the responsibility of the delivery team to get the parameters from the customers."* In addition, a customer project manager says: "*Since most of our resources are tied up in business development, we must use them to their full potential."*

Due to the failure of sales in gathering the needed technical information from the customers, it has caused a great deal of problems in the pre-configurations and deployment stages, resulting in unnecessary delays. This viewpoint was common in many interviews. The operations team lead expresses: *"It may seem very simple to obtain network information directly from the customers, but it raises lots of problems in the pre-configurations and deployment stages. Most often, even customers do not have any idea about their IP parameters. I do not blame them because such information is highly technical and usually customers do not have the right expertise to provide this information to us. When we fail to obtain the customer-specific parameters, we configure the hardware using default configuration files. In cases where we manage to get this information, it turns out to be incorrect. This eventually causes lots of problems for the installation guys because they have to make quite many on-site adjustments to the configurations before the network is up and running. Another big issue is that it takes almost days to receive a reply from the customers. This also slows down the configuration process."*

The customer project manager in the USA who manages the on-site deployments endorsed the comments from the operations team lead by expressing: *"Almost in every customer case, we need to configure edge and radios by rectifying the information related to parameters in the templates. I understand the pain of operations and radio planning teams in getting the parameters related information upfront because it is very difficult to obtain 100% correct information remotely."* Hence, to avoid faulty configurations, coordination between sales and delivery teams is necessary.

The responsibility of the sales team in acquiring the customer-specific network parameters is already defined, however, it is not implemented at all. After receiving the customer purchase order, the sales team is supposed to fill in the customer order form before sending the order to the delivery team. The order form contains all the necessary fields related to the customers' parameters which are required to be filled by the business development team. The filled order form should be sent to the delivery team at the time when moving the customer order to the delivery pipeline. The order form is meant to provide the operations and radio planning teams with the information required for performing customer-specific hardware configurations. Figure 14 shows a portion of the customer order form.

Radio information
Native band class
Duplexing
Frequency No. (EARFCN)
Frequency Midpoint (MHz)
Bandwidth (MHz)
Effective radiated power max. (EIRPD)
Power unit
S1 backhaul
Internet/Connection to DC
L1 Transport type
L2
Security GW address
Default GW address
DNS
NTP
Customer network/Intranet
L1 Transport type
L2
Security GW Address
GW address
UE IP Pool
UE DNS

Figure 14. Portion of the customer order form.

The above figure illustrates part of the network parameters that are needed by the delivery team for doing pre-configurations. At present, the order form is not fed to the delivery process. Automating the delivery process for pushing the sales team to fill in the order form is another requirement mentioned by one interviewee only. Automation did not appear to be a popular solution. The head of services says: *“We must implement a business process management tool which executes the business processes in a manner that no step is left undone. The tool will ensure the information flow, and it will also monitor that all the required steps are completed. The tool should work in a way that the delivery process will not start unless previous steps are done. Such automation is the key to achieving smaller delivery lead times.”*

One of the primary reasons for the unpopularity of automation was that almost every interviewee blamed lack of technical competency at the sales end to be the only culprit behind the unavailability of the order form to the delivery team. This means that it is not an easy task to obtain the network parameters from the sales team even if it is enforced on it by the business process tool. The reason is that getting this information requires a thorough technical site survey during the customer acquisition process. One of the customer project managers explains:

“We need to have the right discussions with the customers upfront during a technical site survey in order to get the correct information regarding various network parameters. However, our sales team is not competent enough to carry out such technical discussions with the customers. Rather than having pre-sales engineers, we only have business developers. There is an absolute need for transferring technical knowledge from engineering to our sales guys.”

Another manager says: *“Yes, it is true that we need to automate our processes, but automation will only work if we have the right competency for obtaining the network information during the customer acquisition stages. If we won’t have the technical competency, no matter how automated our processes are, the order form will always be empty. We should increase the competency level at the sales side.”*

One of the business development managers also accepted the weakness of the sales team. He says: *“A wide variety of expertise is missing in our team. We do not understand the technical aspects of the product. Our first priority is to acquire customers and sign deals with them.”* Hence, there is a serious lack of competency in the sales and business development team. Therefore, automation alone cannot speed up the delivery process of the case company. The first step is to transfer the technical knowledge from engineering functions to the sales team.

Another important requirement that was commonly mentioned during the interviews for speeding up the case company’s delivery process was related to the expansion of resources in the engineering functions. The delivery lead times became significantly longer during 2019 after the case company acquired 100 new customers in the first quarter. This was a drastic increase, and hence, a great deal of pressure was exerted on the engineering functions. In 2018, the resources available in the engineering teams were all working rather effectively due to a small number of customers.

Senior operations specialist explains: *“During 2018, for most of the customers, we received all the required parameters from the salespeople which were given to them by our technical site survey team. Since the customers were so less, the team was able to conduct site surveys for most of the projects. However, in 2019, the number of projects increased rapidly, and it was not possible anymore for the site survey team to visit every customer site and prepare the technical documentation. This has added lots of extra work to the delivery team.”*

Moreover, the operations team lead mentions: “*I believe that we have resource issues in the operations team. We have a team of only four persons, and it is impossible for us to* *first obtain the parameters from so many customers and then also perform the actual configuration work."*

Since the role of technical site survey team is crucial in obtaining the network parameters upfront, a customer project manager states: *"Unfortunately, our technical site survey team is very small, and it is usually occupied and therefore, it is available in very few projects."* Another manager says: "*We should do some resource balancing, giving more resources to our engineering functions."*

The expansion of the customer base has equally increased the workload on the installation team. Due to incorrect pre-configurations, the delivered hardware kit usually has to sit at the customer site for weeks, waiting to be deployed by the case company's own installation team. The team is mostly occupied, and the customers have to wait for their turn. A member of the installation team made the following comment:

"We promise our customers a plug and play type of deployment. For comparatively smaller networks, we have certified subcontractors who can perform the deployments. For very small networks, even customers can do the installations themselves with the help of written networking guidelines. However, due to faulty configurations, plug and play is not possible, and as a result, subcontractors and customers can no longer deploy the network on their own. They always need support from us because they do not have the capability to make adjustments to the configuration files. Unfortunately, this is the story of every customer case we have today. Due to this mess, our team is always busy, and sadly, our customers have to wait for weeks, before we arrive there and do the rectifications."

However, the case company can neither afford to shrink its business development function through resource balancing nor it has the resources to expand its engineering teams. Hence, increasing the technical competency of the sales team through knowledge transfer seemed the only viable solution to speed up the delivery process of the company. A manager explains: *"As a young start-up, we cannot hire more people in other teams. We want to get more sales, hence, we should continue to invest in our sales team."*

Based on the results of the interviews, Table 7 shows the requirements for speeding up the delivery process of the case company's product and the related frequency with which they appeared during the interviews.

Table 7. Requirements for speeding up the case company's delivery process.

Requirements	Frequency
Knowledge transfer from engineering to sales	3
Coordination of sales and delivery	3
Increase automation	1
Increase resources in engineering	4
High technical competence	6

Since enhancing the technical competencies of sales through knowledge transfer seemed to be the most effective solution to speed up the delivery process, the next section presents various techniques which can enhance the technical knowledge of the case company's business development team.

4.4 Factors Enabling Knowledge Transfer in the Case Company

Several knowledge transfer techniques were proposed by the business development managers and the delivery team of the case company in order to enhance the technical competency of the sales team for filling in the customer order form. The results of the interviews regarding the identification of knowledge transfer techniques are mostly based on a singular voice which means that almost every technique was mentioned only once during the interviews. However, all interviewees agreed that enhancing technical knowledge of sales is one of the most essential knowledge transfer techniques for speeding up the case company's delivery process.

Based on an interview, one of the effective ways to ensure knowledge transfer to sales is the changes in the support structure of the company. Presently, there is a strict hierarchy where every team is working in its silo and as a result, knowledge is confined into functional boundaries. A business development manager expresses:

"Our sales team does not have the right mix of expertise. The order form contains a variety of sections, and to fill those require a good amount of engineering knowledge. We need guys from R&D and engineering teams to work with our salespersons. It might be a good strategy to change the team composition where every sales team contains one or two persons with a solid engineering background."

The absence of a sophisticated IT infrastructure is also hindering the process of cross-functional collaboration in the company. The only mode of communication is through email. A suggestion for improving the IT systems was seen in two of the interviews. Senior system specialist says: *"We have only one email box, and we receive thousands of emails on a daily basis. Furthermore, the email group is significantly large which comprises members from all the engineering teams. Hence, no one from the email group has the slightest idea that who is supposed to take the ownership of the help request from the business development team. Also, due to large email traffic, most often, the requests from our sales guys get lost in the traffic because it is very hard to keep track of each and every email within one email group."*

Also, a sales manager explains: *"It is extremely difficult to communicate and seek help through emails. We always try to send emails to our engineering email group asking for assistance in the filling of the customer order form. However, we rarely receive any replies from them, therefore, we do not bother to fill in the details anymore. We need a* *ticketing system where we are able to raise trouble tickets, and they automatically go to the right person/s."*

Apart from changes in support structures and implementing technology, training of the sales team is another essential technique to enable knowledge transfer that emerged in almost half of the interviews. A customer project manager suggests: *"From time to time, we should send people from the sales function with the technical site survey team so that, they can learn by observing the site survey team about the nature of discussions they should do during the customer acquisition process. Our salespersons will only be able to increase their knowledge about the product through learning by doing approach."*

Training of the sales team requires both the transfer of tacit and explicit knowledge. The above comment deals with the transfer of tacit knowledge, however, the case company's business development team also needs access to written documentation that can serve as a guide for the team to conduct the right discussions with the customers. A business development manager says:

"We lack a proper database which contains knowledge management articles made by the technical site survey team. It should go so that whenever the technical site survey team is done with a certain customer case, it should document the site survey process in the form of a report and store it in the SharePoint environment. Such an archive can greatly assist the sales team to be able to perform the site surveys on its own."

According to two of the responses received, the explicit knowledge of the sales team can also be increased with the help of certifications. The company can arrange a crash course for the salespersons which focuses on the technical aspects of the company's product.

Furthermore, only one interviewee stated that the pressure of fulfilling weekly KPIs set by the top management can restrict the process of knowledge transfer to sales. Increasing the technical competence of the sales team will require investing a substantial amount of time. The immense pressure of meeting sales KPIs will certainly not allow the salespersons to be able to concentrate on increasing their technical knowledge about the case company's offering. Hence, the company needs to free up time for them to engage in knowledge management activities. A business development manager explains:

"We do not have the luxury to spare time for the knowledge transfer process. We are facing so much pressure from weekly KPIs that either we can meet the KPIs or increase the knowledge of our sales guys. Visiting customers with the technical site survey team and reading the knowledge management articles demand a lot of time, and we cannot do so without the support of the senior leadership."

Besides increasing the technical competencies of the present sales team, the case company will also need to make alterations in its human resource (HR) policy. This technique is also based on a singular response. The hiring criteria in the sales function should be changed. Currently, HR hires those people in sales who have a formal education and experience in international business. The hiring at the sales side should be synchronized with the requirements of the case company's product. Delivering a private wireless network kit requires high technical competence, and therefore, this must be set as one of the top criteria in the selection process. A customer project manager expresses:

"Most of the guys in the sales team are purely from the business background. The hiring process does not distinguish whether the applicants possess any engineering knowledge. The product we sell is very complex, and this point should be taken into account in the hiring phase. Ideally, in our sales team, we need telecommunication or computer engineers who also have experience of selling. Unfortunately, we have salespersons instead of sales engineers. This message has to be communicated to the HR"

Table 8 illustrates the internal knowledge transfer techniques and the related frequency with which they appeared during the interviews.

Table 8. Internal knowledge transfer techniques of the case company.

Internal Knowledge Transfer Techniques	Frequency
Enhancing technical knowledge of sales	5
Changes in sales team composition	1
Written documentation for sales	1
Job rotation assignments for salespeople	1
Arranging technical certifications for sales	2
Improving IT infrastructure	2
Reducing KPIs pressure from knowledge receivers	1
Alignment of the hiring process with product requirements	1

The next chapter aims to discuss the similarities and differences in the results of the thesis and prior studies. The answers to the main research questions of the thesis are explained in this chapter. The chapter also responds to the objective of the thesis.

5. DISCUSSION

5.1 Response to Research Questions

The objective of the thesis is broken down into the following research questions:

1. *What are the different requirements of ETO products for speeding up their delivery process?*
2. *What kind of knowledge transfer techniques can be utilized for speeding up the delivery process of ETO products?*

5.1.1 What are the Different Requirements of Engineer to Order Products for Speeding Up the Delivery Process?

The main requirements of ETO products that have been identified in prior researches and the case study are listed in Table 9 by the decreasing order of importance. The outcome of the case study shows considerably different results than the literature review.

Table 9. Comparison of requirements of ETO products in prior studies and case study.

Prior Studies	Case Study
High technical competence	High technical competence
Knowledge sharing between engineering & production	Resourcing in engineering
Knowledge sharing between marketing & production	Knowledge transfer from engineering to sales
Standardization & automation	Coordination between sales & delivery
Low frequency of changes in customer order	Automation
Projects of smaller size	
High maturity of design/technology	

High technical competence is the most important requirement in both case study and existing literature. Lack of technical competence is a major cause of slowing down the delivery process of ETO products (Mello et al., 2015). Hence, it results in the loss of competitive advantage of the companies selling ETO products (Caron & Fiore, 1995; Gosling et al., 2014). The results of the case company show that its product architecture is highly complex, and it requires a great amount of technical data that needs to be fed to the engineering processes. Hence, to gather this data, a good level of technical understanding regarding the case company’s product is necessary.

The case company also considers the increase in resources to engineering as another essential requirement for speeding up the delivery process. As discussed in the previous chapters, timely access to complex information can cause a decrease in the processing times of ETO products. Such complex information is mostly generated by engineering functions. Therefore, the company believes that hiring more engineers will ensure timely availability of technical data, and it will consequently shorten the delivery lead time. However, the company also believes that its current business situation does not permit it to invest in the engineering side. Hence, the company considers knowledge transfer from engineering to sales as a more viable solution to solve the problem concerning the availability of critical product information.

According to the analysis of the literature and case study, the need for high technical competence is the primary trigger for the implementation of the knowledge transfer approach. As a result, knowledge transfer and functional coordination are the next most important requirements mentioned in the case study and prior researches, however, their dynamics are substantially different in both. The results of the case study emphasize the knowledge transfer from engineering to sales. Whereas, the literature talks about knowledge transfer either between engineering and production or marketing and production. According to Hicks et al. (2000), two business functions require absolute knowledge sharing practices: engineering and production. On the other hand, Konijnendijk (1994) states that marketing and production are particularly interdependent, and therefore, they should be overlapped to improve delivery speed in ETO companies. However, the results of the case study emphasize the importance of sales in reducing the delivery lead time.

These functional differences in the existing literature and the case study are logical since the production function is entirely absent from the case company, and it is replaced by the delivery. Therefore, according to the case study, knowledge exchange must also happen between sales and delivery. In the context of the case company, this means that critical technical information, which is required for processing a customer delivery, must be handed over to the delivery team by the sales function.

Standardization and automation emerged as light requirements in both the literature and case study for speeding up the delivery process of ETO products. It is highly challenging to perform standardization and automation of ETO products (Willner et al., 2016). Furthermore, the possibility of implementation of these two requirements diminishes even more in the case of complex ETO products (Willner et al., 2016). Despite these claims from the literature, the case company is optimistic about automating its delivery process with the help of a business process management tool. However, an increase in technical competencies and employment of knowledge transfer is a pre-requisite for automation. Nevertheless, unlike automation, standardization is entirely out of question due to a high degree of engineering complexity of the case company’s product.

The literature also mentioned the frequency of changes in the customer order, and maturity of technology as further requirements for speeding up the ETO delivery process (Mello et al., 2015). However, these requirements are mostly useful in the case of basic and repeatable ETOs since these two types possess a low degree of engineering complexity (Willner et al., 2016). As a result, customization aspects are most often small and technology maturity is usually high. Whereas, in the case company, these two requirements do not exist since its offering falls under the category of complex ETOs.

Willner et al. (2016) also highlight the impact of project size on the delivery speed of ETO products where the processing time of small size projects is considerably shorter than the large projects. Even though the case company has a healthy proportion of small and medium projects, it cannot benefit much from it due to competency issues at the sales end. This also shows that project size alone cannot influence the speed of the delivery process, and it always needs assistance from other critical factors such as knowledge transfer and the development of technical competencies.

5.1.2 What Kind of Knowledge Transfer Techniques can be Utilized for Speeding Up the Delivery Process of Engineer to Order Products?

In order to expand the technical competencies of the influencers of the ETO delivery process, a cross-functional knowledge transfer approach is essential. This can only be accomplished with the help of knowledge transfer techniques. The suggested techniques from the literature and the case study are presented in Table 10.

Table 10. Comparison of knowledge transfer techniques in prior studies and case study.

Prior Studies	Case Study
Training of knowledge recipients	Enhancing technical knowledge of sales
Allocation of separate time slot for knowledge sharing	Changes in sales team composition
Identification of right people and right knowledge	Written documentation for sales
Enhancement and integration of IT infrastructure	Arranging technical certifications for sales
Educating managers about the benefits of knowledge transfer	Reducing KPIs pressure from knowledge receivers
Workforce mobility	Job rotation assignments for salespeople
Providing incentives for knowledge sharing	Improving IT infrastructure
	Alignment of the hiring process with product requirements

Enhancing technical knowledge of the sales team is the most essential knowledge transfer technique for the case company. However, knowledge management literature did not point out any specific business functions as knowledge receivers, which can speed up the ETO delivery process through knowledge transfer. This result shows that in ETO companies, the knowledge required to satisfy customers becomes effective if front-line employees have access to it.

Few interesting knowledge transfer techniques which emerged in the case study but have not been stated so clearly in the prior studies are strategies for transferring of tacit and explicit knowledge for the training of knowledge receivers. Although the results of the literature review mentioned about the training of knowledge recipients (Szulanski, 1996; Riege, 2007; Morris & Snell, 2014), it did not answer the question of how to carry out such trainings, especially when delivering ETO products. According to the case study results, strategy for the transfer of tacit knowledge when attempting to reduce the delivery lead time of ETO products is to apply changes to the sales team composition by creating a mix of business developers and engineers. This will assist in the gradual transfer of technical knowledge to the sales function. Similarly, strategies for the transfer of explicit knowledge for speeding up the ETO delivery process are based on the creation of written documentation by the engineering teams, and also certifications for the sales team that can serve as a guide for the enhancement of its technical knowledge.

The other identified knowledge transfer technique from the case study is the reduction of KPIs pressure from knowledge receivers. The literature also confirms this technique by stating that time pressures resulting from knowledge transfer activities should be acknowledged, and hence, it is important to allocate a separate time slot for knowledge sharing (Riege, 2007). During the case study, it was found out that currently there is a great deal of pressure on the sales team for meeting the weekly KPIs, and the team does not have time to engage in knowledge management. Therefore, easing up the KPIs will allow the sales team to invest some time in increasing its knowledge.

Another knowledge transfer technique originated from the empirical research is the occasional job rotation of salespeople. According to Morris & Snell (2014), to promote knowledge recipients' training, companies should execute workforce mobility and rotational assignments. Empirical results show that if salespeople will accompany the technical site survey engineers at the time of defining the product specifications, it will provide them with a holistic view of the type of discussions that should be done with the customers for the acquisition of complex technical data.

Improvement of IT infrastructure also seems to be an important knowledge transfer technique in the case company. The role of IT systems in the knowledge transfer process is emphasized strongly in prior studies (Goh, 2002; Szulanski, 1996; Riege, 2007). Through sophisticated IT systems, it will be easier for knowledge seekers to locate the right knowledge givers for assisting the compilation of complex product information.

Case study results also suggest one more knowledge transfer technique concerned with the alignment of the hiring process in accordance with the product requirements. This technique is completely missing from the present literature. One reason for this gap might be that prior researches in knowledge transfer lack the perspective from ETO environments. Nevertheless, the results of the case study state that in order to strengthen the technical expertise of the sales function and to facilitate the exchange of specialized knowledge within the sales team, the hiring of sales engineers should be promoted rather than the hiring of people belonging purely to business backgrounds.

One of the suggested knowledge transfer techniques mentioned in the prior studies is about educating managers about the benefits of knowledge transfer (Riege, 2007). This strategy can help to convince the top management to allocate some percentage of the total working time to knowledge transfer practices.

Providing incentives for knowledge sharing is another technique originated from the literature. Fey & Furu (2008) proposed to provide monetary compensation to employees for conducting knowledge sharing activities. Such reward systems can prove to be useful in cases where employees have to perform knowledge management tasks out of their working schedule.

5.2 Response to Research Objective

The objective of the thesis which was stated in Section 1.2 is:

> *To speed up the delivery process of ETO products by utilizing knowledge transfer approach*

There can be different requirements and knowledge transfer techniques for speeding up the delivery process of ETO products. This thesis provides several ideas and recommendations for ETO companies. The findings of the thesis including the results of the literature review and case study are presented in Figure 15. The requirements that are not shown in the green color are the ones that cannot be fulfilled with the help of the knowledge transfer approach.

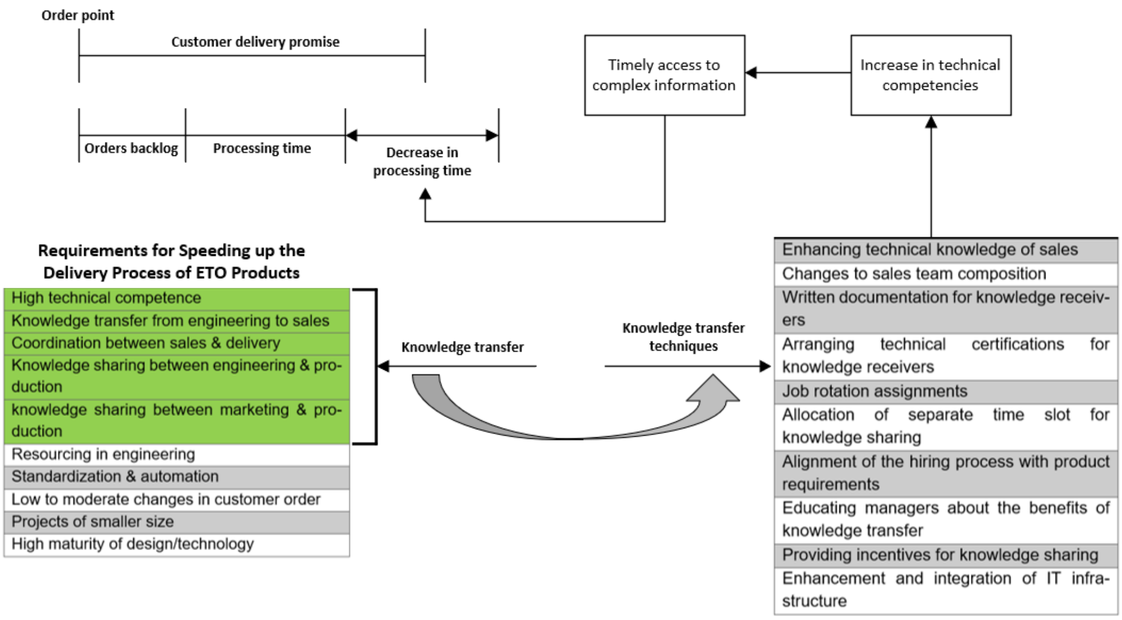

Figure 15. Revised framework for speeding up the delivery process of ETO products through knowledge transfer.

The framework is meant to serve as a guidance to ETO companies for the identification of the right requirements and appropriate knowledge transfer strategies in order to achieve a reduction in the delivery lead time with the help of a decrease in the processing time. The delivery process of ETO products is most often slowed down by large processing times since their processing is highly engineering intensive. Hence, the framework puts focus on increasing the technical knowledge and competencies of the business functions which can directly or indirectly impact the ETO delivery process. According to the framework, these business functions are sales, marketing, engineering, production, and delivery. Their impact can vary significantly between the types of industry and ETO products. For example, in the case company, the role of sales was the most prominent in slowing down the delivery process whereas marketing and production were completely absent.

Thus, the employment of the proposed knowledge transfer techniques is expected to expand the technical competencies of the relevant business functions which will ensure timely availability of complex information required for the processing of a customer order. When discussing the relevant business functions, the importance of sales seems to be highly critical for the success of ETO project delivery. Although there exists no such evidence in prior studies, the empirical findings of this thesis back this claim strongly both in terms of requirements and knowledge transfer techniques. The relevance of sales in the delivery process of ETO products is quite understandable since sales personnel are the front-line employees of any ETO company, and they are the ones who are in direct contact with the customers. Hence, they have the easiest access to understanding customer expectations. If salespeople have the right knowledge and expertise about the product, the collection of information regarding product specifications will most likely be accurate and on time. Therefore, the proposed framework also contains the knowledge transfer techniques for enhancing the competencies of the sales function when attempting to speed up the ETO delivery process.

However, to evaluate the utility and practicality of the framework, it needs to be tested. Although the framework for speeding up the delivery process of ETO products through knowledge transfer seems to have support both from empirical insights and insights from the theoretical literature, the feasibility of its implementation should be considered. Based on the empirical discussions with the case company, the most difficult knowledge transfer technique to implement is job rotation assignments for sales personnel in which they are supposed to accompany the technical site survey team to gain the knowledge required for acquiring customer specifications. The case company does not have sufficient financial resources to be used as travelling expenses. The technical site survey team has to travel internationally due to the global spread of the customer base, and being a startup, the case company cannot afford to bear the international travelling expenses of extra personnel. Even though the sales team also has a global presence, the majority of the enterprises buy small size networks that are not part of the site survey team's portfolio. Hence, most of the sales teams will not have a chance to visit the customer site, present in their own local sales territory, with the site survey team.

Another knowledge transfer technique which seems to be difficult to apply in the case company is the alignment of the hiring process in accordance with the product requirements. According to the empirical discussions, when the case company hires a person in sales, priority is given to those candidates who possess strong communication and negotiation skills and have a good understanding of B2B selling. The company's top priority is customer acquisition which can only be made possible with the help of appropriate soft skills. If the company starts to give priority to persons with a solid engineering background, there is a significant risk of losing the soft skills from the sales team. The general viewpoint in the case company is that soft skills are difficult to acquire as compared to hard skills. It is considerably easier to train the business developers about the basic technicalities of the product rather than teaching communication skills to engineers.

Changes to the sales team composition emerged as another unpopular knowledge transfer technique for the case company. The aim of this approach is to create a mix of business developers and engineers in the sales function by transferring some of the existing engineering resources to sales. The company strongly considers this technique as highly unfeasible since its engineering functions already lack resources and such a shift will put further pressure on engineering tasks.

On the other hand, the most popular knowledge transfer techniques mentioned during the empirical discussions are related to the preparation of written technical documentation and certifications for the sales team. The case company is committed to allocating a separate timeslot to engineering teams for the preparation of knowledge management articles for the salespeople. However, it might be a suitable recommendation for the company to exercise this technique with the help of a reward system to encourage the completion of tasks, as mentioned in the literature. The reward system can be based on the number of knowledge management tasks completed by a sales team member. The tasks can comprise reading technical documentation, participating in virtual or face-to-face meetings with the engineering teams, and completing certifications.

According to the expert opinion in the case company, certifications and knowledge management articles can provide the sales team with enough technical expertise that they will be able to acquire between 40% and 60% of the product specifications during the customer acquisition stages. This will significantly reduce the workload from engineering and give access to almost half of the complex information it needs to process an order. As a result, it might decrease the delivery lead time from 7 weeks to 5 weeks although it will still not be able to meet the customer delivery promise which is between 2 to 4 weeks. Nevertheless, with the application of just a few knowledge transfer techniques from the proposed framework, the case company might be able to cut 2 weeks of processing time from its delivery process. However, it would have been interesting to see the effect on the processing time for an ETO company that also implements the rest of the knowledge transfer techniques besides written documentation and certifications.

6. CONCLUSIONS

6.1 Academic Contribution

The first and foremost theoretical contribution is the theoretical framework for speeding up the delivery process of ETO products that has been proposed by combining whatever existing and relevant literature was available on the topic. The study adds to this by providing empirical support for the fruitfulness of the framework. The thesis found strong empirical evidence to speed up the delivery process of ETO products through knowledge transfer.

This thesis gives a broader view of how ETO companies can speed up their delivery process with the help of a knowledge transfer approach. This research area has not been researched commonly. The thesis tries to examine different aspects of the subject matter through a case study. Most of the prior studies about the requirements of ETO products for speeding up their delivery process have been done only in the manufacturing sector (e.g., Konijnendijk, 1994; Mello et al., 2015; Willner et al., 2016; Hicks et al., 2000). This study adds an additional layer by investigating the requirements of ETO products in the service industry. Furthermore, when attempting to speed up the delivery process of ETO products, most of the prior studies do not distinguish between the type of ETOs when highlighting the requirements. However, this study also presents the viewpoint of complex ETO products.

This thesis also studies the impact of knowledge transfer on speeding up the delivery process of ETO products. To the best of the author's knowledge, there is little to no academic research which establishes a linkage between knowledge transfer techniques and delivery speed of ETO products. Also, apart from creating this linkage, the thesis attempts to measure the impact of knowledge transfer in quantitative terms on the reduction of delivery lead time. Whereas in prior studies, it is emphasized only in theoretical terms, the importance of knowledge transfer approaches in making the business processes more efficient (e.g., Riege, 2007; Morris & Snell, 2014; Goh, 2002). Moreover, the knowledge transfer techniques presented in the existing literature are highly generic in their content. This means that those techniques did not represent any specific industry or product (e.g., Szulanski, 1996; Fey & Furu, 2008). However, this thesis presents several knowledge transfer techniques that originated from a case study done for a service company that sells a complex ETO product.

6.2 Practical Implications

The study has direct managerial implications for ETO companies involved in B2B cooperation, who are dealing with the slowness of the delivery process. The competitive advantage of an ETO firm can be defined by its response time to varying customer needs.

However, providing customized products to customers with the ability to meet the delivery promises can be highly challenging. The challenge usually comes from the unavailability of the correct information regarding customer specifications that might result in longer processing times.

In the B2B context, customer-specific information can be significantly complex, and obtaining such information requires high technical competencies. Furthermore, those ETO companies that are part of a COS, their ETO products are even more complex. Thus, the framework of this thesis recommends enhancing the technical knowledge of the employees who are responsible for the generation of product information to ensure its timely availability. For example, in the case company, sales and business development function are responsible for providing the product specifications to the delivery team. Hence, this thesis proposes to employ several knowledge transfer techniques for expanding the technical competencies of the sales team for it to be able to produce customer-specific information at the right time. Failure to do so will shift the same workload to the delivery team that will cause an increase in the processing time of a customer order.

This thesis also demonstrates to ETO companies the relevance of the sales department in decreasing the processing time of the delivery operations of ETO products. The reason is that sales personnel are the front-line employees of any ETO company, and they are the ones who are in direct contact with the customers. Hence, they have the easiest access to understanding customer expectations. If salespeople have the right knowledge and expertise about the product, the collection of information regarding product specifications will most likely be accurate and on time.

For ETO firms, the study shows the importance of cross-functional knowledge-sharing to speed up the delivery of their ETO products. However, the type of business functions involved in the knowledge-sharing practices can vary greatly from industry to industry. Since the case company is part of the service sector, the knowledge-sharing activities will mostly be confined to sales and engineering. On the other hand, in the manufacturing industry, knowledge transfer might also happen between production and engineering.

The feasibility regarding the implementation of knowledge transfer techniques for speeding up the delivery process of ETO products is another important aspect for ETO companies to consider. It is highly probable that not all the techniques proposed in the framework are feasible to employ for a company. For instance, the case company is only willing to increase the technical knowledge of its sales team through written documentation and certifications rather than utilizing job rotations and team composition changes. Therefore, the degree of implementation of the proposed framework might also vary considerably among companies.

6.3 Research Limitations

While the study aims at presenting a framework based on empirical and theoretical findings, there still exist some observable limitations which are worth noting. For the scope of the empirical research, only one case company was relied upon. Although the proposed model was in line with the empirical findings from the case company, it should also be tested for other companies. Also, the effectiveness of the framework relies only on expert opinion rather than on actual implementation. Thus, there is a definite need to test the usefulness of the proposed model with real implementation. In addition, since this research is based on a single case study design, it may cause uniqueness and artificial conditions surrounding the case. Furthermore, the way in which the case study method has been implemented in this thesis may include interpretations of the author and thereby affect the results.

The proposed knowledge transfer techniques of this study are based only on the opinions from sales and engineering. Therefore, due to the characteristics of the case company's offering, the framework lacks the empirical data from other business functions in which the knowledge transfer approach might play an important role in speeding up the delivery process.

Another important point to highlight is that the author of this thesis was employed at the case company. Even though it may have helped with the accumulation of knowledge and access to resources, it can also mean that some inevitable bias is involved while the empirical data was being collected and analyzed. Hence, there is still room for empirical data to be collected and analyzed more impartially. The empirical data was collected through unstructured qualitative interviews and such a research methodology has its own set of limitations. A downside of unstructured qualitative interviews is mentioned by Bryman & Bell (2011) who argue that the unstructured nature of the empirical data collected can somewhat reduce reliability. Thus, these limitations can manifest themselves in the reliability of the results of this thesis.

In addition, it is essential to mention that most of the interviews were conducted online via audio calls, where it is hard to observe any behavioural clues. Although the individuals selected for the qualitative interviews had relevance to and expertise on the subject matter, there is always a chance that personal biases and opinions of the interviewees might interfere with the thesis findings.

A limitation faced during data collection from literature was that the existing literature did not exactly address the same problem area as of the thesis which focused on speeding up the delivery process of ETO products through knowledge transfer. The problem area was highly contextual and specific and hence, it was difficult to find relevant academic data sources.

6.4 Future Research

The study aimed at developing a framework for speeding up the delivery process of ETO products utilizing a knowledge transfer approach. Although the study did achieve its objective, there exist certain limitations such as lack of existing literature on the knowledge transfer techniques specifically meant to speed up the ETO delivery process and concrete empirical evidence to support the effectiveness of the framework. Hence, there is a room for validating the findings of the study further and especially their practical application with more case companies. The framework is tested in a service company with a highly unique product, however, the utility of the framework for other industries and products can also be investigated.

Moreover, the empirical findings of this thesis are based on the results from complex ETO product. Therefore, further studies are needed to cover other types of ETOs such as repeatable ETOs and non-competitive ETOs. Also, due to the scope of the thesis, the framework focused on the knowledge transfer techniques only at the intra-organizational level. Thus, more research might be needed to evaluate the impact of inter-organizational knowledge transfer techniques on speeding up the ETO delivery process.

As mentioned in the limitation section. the thesis only reflects the viewpoints of sales and engineering. Other business functions such as marketing, production, and logistics might also have an important effect on the speed of the delivery process of ETO products. Thus, further studies should include some case studies which are focused on finding knowledge management issues in other business functions when it comes to speed up the ETO delivery process.

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