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THE EFFECTS OF DIGITALIZATION ON SUPPLY CHAIN MANAGEMENT FROM LEAN PERSPECTIVE

Master’s Thesis – March 2020

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ABSTRACT

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Digitalization is an emerging phenomenon leading to pervasive changes in industries. Corporates and consultancies recognize the potentiality of digitalization in Supply Chain Management. Whereas, there is not adequate research from the academic world to shed a strong light on how digitalization affects supply chain management. Lean, a relevant scope, is an interesting lens to view the effects of digitalization on supply chain management.

This thesis is constructed based on a qualitative case study research method to gain an understanding of a new phenomenon. Three themes: digital technology development, digitalization in supply chain management, Lean outcomes are investigated. Three global companies set as the empirical case study provides rich data for understanding the real industrial world.

Via analysis, a vivid picture of how digitalization changes supply chain management in companies are depicted, and Lean outcomes are evidently shown. Cross-case analysis aligned companies, suggesting the relevance of contextual factors. Findings point out links and new values between theory and practice. Furthermore, it raises concerns to continue building theory as well as formulate a strategy for digitalization in supply chain management.
ACKNOWLEDGMENTS

Digitalization continues its enchanted journey in today’s world, changing human life. I am excited to bring this pervasive phenomenon into my field of study in Supply chain management. Supply chain management and Lean I have studied at LUT give me key concepts to start the research. More and more surprise comes on the way I dive deep into scientific materials and expose to the real world.

This thesis’s research cannot be completed without the professional guidance of my thesis supervisors who stopped me from carrying out too novel topics. Instead, they steer me in the right direction by pulling my interested novel topic on the ground of research, showing me the lines between what is possible and not. Many dedicated processes cannot be expressed all here. Above all, I truly appreciate the support and professionalism of my university LUT, my faculty, my thesis supervisors: professor Jukka Hallikas, D.Sc Sirpa Multaharju.

Behind the work of this thesis is the kind support of many people. Rasel Khan who is a mentor and a LUT’s alumnus accompanied me from a poor start to the best of my academic writing. My ex-boss To My Chau - CEO of Phung Vinh Hung Paper JSC, top managers in the corporate world are willing to share their knowledge despite their busy business life. To show appreciation, I have tried my best to gather knowledge from the research world, construct research via an established method to increase reliability and validity.

Day by day, keeping up between study as a hobby and money from a side job, I feel in many moments as if I could not walk further. My friends, my family, my partner who are there to motivate me and remind me of how bright the beginning and how good is the intention to study. A special thank you from the bottom of my heart.

In the end, I am glad to submit my work and graduate. After my thesis, I realize it is so much important to research on digitalization in Supply Chain Management from a Lean perspective. I hope more research and projects will be developed on this topic.
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<tr>
<td>AI</td>
<td>Artificial intelligent</td>
</tr>
<tr>
<td>BIM</td>
<td>Building information model</td>
</tr>
<tr>
<td>ERP</td>
<td>Enterprise resource planning</td>
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<tr>
<td>ETA</td>
<td>Estimated time of arrival</td>
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<td>RA</td>
<td>Robotics arm</td>
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<td>RPA</td>
<td>Robotics process automation</td>
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<tr>
<td>RQ</td>
<td>Research question</td>
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<tr>
<td>SCM</td>
<td>Supply chain management</td>
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<td>SCN</td>
<td>Supply chain network</td>
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1. THESIS INTRODUCTION

This thesis studies the impacts of digitalization on supply chain management from the view of Lean philosophy. In more specifically, it examines the process that digitalization such as digitalized process, robotic and automation brings improvement in supply chain management by reducing waste and increasing value to customers as defined in the Lean philosophy. The major aim of this thesis is to gain deep understanding of how digitalization can boost supply chain in a lean way, and secondary to unpack the possibilities to utilize digitalization for lean supply chain. This introduction chapter will introduce the background leading to the significance of research on this thesis topic, then present the research questions basing on which key concepts and theoretical framework are selected.

1.1 Research gap and significance

The recent development of digitalization is a strong wave leading to pervasive changes in many industries. Digitalization forces companies to reinvent their new way of doing business (Bouwman et al. 2017, 2). 73% of respondents in a large-scale survey acknowledged that digitalization helps them reach operational excellence (Lehmann 2018, 27). It is predicted that digitalization is going to reshape supply chain model to supply chain 4.0 in which automation will boost supply chain efficiency by automating the physical tasks and planning (McKinsey & Company 2016). For instance, combining RFID (Radio Frequency Identification) and EID (Electronic Data Interchange) via system connected with physical workflow and ERP automated EID transactions will bring improvement in time and accuracy in supply chain (Radley Corporation 2017). The potential of digitalization brings to supply chain needs further investigation. The time of digitalization in supply chain becomes more vivid, which creates an advantage to start research in this field.

Lean was born by Toyota in global automotive industry manufacturing with a purpose to better manage the supply resource, and then expanded rapidly to other industries and broader contexts (Hines et al. 2004, 994). Lean become a philosophy that no longer wraps itself in the automotive industry (Singh and Pandey 2015, 38-39). Lean philosophy is applicable and important in many different industries and contexts for better waste reduction and value development.
Going beyond the shop-floor area, Lean Supply is studied with the recognition of Lean in supply chain network and supply relationship management (Hines 2014, 995). Numerous Lean Supply Practices are invented and used by big corporations globally (Tortorella et al. 2017, 98-101). Lean is found significant to adopt in supply chain and it was evident that Lean increased the supply chain performance. For this reason, Lean has been a good combination to develop further with supply chain.

Research has shown that Lean and digitalization have a positive relationship. Andreas et al. (2018, 896-901) advocate the combination of Lean and Industry 4.0 because digitalization helps the value stream mapping map correctly according to the real-time situation and therefore companies can react quickly to the volatility and variant mix from customers. Dennis et al. (2017, 2846) state that Lean production is not adequate to fulfill the market demand for customization basing on which digitalization and automation appeared in combination with Lean as a solution. Ozan Koseoglu (2018, 1298-1321) shows limits in the current Building Information Modeling and Lean construction, and indicates the potentials and benefits of using digitalization to improve the current model with Lean. Nevertheless, current researches were limited within the manufacturing or shop-floor field, leaving a room to expand the view from shop-floor to supply chain.

The research gap and significance presented in the previous paragraphs suggest a study on the combination of three pillars: Digitalization, Supply Chain Management, Lean philosophy. However, which directions in specific this study should go through? There were numerous studies on the impacts of digitalization on supply chain, supporting study direction from impact of digitalization on supply chain. Furthermore, digitalization for the present and future is changing the way companies work in supply chain. In a closer look, digitalization bringing to supply chain speed and accuracy, which can result in time reduction and value creation to customers, a joint point with Lean. Yet, whether or not digitalization supports supply chain management in a Lean way is not yet confirmed or discovered in detail. Hence, the study on the influence of digitalization in supply chain management under the light of Lean philosophy triggers the interest of further research.
1.2 Research questions and objectives

Within the research direction represented in part 1.1, In order to clarify whether and how digitalization influences supply chain management in a Lean way, the main research question (RQ) is: How can digitalization support supply chain management in a Lean way? The aim is to investigate the process of how digitalization brings impacts to supply chain management in a Lean way. To answer this main question, three sub-research questions (sub-RQ) should be answered (Figure 1).

Figure 1: Thesis research questions and objectives

It is prior important to know where the company stands (Florian Bienhaus & Haddud Abubaker 2018, 965-984; Beck Ron 2018, 21), and therefore, this idea is indicated in the first sub-RQ: How has digital technology developed in supply chain management? This question aims to reveal what technologies as well as the process of adopting the new technologies in SCM at present and in the future.
After knowing the technology development status in SCM, the next step is to understand how those technologies work in SCM. This process of looking into ways of using digital technologies in SCM or how technologies transform SCM explains key issues in the main research questions, before reaching out to question the effects. Hence, the second sub-RQ is formulated: “How has digital technology transformed supply chain management?” Accordingly, the research objective is to analyze the links between digitalization and the impacts digitalization brings to supply chain management.

Lean philosophy basically focuses on reducing waste, and increasing value to customers (Demers 2002, 31-33). Reducing waste also means improving performance. Therefore, the effects that this thesis tends to investigate are viewed through supply chain management performance and customer value. The third sub-RQ is generated accordingly: What are the effects of digitalization on supply chain management performance and customer value? The related research objective is to clarify Lean outcomes in the form of supply chain management performance and customer value.

1.3 Conceptual framework and key concepts

Following the research questions and objectives set in part 1.2 and to investigate the current situation of digitalization of the researched firms, the framework to be used in this thesis consist of three main parts: digitalization technology development in SCM, Digitalization in SCM, Lean philosophy to view Lean outcomes. Elements of the main parts of this thesis conceptual framework are constructed from the literature review (chapter 3).

Knowing digital technologies where the SCM at the researched firm stands as explained in the first research question is important to conduct first. Technology elements encompass mega-trend technology and possible related technologies in SCM. In the next part Digitalization in SCM, technology put in SCM context, leading to changes which are viewed in the four main areas: Integration, Automation, Reconfiguration, Analytics, in relation with Customer’s voice and backed by understanding of supply chain network, SCOR process, three flows of supply chain. Lastly, the Lean outcomes from digital technology to SCM are proven through the improvement of SCM performance and customer value increase. Figure 2 illustrates the conceptual framework of this thesis.
Digitalization, Supply Chain Management, Lean Philosophy are large concepts to be used as the theoretical foundation for this research to develop. Narrowing down to a deeper level, “digital supply chain”, “Lean Supply” are concepts which locate in merging points of large concepts.

Basing on the research purpose and research questions, the merging area of Digitalization and Supply Chain Management is under the high intention of investigation from which further investigation of Lean is combined. Other sub-key concepts, which are not in the merging areas of large concepts but important for answering the research questions, are “digital technology”, “Supply Chain Network”. All key concepts are presented in the vent diagram Figure 3. The study from the literature of key concepts will be presented in the chapter theoretical background of this thesis.
1.4 Research approach and methodology

The research question of this thesis addresses a big issue that does not have a similar previous study. However, this big issue is divided into smaller issues into sub-research questions where supporting theories are found. The theories in chapter 2 play a supporting role in formulating the assumption that Digitalization positively impacts supply chain management presented in the outsets of increasing SCM performance and customer value (or Lean way). After that, empirical data will be used to justify the assumption, and therefore the main research question is answered. In terms of business research method theory, abduction is introduced as the merge of induction (theory to reality) and deduction (reality to theory): deduction is used for hypothesis construction which is justified by induction logic with empirical data (Staat 1993, 225-237; Schwandt 2001; Eriksson and Kovalainen 2008(396,407),(462,437), 11-24).". Hence, this thesis is applying “abduction” research logic.

The effect of digitalization on supply chain management recently becomes the subject of interest. A few studies published recently shed some light on the impacts of digitalization on supply management (Florian et al. 2018, 965-984; Calatayud et al. 2019, 22-38; Szozda 2017, 401-414), but the issue remains new and lack of researches. There is a need for enriching the understanding of digitalization on supply chain management. Furthermore, as described in the
research gap and because of the Lean combination, this topic suggests a novel study that needs a proper method to approach beyond utilizing the relevant literature.

Previous studies clarify that in the situation of insufficient theory in the field research or a new phenomenon, case study to build theory is highly recommended to use (Dubois and Araujo 2007, 170-181). Qualitative case study is a suitable method to be used at the stage when theory is formulating (Eisenhardt and Graebner 2007, 25-32). Recent literature reviews of the digital supply chain also show evidence from the research world that qualitative case study is necessary to build theory, framing the concepts of an emerging digitalization in SCM phenomenon (Iddris 2018, 47). In the field of this thesis, the combination of digitalization, digital supply chain, and Lean needs theory development approach. For these reasons, the idea of implementing qualitative case study in this thesis is formulated.

Another method like large-scale method may not be feasible to apply because the large-scale theory testing method (quantitative) needs well-grounded literature and ready in-deep study of the research topic (Eisenhardt and Graebner 2007, 25-32). Literature review in Chapter 2 shows that there is no well-grounded literature directly support answering the research question, the large-scale quantitative method seems to be too early to adopt. Therefore, qualitative case study is suitable, if not the best, method to serve the purpose of this thesis.

Using the case study method is expected to bring multiple good aspects to the research topic of this thesis. The case study method using rich case description has a considerable contribution to theory development (Dubois and Araujo 2007, 170-181). Moreover, compared with quantitative method, case study qualitative method provides strong power of explanation, gives insights into the case without neglecting the context, solves the problem of heterogeneity and complexity that quantitative method fails to tackle (Dubois and Araujo 2007, 170-180).

Case study can be used to build understanding by exploring, explaining the effects that digitalization brings to supply chain management in a Lean way. By describing the cases, identifying patterns via repetition logics, theory is developed (Eisenhardt 1989, 532-550). Similarly, it is one possible way to utilize case study method to identify repetition between cases, or between a case with others in the literature, to finally build a new theory or enhancing the findings of previous studies.
1.5 Delimitation

Digitalization is studied in many different contexts and areas, but in this thesis, it only focuses on the context of supply chain management in which related scopes are presented in the conceptual framework (details in chapter 1 part 1.3, and chapter 2 part 2.3.2). To serve the research purpose and answering the research question, there could be many issues to discuss about digitalization, but this study will only focus on what kind of technologies and status of technology development that relates to SCM, and then the transforming effects digitalization brings to SCM.

Supply chain management itself is a large landscape, the work of diving deep into every part of SCM like relationship management, supplier selection is too large to capture. For this reason, not all scopes belong to SCM are analyzed, but scopes that really make sense in analyzing the effects of digitalization to SCM are selected. Therefore, a new framework with selected parts of SCM (in chapter 2, part 2.3.2) which previous studies show strong relevant and better fit to the context of digitalization chosen to define scopes in SCM to be analyzed in this thesis.

Lean is also a large topic with many techniques, toolboxes, best practices. However, this study does not use those obvious presences of Lean to focus on. Lean in this study is used in its philosophy meaning to view effects from digitalization to supply chain management. It does not matter if case companies use established official programs called Lean or not. The focus point is to see if the effects of digitalization to SCM in case companies align with Lean philosophy or not.

Because effects from digitalization to SCM can be either negative or positive, it is important to know whether this study covers two extremes or just one part. The effects or benefits or impacts using in this study to express the results of digitalization in SCM are defined as positive. Therefore, this thesis only focuses on studying the positive effects, and leave negative effects or criticisms around digitalization for future studies.

As this thesis research purpose is to investigate and explore, the more diversified the collected cases the more benefits it brings to the research. Hence, this study will not select or focus on one industry or one location, but multiple industries actively in different locations. However, the resources and access to empirical cases are limited, this study finally covers three cases.
which all have active progress in digitalization, supply chain, and lean globally. Detail criteria to select cases that serve the research purpose and researches questions are constructed as stated in chapter 3, part 3.2 of this thesis.

Using multiple case study method can draw many questions on validity and reliability from the traditional research perspective. Yet, it is important to note that each case can potentially represent an independent picture, comparing and generalization are not main purposes in this study. Thus, this thesis research should not be limited because of generally doubted sense of validity and reliability, but to encourage the exploration and at the same time not neglecting validity and reliability. This point is taken basing on scientific articles which are described in chapter 3, part 3.5.

View of analysis mainly comes from organization view, and only issue interpersonal interaction as nature inherent part of supply network may be viewed from individuals. The whole supply chain network may not be presented in this thesis, but the network which is visible to the interviewee and in secondary data will be under investigation.

1.6 Structure of the thesis

This thesis is structured into six chapters. The first chapter begins with the found research gap and the significance of carrying out this thesis, following by important starting points of research consisting of research questions and objectives, conceptual framework and key concepts, research approach, and delimitation. The second chapter is a literature review developing from relevant key concepts to more detail ones with strong links to the research questions. The third chapter explains research methodology and data collection which reveals the reasons why a particular method is chosen and how this thesis is conducted scientifically. The fourth chapter gives introduction information of three case companies with contextual information. Chapter fifth presents empirical data gaining from interviews, analyzing with support from previous parts of the thesis to formulate the analysis and empirical findings of this thesis. The last chapter (chapter sixth) discusses the results of this thesis as research and draws the conclusion points of the whole thesis. Interview question list, supporting tables and visuals mentioned along the text of all chapters are placed in the appendix located after the last chapter of this thesis.
2. THEORETICAL BACKGROUND

In this chapter, three key concepts Digitalization, Supply Chain Management, and Lean philosophy are studied. At first, each concept is analyzed separately on its meaning, outstanding points, and relevant issues to the research questions. Then, pairs of concepts are viewed together to gain a closer look at the scope of this thesis. While all knowledge presented in this theoretical background chapter plays supportive roles; basing on the direction of research and research question focus, the literature review on Digitalization technology development (in 2.1.1), Digitalization and Supply chain management (in 2.3) are expected to provide significant contribution to the understanding and setting up of the empirical study.

2.1 Digitalization

Beck (2018, 21) points out that digitalization has existed about 40 years ago in the processing industry, but till the occurrence of the recent technologies such as robotics, machine learning, digitalization has been gaining more attention and momentum. The origin of digitalization in business has a deep root in market uncertainty forcing companies to search for more flexibility to react against market changes, demand volatility, and speed pressure (Beck 2018, 21; Wang et al. 2006, 42-44). Asserting and adding another root cause of digitalization in business, Bauer et al. (2018, 334-335) find that motives of many companies to digitalize are solving the existing problems of market uncertainty such as lack flexibility and information, ramp-up pressure, and further to use technology as a means to gain global competitiveness.

The term digitalization is understood differently depending on the context it applies in. Gray and Rumpe (2015, 1319) describe digitalization as an integration of digital technology into any life’s aspects such as science, business, culture, etc. Kuusisto (2017, 342) also cites there are many different contexts which digitalization’s meanings base upon. Besides pointing out the multiple aspects in which digitalization is used, Kuusisto (2017, 342) recognizes the importance of putting context into defining digitalization to prevent ambiguity: “Digitalization is often used as a vague term to describe many different things depending on the context”.

In a business-oriented context, digitalization is discussed widely as a phenomenon, a process that changes the way business works. By accumulating previous meanings of the term digitalization, Gobble (2018, 56) cites that digitalization is understood as a process of using
digital technology and digital information to generate and perceive value in a new way, resulting in the transformation of the business model and business process. Similarly described, Harvard Business Review regards this process of transformation as digital transformation (Harvard Business Review 2015, 1-2). Gartner (2019) defined the term digitalization as the following: “Digitalization is the use of digital technologies to change a business model and provide new revenue and value-producing opportunities; it is the process of moving to a digital business.”

Table 1: Differences between digitalization, digitization, digital transformation, innovation

<table>
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<th>Concepts</th>
<th>Differences</th>
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<td>“Digitalization” vs “digitization”</td>
<td>“Digitization is the straightforward process of converting analog information to digital—turning pages into bytes, for instance, by scanning a document or uploading a sound recording. It often also captures the process of moving a process from manual to digital—replacing hand-filled forms with online versions that go directly into a database, for instance”. (Brennen and Kreiss 2014, i-SCOOP 2016, Gobble 2018)</td>
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<td></td>
<td>“Digitalization refers to the use of digital technology, and probably digitized information, to create and harvest value in new ways.” (Brennen and Kreiss 2014, i-SCOOP 2016, Gobble 2018)</td>
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<td></td>
<td>“While digitization is more about systems of record, and, increasingly, systems of engagement, digitalization is about systems of engagement and systems of insight, leveraging digitized data and processes.” (i-SCOOP 2016)</td>
</tr>
<tr>
<td>“Digital transformation” vs “Innovation”</td>
<td>“Transformation efforts focus on employees while innovation efforts focus on changing customer behaviors”. (Gotelf 2017)</td>
</tr>
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<td></td>
<td>“Digital transformation describes a sometimes extended process of change that may have multiple goals, while innovation is focused on the moment of the invention and implementation of that invention.” (Gobble 2018)</td>
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Mentioning about terminology, it is important in theoretical studies to avoid confusion or misused with seemingly interchangeable terms. Brennen and Kreiss (2014) pointed out the difference between the two terms “digitalization” and “digitization”. European innovation consultancy i-SCOOP 2016 discussed the differences between the three terms “Digitization”, “digitalization”, and “digital transformation”. In the following year, Gothelf (2017) asserts that digital transformation is not innovation. Gobble (2018, 56-57) provides clarity to the term digitalization in comparison with other considered similar terms “digitization”, “innovation”. Breakdowns of differences in the meaning of similar terms are presented in Table 1. Those similar terms should be used with caution to ensure the science value of the research.

Benefits coming from the emergence of Digitalization are evident and deeply discussed. Tuomaala (2018, 25) finds that digitalization plays a key role in boosting the productivity of the process industry. In a large survey of 385 use cases, the following benefits are acknowledged in descending order: efficiency increase, error prevention, cost deduction, function support, lead time reduction, quality improvement, prevention of machine disruption time, predictive maintenance, traceability, resources efficiency, schedule adherence (Bauer et al. 2018, 334-337). Digitalization can help firms gain many benefits, but going more in-deep analyzing, problems in reality show certain challenges: uncertainty in technology selection and how to use technology in the business process (Denner et al. 2018, 331).

Digitalization is studied together with a wide range of scopes such as business models (Parida, 2019, 1), value co-creation (Lenka 2017, 92), information management (Riedl 2017, 475). Digitalization and supply chain management recently occurred as an emerging issue when the wave of innovative technology brings promising benefits to the field. As a combination of digitalization and supply chain, digital supply chain was discussed in many papers, but the ignorance of the theoretical base is recognized as a current blinding spot (Iddris 2018, 47-48). Regarding lean, digitalization is discussed with lean on many different angles (Roy 2015, 27-30; Meissner 2018, 81-86; Stenholm 2016, 1595-1604).

In summary, digitalization can be understood as a process of using digital technology leading to changes in value creation, business model, and business process. Digitalization brings multiple benefits to firms including productivity increase, quality improvement, waste reduction. Serial of studies show that the reason many firms decided to invest in digitalization
falls into two categories: fighting against the thread of market uncertainty; winning competitive advantage.

2.2 Digital technology development

Technology is an essential part contributing to digitalization. The essence of the first sub-research question and its objectives suggest the significance of studying on technology development in digitalization. Hence, literature review on technology in digitalization is considered paramount importance, facilitating the process of answering the first sub-research questions which after all contribute to the unitary whole picture of this research.

About concepts, there is no conceptual research on the aspect of technology in digitalization. However, the term “Industry 4.0” is well accepted not only in academic life but also in industrial society (Ozte me and Gur sev (2018, 1). Ozteme and Gur sev (2018, 5) cited that industry 4.0 encompasses digitalization and automation. Borangiu et al. (2019, 151) point out that “Industry 4.0 focuses on cyber-physical production systems (CPPS) which will provide digital representation, intelligent services, and interoperable interfaces in order to support flexible and networked production environments”. For study and explore digitalization technology, Industry 4.0 is a better term to be used while the boundary between digitalization and Industry 4.0 should be well alert to not create a mixed understanding.

Despite of the lack of conceptual ground, technologies such as ERP tools, Internet of Things, Analytic, etc appeared in studies of digitalization. Answering the questions (what kind of technologies in digitalization, how that kind of technology impacts to business and supply chain management) are still possible to answer. The following paragraphs are the result of gathering related literature review.

Harvard Business Review 2015 sponsored by Microsoft, in a large-scale survey, regards Big Data, Could, Social, Mobile as four mega-trends of digital transformation, and security risk is addressed as a prominent concern. Internet of Things is described as the back born technology for the possibility of using Big data (Harvard Business Review 2015, 7). Spremic (2017, 215-218) categorizes technology into primary (mobile, social, cloud, Big Data, and IoT, etc) and secondary (3D printing, wearables, virtual and augmented reality, robotics, etc).
In Supply Chain Management, Florian et al. (2018, 965-984), via literature review, cites that Artificial Intelligence and Big Data are two key drivers for organizations in their journey of digital transformation. Calatayud et al. (2019, 22-38) also emphasized the importance of Artificial Intelligence as one out of two most frequently technologies associated with future supply chain beside Internet of Thing (IoT).

In supply chain and supply networks, Hanifan et al. (2014, 3-4) pointed out that Big Data, Mobility, IoT, Cloud and Social are disruptive technologies that pave the way for the transformation to a more intelligent, agile, and connected supply chain and supply network. In a recent article carrying out the literature review of 109 articles on Digital Supply Chain, three most often discussed terms are: Big data, Cloud Computing, Internet of Things (Büyüközkan and Göçer 2018, 159-160). RFID (Radio Frequency Identification), the emerging technology bringing disruptive change in Logistics, is now leveraged up with Artificial Intelligent (Gunasekaran 2014, 3-4).

In recent research, blockchain technology emerges as a new potential for adoption in future SCM (Michel 2019, 22-23). Regarding blockchain, Wang et al. (2019, 71) find that trust is the decisive factor in the adoption of blockchain in supply chain, and while the potentials of blockchain are obvious, the understanding of blockchain in SCM is still limited.

From the organization's point of view, Ivancic et al. (2019, 42-46) find out that firms consider the three areas Big Data, digitalized process (the standardized process in terms of workflow and terminology), internal IT system (Enterprise Resource Planning) transformation important in digital transformation. In Industry 4.0, technologies are typically categorized into nine technologies in which Internet of Things, Big Data, Cloud were included.
Table 2: Summary of technology elements in digitalization

<table>
<thead>
<tr>
<th>Technology elements</th>
<th>Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internet of Things</td>
<td>V1, V2, V4, V6, V7, V8</td>
</tr>
<tr>
<td>Big Data</td>
<td>V1, V2, V3, V4, V5, V7, V8</td>
</tr>
<tr>
<td>Cloud</td>
<td>V1, V2, V4, V7, V8</td>
</tr>
<tr>
<td>Social</td>
<td>V1, V2, V7</td>
</tr>
<tr>
<td>Mobile</td>
<td>V1, V2, V7</td>
</tr>
<tr>
<td>Artificial intelligence</td>
<td>V5, V6</td>
</tr>
<tr>
<td>Blockchain</td>
<td>V9, V10</td>
</tr>
</tbody>
</table>


The existence of technologies can be abundant and vary, but what are the advanced and dominating technologies representing the digitalization era? Key technology elements of digitalization are synthesized in Table 2. The frequency of Internet of Things, Big Data, Cloud in all articles and in big-scaled data articles triggers the interest to have an in-deep review in the following parts. They seem to be in the role of dominating technologies (or technologies create mega-trends) in digitalization. Artificial intelligence is also chosen to have a separate in-deep study because of its relevance to supply chain discussed previously.

Social and Mobile are not studied deeply in this part, it does not mean they are any less important than others. Social and Mobile play an interesting role in digital transformation. Mobile increases employees’ connection to work (via corporate’s application and access to corporate data), and to each other, contributing to the increase in employee’s productivity. Consulting and service are sectors where the transformation is heavily influenced by Social Media Technology. Social Media can easily be seen as an important factor in the marketing department, but advancing firms utilize Social Media for better communication and understanding customers, employees, partners and suppliers. (Harvard Business Review 2015, 8-9)
2.2.1 Internet of Things and Big Data

Ochoa et al. 2017 (82) describe Internet of Things “The IoT paradigm refers to a worldwide network of interconnected heterogeneous objects that are uniquely addressable and interact among them using standard communication protocols”. Internet of Things and Big Data are two concepts going together and having a strong relationship.

Internet of Things is certainly a base for Big Data solutions. Internet of Things has a large-scale nature basing on which a large amount of data is collected, making Big Data analytics at real-time possible and essential in organizations (Ochoa et al. 2017, 82-84). Harvard Business Review (2015, 7) also cites that Internet of Things is an important invention that facilitates Big Data to be collected. Within Supply Chain context, using Internet of Things enables to track and trace physical items basing on which smarter and quicker decision is made, for instance: optimization in warehouse and transportation (Zhou 2015, 1). However, Internet of Things with sensors collecting big amounts of data is also the challenge for the processing system to handle (Ochoa et al. 2017, 820-84).

Big data, or data analytics, used to have obstacle because of the vast volume of data, now is enabling with new solutions to support for a faster and complex decision making, gaining more insights and even support new product and service development process (Harvard Business Review 2015, 7). Big Data with the support of Internet of Things is becoming essential because it gives new solutions for data analytics and real-time process (Ochoa et al. 2017, 82-84). Lehmann 2018 via a large-scale survey

2.2.2 Cloud

Harvard Business Review 2015 specified that Cloud has two clear impacts on corporates: responsiveness improvement, and cost-saving. Cloud intensively leads the changes in activities of the IT department (Harvard Business Review 2015, 5-6). Cloud and Virtualization are the main drivers to speed up in manufacturing (Borangiu et al. 2019, 150). Within the manufacturing topic, Borangiu et al. (2019, 150-151) also recognize the fact that Cloud is often adopted in the business process layer, but the implementation process is much slower in the manufacturing layer. High-performance computing, system design, information integration can be one of the main challenges in implementing Cloud (Borangiu et al. 2019, 161).
Cloud computing in Supply Chain Management is still in the early stage of development (Jede and Teuteberg 2015, 438). The main reasons for using Cloud in Supply Chain Management are increasing competitive advantage (expectation of higher IT in value and performance, better support Supply Chain Management), and cost-saving (expectation of the lowest IT operational cost) (Jede and Teuteberg 2015, 445-447). The risk that discussed most often in the literature regarding Cloud and Supply Chain Management is the security thread (Jede and Teuteberg 2015, 446). Cloud computing in Supply Chain Management is also called “Cloud-based Supply Chain Management” (Giannakis et al. 2019, 585). In recent research, Giannakis (2019, 585) et al. find that the Cloud-base Supply Chain Management system improves effectiveness in Supply Chain responsiveness which is considered top importance in the nowadays target of organizations to better respond to customers’ demand and changes in the environment.

2.2.3 Artificial Intelligence

Min (2010, 13) cites that “Artificial intelligence (AI) was introduced to develop and create "thinking machines" that are capable of mimicking, learning, and replacing human intelligence.”, and notices that AI has not yet popularly used in Supply Chain Management. Till 2014, in Logistic and Supply Chain Management, AI has been used to achieve automation, for instance: in cross-dock AI powers the optimization and automation of the whole delivery process (Gunasekaran 2014, 1).

The combination of AI, Big Data, and a suitable model help to reduce the distortion causing by bullwhip effect in Supply Chain Management (Aggarwal and Dave 2018, 51). Despite the Bullwhip effect presents and impacts on many different aspects, the Bullwhip effect is a demand management process problem (Donovan 2002, 45). In 2015, a computing system is developed using AI to model the process of order management (Mortazavi et al. 2015, 207). There is not any confirmation of how effective the AI systems run till the end, but there is a certain opportunity to tackle the complex problems of supply chain by utilizing AI and big data for a more agile, more intelligent system. Demand management is one typical example that AI is encouraged to develop.
2.3 Supply chain management and digitalization

Madenas et al. (2014, 336) cite that most studies used a definition of Supply Chain Management (SCM) by Lambert et al. 1998 and Mentzer et al. 2001. Lambert et al. (1998, 4) suggest the framework for Supply Chain Management which encompasses three pillars: “Supply Chain Network Structure, Business Process, Management Components”. Mentzer et al. (2001, 4) describe Supply Chain Management as “a set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer.” Study SCM is to select one theory and supplement it with other features (Halldorsson et al., 2007). In this thesis, the definition of Mentzer et al. (2001, 4) is selected to be used.

Following the definition of Mentzer et al. 2001, SCM is broken down into: supply chain network, three flows (products/services, finances, information). Inheriting from this definition, later studies added up to the understanding and knowledge of SCM. For example: in the age of digitalization, SCM is seen with the combination of digitalization, a “Decomposed framework for the supply chain management” is generated recently, indicating elements when digitization comes into the field of SCM (Büyüközkan and Göçer 2018, 172).

2.3.1 Supply Chain Network

The theory of Supply Management is built from either of the two main approaches: Resource-based view (RBV) or Industrial network (Dubois and Araujo 2007, 171). Supply Chain Network is the foundation in Supply Chain Management which existed in the definitions of supply Chain Management (Lambert et al. 1998, 4; Mentzer et al. 2001, 4). The framework of Büyüközkan and Göçer (2018, 172) presented in part 2.3.2 also take network as a part of its construct.

Compared with supply chain, supply network is considered a better term to express the nature of multiple suppliers and buyers or customers in supply chain (Christopher, 1998, 231). SCN is coined as “a network of interconnected businesses involved in the ultimate provision of product and service packages required by end customers” (Harland 1996, 64). Supply Chain Network (SCN) is a net composed of sets of firms and a set of connections between firms (Hearnshaw and Wilson 2013, 444). Although different scholars have different ways to describe,
their descriptions of SCN can be unified into the understanding that SCN is built from nodes or firms, and connections.

As mentioned, SCN is built from nodes and connections. The smallest unit consists of “two parties” and “three parties” types, which each type open different implications and further understanding of a more complex issue of the whole picture of SCN. Buyer and seller relationship is illustrated as “dyads” and “triads” (Choi and Wu 2009, 263). “Dyads” relationship type in a network is constructed from two firms connecting to each other, which is by nature seen as the smallest unit in SCN by the majority of scholars, but “triads” (three-parties connection) is actually the smallest unit in SCN (Choi and Wu 2009, 263).

Widening the view, SCN structure is developed bigger with the concern of “clustering coefficient” and “distribution of nodes”. The whole structure of SCN reflects its nature of complexity. The clustering coefficient concerns the cross-connections or other connections than the simple dyads connections across supply chain. The clustering coefficient illustrates the idea that suppliers of a buyer can know each other, or buyers of a supplier can have a connection. Distribution of nodes refers to seeing nodes with two dimensions: number of connections (= n), the number of firms with n connections. Basing on this method of mapping, the distribution picture will reveal the existence of firms with high connections and firms with low connections. (Hearnshaw and Wilson 2013, 448-450)

Network is not only about node, but the connections that shed the light on understanding the essence and uniqueness of a particular SCN. Different kinds of connections between nodes of the network relate to different kinds of flows of goods, finance and information which firms exchange (Hearnshaw and Wilson 2013, 444). Such connections are also called “links between firms”, and are classified into two types: “exchange processes (information, goods and services, and social processes) and adaptation processes (personal, technical, legal, logistics, and administrative elements)” (Halldorsson et al. 2007, 287). Connections are also the place where the relationship aspect is raised. Halldorsson et al. (2007, 287) claim that “personal chemistry between parties, long-term, trust-based relationships between the supply chain members” are important in studying SCN.

SCN has been recognized as a subject of complexity, and studies have put effort into depicting a good SCN. Many issues contribute to the complexity of SCN could be from the basic level
such as structure of network, links, to more complex detail such as behavior, loops and exchanges (Mena et al. 2013, 58-59). Studying the complexity of SCN, Hearnshaw and Wilson (2013, 442) argue that an efficient supply chain network possesses three characteristics: “a short characteristic path length”, “a high clustering coefficient”, and “a power-law connectivity distribution”.

It could be said that supply chain network has been studied a long time ago with numerous issues, but comprehensive studies on changes in supply chain network in the digital age have been so far limited. Via reviewing numerous articles regarding digitalization, Büyükozkan and Göçer (2018, 172) address the current unified need of re-defining supply chain network and the role of SCN in supply chain integration. However, Büyükozkan and Göçer (2018)’s study only reaches to the point of raising the new issue rather than giving an analogy of how SCN changes under the effects of digitalization. The most recent research published in May 2019 also points out the recognition of renewing SCN due to the digitalization changes in the manufacturing area, but the way to conduct is still difficult because of the nature of the complexity of SCN (Tziantopoulos et al. 2019, 510).

2.3.2 Digital Supply Chain Management

Traditionally SCM is viewed within four issues: network, information flow, good flow, and financial flow. Modern or digital SCM requires a framework that not only inherits the basics of SCM but also covers newly arising issues. Conventional four issues of SCM are not exhibited explicitly but interweaved in new issues of or digital SCM. In 2018, Büyükozkan and Göçer (2018, 172) proposed a new framework for digital SCM. This new SCM has five main components namely Supply Chain Integration, Supply Chain Automation, Supply Chain Reconfiguration, Supply Chain Analytics, Supply Chain Process. (Büyüközkan and Göçer 2018, 172-173).

Supply Chain Integration concerns the coordination in information sharing, resource sharing, supply chain network linkages. Supply Chain Automation categorized into Robotic Technologies, Process Automation, Intelligent Processes with the emphasis on accuracy. Supply Chain Reconfiguration encompasses the process of adjusting the structure of an organization, Supply Chain Network, Supply Chain operational ability to improve performance with the existence of risk. Supply Chain Analytics facilitates Real-time execution decisions,
process optimization, advanced forecasting. Lastly, Supply Chain Process, a reliable and rather conventional way in strategic decision making, is one of the main components that express a repetition set of activities: Plan, Source, Make, Deliver, Return. (Büyüközkan and Göçer 2018, 172-173)

It could be said that by building components of automation and analytics, Büyükoğuzkan and Göçer (2018) clarify the link of technology and SCM. Büyükoğuzkan and Göçer (2018) basically use the discussed technologies in part 2.2 (IoT, Big Data, Cloud, AI) of this thesis which facilitates directly to automation and analytics. Further, Büyükoğuzkan and Göçer (2018) supplement robotics as part of technology to generate automation in SCM.

After 2018, supply chain management in the digital age continues to receive more interests in exploring new aspects digitalization bring to SCM: supplier selection (Cavalcante et al. 2019), supply partner selection (Büyüközkan and Göçer 2019, 1-18). Michel (2019, 22-24) emphasizes the role of AI, and its combination with machine learning, newly blockchain technology in digital supply chain. However, Michel (2019, 24) shifts the focus from the threat of layoffs to refining how to use Human resources that fit the new context of digitalization. Muncaster (2019, 22) adds the importance of customer feedback in digital supply chain.

By modifying Büyükoğuzkan and Göçer (2018)’s framework and adding important issues of digitalization, the below framework is constructed and presented in Figure 4. The modification is made by putting the conventional component SC process (SCOR model) in the secondary role, link technology its transformation in SCM, add “blockchain” and refining Human resources, and customer feedback. Modifying this way, the new framework is updated and holds more power of explanation within the context of digitalization.
2.3.3 Impacts of Digitalization on Supply Chain Management

Digitalization emerges and changes the structure, the ways to operate in SCM. For example Internet of Things, one of the mega-trend in digitalization, can enable visibility of good flows (transparency and traceability), connect large scales of people and things via multiple numerous devices (flexibility, adaptability, scalability), resulting in effortless decision making, business process improvement, cost-saving, risk mitigation (Zhou 2015, 2). The positive impacts digitalization bringing to SCM are undeniable. The below paragraphs presents numerous studies revealing the impacts of digitalization on SCM.

Michel (2017, 22-26) mentions 6 digital supply chain megatrends in which impacts of digitalization in SCM are incorporated. Those impacts are: network visibility (one firm can see activities and events of other firms in its SCM network); more relevant data to a specific process with actionable solutions; better cope with risks and changes by scenario-based planning technology (instead of human work, digital application will quickly suggest the possible action plan); smarter and better in transportation thanks to predictive analytics, smart road and IoT;
less labor requirement and a new way of operation in warehouse and workstation because of mobile robotics; increase connection significantly via cloud computing. (Michel 2017, 22-26)

Voices of the industrial world reveals the impacts of digitalization on SCM. In 2016, McCrea (2016, 40-44) cites that SCM of global companies can utilize tools of digitalization to gain efficiency in SCM, by simplifying operation, taking advantage of data, creating seamless flows of products and information. Advancing firms and consultancies unanimously realize impacts they receive from digital transformation: improve collaboration or more connected (people and network); increase performance and productivity; increase speed and ability to scale up; smarter process; support in strategies (more disruptive and more innovative); adding more value to customers and intangible assets (example: relationship aspects) (Büyüközkan and Göçer 2018, 157-177).

Hanifan (2014, 1-3) finds similar impacts in Supply Network which are expressed in four aspects: “Connected”, “Scalability”, “Intelligent”, “Rapid”. “Connected” shows in “real-time visibility” in working between people within a firm and inter-organization connection. “Scalability” enables “end-to-end” network integration. “Intelligent” is a result of innovative technologies (mobile, smart device, etc.) and better analytics. “Rapid” means speedy and flexible response to changes from the environment (such changes can be from market uncertainty, urgent event, changing suppliers). (Hanifan 2014, 1-3)

The survey on the impacts of digitalization on procurement function of SCM reveals key highlights: role of procurement will be extended to more data involvement, procurement becomes strategic function of an organization, higher chance for transparency and trust-building in supplier relationship management; collaboration and communication improvement through Cloud computing; speedy transaction and process; new supportive force from predictive analytics and automation. (Florian et al. 2018, 965-984)

Many studies are presented, but they seem to be quite fragmented. To unify all the above-presented studies, spot major impacts, and co-occurrent between discussed issues in this part, quantitative text analysis method is applied. Basing on the frequency of an issues discussed (Figure 5) and the co-occurrence (appendix 2), major digitalization impacts on SCM can be summarized: increasing connection (regarding to people, collaboration, network, process), a more intelligent characteristics (applied to process, in discussion with novel technologies),
more visible or more transparent (in supply network, supplier relationship). Increasing in the speed of operation, scalability, productivity, efficiency are also frequently discussed issues.

![Frequency of issues discussed in literature](image)

**Figure 5**: Major impacts of digitalization on SCM

### 2.4 Lean philosophy and supply chain management

Despite lean supply is discussed in a different context (issues, industries, and disciplinaries), this part only focuses on exploring the meaning of Lean as a philosophy and how it relates to supply chain management. In a more precise word, this part target at knowing “what is a lean way in SCM?” because “lean way” is an essential part of the main research question. Therefore, Lean philosophy is studied in part 2.4.1, and the forms of the output of Lean in SCM will be the focus on part 2.4.2. By uncovering the meaning of “lean way”, the literature review will facilitate composing interview questions, and finally to answer the research question of this thesis.

#### 2.4.1 Lean philosophy

Lean appears at first a solution to fix the pitfall of the mass-production model and then developed to the philosophy. Tracing back to the history, the philosophy has rooted from a method of Toyota to improve the mass production model by switching the focus from pursuing quantity to satisfying customer’s demand (Riley 2010, 8; Demers 2002, 31). Lean is popularly known via its five basic principles, Lean techniques and tools, and depending on companies’
choices the specific methods are selected (Demers 2002, 31-32). The recognition which Lean is applicable in many environments under different techniques and tools proves the philosophy characteristics of Lean (Demers 2002, 33).

In Lean philosophy, waste removal, efficiency are obviously goals to achieve, but more importantly, the final customer’s perception of value should go first. Hines and Taylors (2000, 4) discuss Lean thinking in systematic order where the customer is the starting point. Understanding value in the final customer’s eyes proposes how waste and related activities are defined (Hines and Taylors 2000, 4). In management, Bill and Brain (2011, 15-17), based on leader’s view of Toyota, systematize Lean philosophy or Lean thinking in 5 basic points: “customer first”, “people are most important asset”, “Kaizen” (improvement is not a sudden big change, but rather small and continuous), “Go and see” (work with working people in person, and see the real situation), “efficiency thinking” (more output, less input).

Many types of wastes are discovered and classified in Lean, the root to name them as waste starts from “value” defined by final customers. However, the system or operation needs some activities to maintain its function, not all non-value adding activities in customer’s eyes are waste. Therefore, Hines and Taylors (2000, 10) mention types of wastes with the build-in content of 3 types of activities (Value-adding; unnecessary non-value adding; necessary non-value adding) which are classified based on two criteria (value-added to the customer; functional necessity). Only unnecessary non-value adding activities (not add value to customer and system still works without them) create true waste that needs to eliminate (Hines and Taylors 2000, 10). Thus, final customers define what is value, value contributes to the process of classifying what is waste and what is not, and finally truly waste is waste that unnecessary for working function.

Adding up to the discussion of “value” in Lean, it is interesting to note that value is added by not only reducing waste (as mentioned in the above paragraph) but also developing value to customers. Reducing waste means adding value to customers. Developing value to customers means to add extra features to product or services which customers consider beneficial (for example: designing product in a smaller compact shape). Surprisingly, increasing value-adding activities to customers does not necessarily mean cost more. (Hines et al. 2004, 997)
Lean exists in Supply Chain in the form of philosophy. In studies of Lean supply practices, Tortorella et al. (2017, 101) synthesize 22 supply practices that relate to Lean which companies have been adopted (details in appendix 3). In these 22 Lean Supply practices, companies do not need to technically apply the traditionally well-known tools in Lean (or named their programs Lean), but rather embed Lean thinking or Lean philosophy in their operation and strategies. In other words, Lean thinking exists in corporate operation and strategies without the necessity to name it “Lean”.

2.4.2 Lean in supply chain management

Lamming (1996) notices that Lean production was studied first, and the existence of supply chain management was found inside Lean production. According to Lamming (1996, 187) Lean in Supply Chain, or “Lean Supply”, brings more cooperation because the cost of damage or value will affect not only customers but also suppliers. Lamming (1996, 188-190) pointed out three features of Lean supply:

- “Transparency”: open-book technique is applied (costs and margin are open to view by both sides).
- “Relationship assessment” instead of “vendor assessment”: by practice, one side “vendor assessment” is a flaw, there is a need for two-way replacement or “relationship assessment”.
- Excuses and blame: a strategy to apply when something went wrong, excuse to avoid the penalty, and blame others to gain higher position and benefit. In the long run, this strategy increases process costs for those who use it. Lean is understood as no blame no excuse culture.

Basing on Lamming’s highlights of a Lean Supply feature, the concept of bringing value to the customer in Lean philosophy is clarified further to more cooperation and more transparency between buyers and suppliers. Or in other words, more cooperation and transparency are outsets of Lean Supply, which finally results in increased value to customers.

Developing from Lamming (1996) and other 25 authors, Tortorella et al. (2017, 100-101) collected all Lean Supply Practices (LSP) which give the concrete idea of output forms where Lean and supply chain management are combined. All 22 LSP have one point in common which
is driving towards more value to customers. The differences are in the way the philosophy expresses in activities of organizations. To bring more value to customers, SCN works in closer and more tighten, more cooperative, open and two-way principle buyer-supplier relationship (for instance: win-win agreement), SCM operates in a more efficient way (save costs, times, more organized).

To understand how LSP (or the outset forms of Lean and Supply Chain Management) links to Lean philosophy, Figure 6 is generated. LSP can exist under various forms, but they go through the same path and same result.

Figure 6: Links from Lean Supply Practices to Lean philosophy

Lean has a relationship with Supply chain management performance. From theory, the way the LSP and described discloses the characteristics of high supply chain management performance such as more efficient, cost-saving, better forecast and planning. Lean philosophy embedded in SCM results in better SCM performance by nature. In the real world, quantitative research finds a significant positive relationship that companies with higher Lean level are those who have higher SCM performance (Tortorella et al. 2017, 108).

Lean and Supply Chain performance is a combination that can be measured. Tortorella et al (2017, 106) measure via four indexes: “Supply lead-time, Costs with supply and raw materials, Inventory level, Delivery service level, Quality”. Arif-Uz-Zaman and Nazmul (2014, 596) proposed the optimal model to measure Lean Supply Chain Management which presents the quantitative performance index of each process step basing on the SCOR framework (appendix 4).
Nowadays, sustainability is becoming a more and more important issue with consumers. The United Nation released 17 sustainable development goals. The wave of sustainability exists in inter-government, society, organization, and consumers who are often called the final customers. Consumers can receive better value through green products and services (Toppinen et al. 2013, 774; Newman et al. 2012, 511; Taghikhah et al. 2019, 652). Increasing sustainability means contributing to increase value to the final customer. Therefore, supply chain performance in a lean way should include sustainability. In fact, numerous researches show Lean advocate Green practices in Supply Chain Management (Singh and Pandey 2015, 33-46).
3. RESEARCH METHODOLOGY AND DATA COLLECTION

This research is designed with a combination of theory and empirical data to interact with each other via an abductive approach. Research question of this thesis aims to open understanding of an emergent field. Therefore, both theory and empirical analysis are used in combination to complement each other or to open new value that previous researches haven’t studied. For this reason, the abductive method is chosen to direct the way between theory and practice to formulate findings of this thesis, giving exploration value on the way to answer the research question.

Figure 7 is drawn to illustrate how this thesis is designed from research question to findings. Research question comes first, following by relevant theory and empirical analysis. An empirical study is conducted via qualitative research with multiple case studies. To facilitate the research aim of exploration, and to utilize the empirical data, both single case and cross-case analysis are carried out. Findings are generated as a result of the abductive method.
3.1 Case study selection

From the methodological point of view, case selection is considered the most important decision (Dubois and Araujo 2007, 179). Selecting cases is not only about deciding how many cases but also knowing why a case is necessary for research. Such questions ‘how many cases are enough?’ or ‘what kind of criteria to choose cases’ actually do not make sense in the qualitative case method. However, to explain the suitability and the meanings of the decision to choose a case/cases do. Eriksson and Kovalainen (2008), and Eisenhardt and Graebner (2007, 27) cite that in the qualitative case study, there is no such similar criterion to quantitative study regarding the minimum number of cases, but the number of cases is decided by study aims and research questions.

Single case and multiple cases, the two often known in the case study method, have different usages. Multiple cases method provides stronger base for theory building (Eisenhardt and
Graebner 2007, 27), a possibility of generalizing method in theory building (Dubois and Araujo 2007, 177), and serve enhancing previous literature reviews basing on comparing the similarity of real cases with findings in literature (Erikson and Kovalainen, 2008). Whereas, a single-case provides an in-deep and rich description of a new phenomenon which is probably hard to find many good cases to study (Eisenhardt and Graebner 2007, 27).

This thesis is a study aiming to gain an understanding of an emergent phenomenon, which indirectly supported by previous studies. In other words, it can contribute to theory building regarding the topic of the digitalization effect in SCM and Lean. It could be seen that the studied phenomenon in this thesis is not extremely new to the point that only one case is possible to conduct. Multiple cases appear to be the better choice, a better base for theory building, enhancing current knowledge, but still, potentially provide a deep description of the studied phenomena.

The cases to be studied in this thesis should be relevant to the research aim and question shown in chapter 1. Hence, selected cases should fulfill three basic requirements. There are three general scopes that selected cases should cover: Digitalization, Supply Chain Management, Lean philosophy. Case companies should have experience of digital transformation, have Supply Chain Management visibility (such as SCM department), and advocate Lean philosophy. If case companies are large in operation or have a global network, it would benefit this research in a way that it gives more space to explore and enhance the representative power of the case.

“In practice, however, once theoretical requirements are addressed, the selection may be influenced by pragmatic considerations, such as access and feasibility” (Erikson and Kovalainen, 2008). Due to limitations (presented in chapter 1 part 1.4. Delimitation), this thesis has three companies to participate as cases (details information in chapter 4) to provide empirical study, although they could be in the same industry or same location. However, from the research aim, this study does not target to generalize demographic characteristics, the same industry or same location is not necessarily important. These companies satisfy the three basic requirements and have a global operational network. Due to confidential issues from the case company’s side, all case companies are coded.

3.2 Interview method
The interview is the primary source of empirical data of the thesis. The interview is designed mainly to answer the main research question by tackling two sub-research questions. Key issues from literature reviews connecting with each sub-research question on which questions of the interview are generated. In specific, the question list is compiled into three sections (in the appendix). The first section addresses issues of technology development, targeting to answer sub-research question 1. The second section embedded issues of supply chain management and digitalization (literature chapter 2, part 3) and the conceptual framework of SCM (Figure 2) to facilitate answering sub-research question 2. Finally, the third section of the question list are questions to investigate Lean outcome after all.

Figure 8: Interview question list content design

To gain the best exploration value and in-depth understanding of a specialized topic of this thesis, the semi-structured interview method is adopted instead of a survey interview. Three themes in accordance with three sections of the question list are in a flexible exploration with the participant in the interview. The closed-end and open-end query types are utilized to complement each other. For some issues which are certainly applicable in the case study, questions are open-end type, for other issues they can start with closed-end and following up open-end questions to explore further if possible.

The interview is conducted with one respondent at a time. The average time of the interview is 30 to 60 minutes depending on the case (Table 3). Because of the issues this thesis aims to study (presented in chapter 1, part 1.2 and 1.3), the interviewed people should be somewhat at the
expert level and have also broad knowledge not only in-deep knowledge of SCM but also know digitalization and Lean. Respondents of the interview are managers of SCM or similar functions who have broad knowledge and expertise enough to know both SCM, digitalization, and Lean. The interviews are carried out via online call and electronically recorded in late October to November 2019. Otherwise, the content of the interview is recorded by note-taking.

Table 3: Interviews conducted with case companies

<table>
<thead>
<tr>
<th>Case company</th>
<th>Industry</th>
<th>Interviewee’s position</th>
<th>Experience in case company</th>
<th>Interview time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpha</td>
<td>Forestry</td>
<td>Vice President of Supply Chain Operation</td>
<td>23 years</td>
<td>28.11.2019: 11:00-12:00</td>
</tr>
<tr>
<td>Beta</td>
<td>Forestry</td>
<td>Supply Chain Director</td>
<td>10 years</td>
<td>08.01.2020: 12:01-12:57</td>
</tr>
<tr>
<td>Gamma</td>
<td>Construction</td>
<td>Vice president, Head of Purchasing and Supply Chain</td>
<td>10 years</td>
<td>05.12.2019: 17:00-17:45</td>
</tr>
</tbody>
</table>

3.3 Data collection

According to the previous study, there are some key notes regarding the case study method. First, keeping good quality and credibility of the research should be minded from the very beginning of data collection. In multiple cases, a similar method of data collection is necessary for the following parts of the analysis in the research. Data can be gained through various sources which are categories into primary and secondary (see more in appendix 5). Research objectives will give the idea of suitable sources of data collections. (Farquhar 2012, 65-83)

Interview is a very commonly used method to collect primary data and it is an efficient way to provide a rich explanation for a new phenomenon (Eisenhardt and Graebner 2007, 28). Not just because of its popularity, but because of the objectives of this study, the semi-structured interview is considered the best to serve this research. Because the case study method is conducted with the selected number of three cases, multiple cases should use the same method of collecting data. The same method, semi-structured interview with the same question list, is
set up to collect primary data from three cases. To ensure successfully gain quality of the harvested primary data, case and represented person for each case are carefully selected as presented in part 3.1 Case study selection, and interviews’ records are secured with electronically record and note-taking if needed.

Secondary data is gained through press release documents found online or in hard paper form of each company. To increase objectivity, secondary data can be also collected from articles written by external case company’s sources (consultancies, social media, industry scientific articles). Secondary data can be varied in the time dimension, while there is a need for similarity in the method of collecting data as stated in the previous paragraph, suggesting the idea to fix time relating to secondary data. Hence, the most recent five years of publication are set as the standard to collect secondary data.

3.4 Empirical analysis method

After the interview, the empirical data is recorded. However, the collected data is very fragmented and diverse. To interpret, data need to be organized, and then interpreting method is needed to align the rich text of empirical data into the proper structure of this study. This part
presents the method of single case analysis and cross-case analysis to interpret primary data from interviews.

**Single case analysis**

Single case analysis as mentioned above is used with a purpose to investigate in detail. It needs a method that provides enough openness and space for exploration. Transforming data is an approach to handle qualitative data which is more open or less restrictive than other methods in the qualitative case study (Simons 2009, 119-120). This approach appears to be a suitable established method to construct research analysis in this part.

Accordingly, description, analysis, and interpretation are used to facilitate transforming data. Central of a data description is to understand the key question “what is going on here?”. Analysis focuses on finding the insights into why things work and why not. Interpretation will solve the last puzzle of the outcomes that can be made after all. Wolcott (1994, 11-36)

Table 4: Structure for single case analysis (adapted from Alcott (1994))

<table>
<thead>
<tr>
<th>Methods of analysis</th>
<th>What is going on here?</th>
<th>Why? Why not?</th>
<th>Conclude Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Conceptual framework</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Technology development</strong></td>
<td>IoT, Cloud, AI, Big Data, blockchain, others</td>
<td>Narrative, description</td>
<td>In-deep analysis</td>
</tr>
<tr>
<td><strong>Digitalization in SCM</strong></td>
<td>Integration, reconfiguration, automation, analytics Customer’s voice</td>
<td>Narrative, description</td>
<td>In-deep analysis</td>
</tr>
<tr>
<td><strong>Lean outcomes</strong></td>
<td>SCM performance, Customer value</td>
<td>Narrative, description</td>
<td>In-deep analysis</td>
</tr>
</tbody>
</table>

Thematic order as one out of two commonly used methods in single case study analysis which is defined as “emphasizing themes, issues, problems, and conceptual categories” (Eriksson and Kovalainen 2008, 115-136). Inside the analysis of each case, main themes constructed in the
conceptual framework at the beginning of this thesis and key issues of each main theme are taken as key categories for analysis. Points considered extraordinary gained through interview data are also analyzed. Short narratives might be presented in quotation marks to give exact pieces of evidence and authentic ideas if necessary.

**Cross-case analysis**

For the case study research strategy, the analysis part depends on the focus designed at the beginning of the research (Farquhar 2012, 30-48). The focus as stated in the first chapter is to explore. The cross-case analysis is established to investigate from the angle of viewing three cases together. Disregard cross-case analysis may lead to subjectivity and waste of exploration value that cross-case analysis can bring to. It is also important to note that this cross-case analysis part is not for generalization of forming theory, although comparison and generalization techniques may appear.

Cross-case analysis can be conducted through comparison, finding similarities and differences, or reflecting the contrast with theory (Eriksson and Kovalainen 2008, 115-136). The analysis is constructed in a thematic order. The below analysis is constructed basing on the main theme and conceptual framework built in the first chapter. Along with the set structure, when viewing three cases together, similarity and difference points appear more vividly as well as patterns can be spotted.

**3.5 Validity and reliability**

By the nature of academic research, quality should be at a strict level. Validity and reliability have been for a long time the approaches to research quality (Farquhar 2012, 100). In the case study, validity and reliability raise big concerns in the research world, following by studies on increasing validity and reliability (Riege 2003, 75). However, the case study method quality is not necessarily always established through the existing validity and reliability tests. Pursuing current methods of validity and reliability may cause constraints on the exploratory purpose of the case study method (Riege 2003, 80). Thus, it is not necessary to compromise the exploratory purpose of case study research to meet traditional validity and reliability tests, but validity and reliability should be aware of during carrying out this type of research.
Many authors developed different ways to clarify the validity of the case study in which can be gathered into three types of tests: construct validity, internal validity, and external validity (Riege 2003, 78-79). Construct validity can be gained through using multiple sources (Flick 1992 175-198; Jick 1979, 602-611), or establish a chain of evidence (Farquhar 2012, 101; Riege 2003, 82), using key informant review (Riege 2003, 82; Yin 1994). Internal validity applicable to an explanatory case study considered how the causal relationship is explained by data and analysis in the research (Farquhar 2012, 100-112). Finally, the external validity of the case study method as said is the ability to generalize from the studied cases of research to all cases (Farquhar 2012, 100-112; Riege 2003, 80).

Within the existing methods to test the validity and reliability of case study methods, the quality of the case study method of this thesis is strengthened. To construct validity, both multiple sources (multiple secondary data sources, and three case interviews as primary data), chain of evidence established in the records of interviews, and thesis supervisors’ review as key informant review are in use. Internal validity is established through the causal relationship from digitalization to effects in Supply Chain Management from the lean perspective shown in the analysis of empirical data from multiple cases (in chapter 5 of the thesis). External validity is not the main target of this thesis because the main purpose is to establish an understanding of a new phenomenon, but not to create a ground theory that applicable for all other cases out of this study.

Reliability concerns the trustworthiness aspect of the research or the honesty of data used for research (Farquhar 2012, 100-112; Shenton 2004, 63-75). To increase the reliability of this study, well-established methods to increase the reliability of the case study method namely data recorded by machine, note-taking, semi-structured case study protocol (Riege 2003, 82-83) are all adopted to conduct this thesis. Data in this study is obtained via multiple sources which are discussed together to reveal the true picture of the case. Participants of the interviews are informed in advance about relevant information. Interview conducted with openness. A one-to-one interview is designed to prevent bias caused by influences of the presence of other people.
4. CASE INTRODUCTION

Three case companies participate in the case study interviews have common points and industry differences. They are all global firms in which SCM has a wide landscape to play its role. Three companies considered innovation and digitalization important. Sustainability is a common topic of interest for all companies. The difference is that Alpha and Beta belong to the forest industry in which they play active and leading roles, whereas Gamma is a famous company in the construction industry.

Operations (offices, factories) are important in business in general and in SCM in specific. To give a picture of the operational presences of each case company and overview, Figure 10 roughly presents three case companies in three different colors on the world map.

Figure 10: Geographical distribution of case companies

Due to the confidential agreement with case companies, detail information of each case is kept at a minimal level. Data in this part is generalized enough to maintain the level of confidentiality but not to lose the purposes of giving an informative picture of case companies.
4.1 Case Alpha

Alpha is a global firm specializing in forest-based products with more than 10 billion EUR sales and around 20,000 employees. Over 100 years in the industry, this firm developed its business to the global level (shown in Figure 10). In the industry, Alpha acts as an active player, possesses industry in knowledge and a broad supply network, staying as a successful example of innovation and sustainability. The operation and legal entity over 100 years have changed many times due to the merge and acquisitions, which enriches the firm experiences in complex operational management.

Alpha’s strategies aim at high performance, demand change adaptivity, environmental sustainability, and long-term competitive advantage. Innovation and continuous improvement come to bring new value to the existing business and increase value to customers, facilitating the process of reaching goals set in its strategies. To increase stakeholder value and response to the positive orientation of the industry, this firm expects to capture the full value of the bioeconomy.

Alpha carries out innovation through developing new products/services, new businesses, and digitalization. This firm believes that digitalization can optimize processes and outcomes, bring agility to business and supportive forces for operation and decision making, and at the end create the firm’s competitive advantage. Digitalization takes place in this firm with the presence of robotics and process automation. The production site is the starting place where innovative technologies are adopted. In the future, front-desk processes and supply chain are expected to experience more digitalization move. A user-friendly mobile application is one of the interesting examples of this firm’s digitalization journey.

Digitalization initiates by searching for cooperation with capable partners. By engaging with universities, research institutes, starts-up and technologies suppliers, innovation and capabilities from outside of this firm are utilized, which also means that this firm does not have to spend internal resources to start creating from scratch. Digitalization projects are conducted via the pilot stage and then expansion. Areas are intended to put digitalization in focus is production, customer’s experience, supply chain, and administrative works.
4.2 Case Beta

The case company coded as Beta is a global firm operating in the Forest Industry. Beta has operations in all continents (shown in Figure 10), hires more than 20,000 employees and generates sales of more than 10 billion EUR recorded in 2018. This firm has been known as the main contributor in the forest industry with a long history for several hundred years. The commitment to bring eco-friendly, sustainable solutions embedded in product development and technologies has been for long the main them of business. To move forward in its industry and to take responsibility for society and environment, this firm continuously seeks improvement in process, input efficiency.

As part of its development strategies, innovation and technologies have been progressing. As of 2018, the outstanding technologies this firm accelerates in operation are Robotics, Augmented Reality and 5G. Thus, real-time information comes into effect in maintenance work. Robotics adopted to automated processes in offices and operations, bringing cost and time-saving results. Data and analytics are also available, acting as a supporting role for strategy making. For the time being, it continues to pay attention to new technologies namely Artificial Intelligence, Automation, Robotics. Furthermore, security is raised together with the process of adopting new technologies.

Digitalization is expected to bring a competitive advantage to this firm. Competitive advantage will be built upon different areas to which digitalization touches. Digitalization enables optimization and efficiency in many functions including supply chain and sourcing. Supply chain will be more transparent together. Processes in both back offices and production areas become more intelligent and automated. Customers are engaging in the more digitalized experience, and a new business model is forming.

Digitalization has been implemented step by step under the form of projects of new technologies. The process of digitalization becomes more and more visible. Digital invoicing is said as preferable to its customers and suppliers. Robotics, 5G, big data are in place and waiting for multiplication within its systems. To go forward, a nurturing culture encouraging people to change with new things and experiment is considered not any less important than the technology side, and customers’ voice is considered throughout the process of making the best use of industry know-how and innovation development.
4.3 Case Gamma

Gamma is one of the world-leading companies in the construction industry and has a history of more than 100 years. After several times of expansion, mergers and acquisitions, Gamma has developed beyond its homeland to become a global corporation, serving the European region, UK and US. Reported in 2018, Gamma hires more than 30,000 employees and achieves more than 15 billion EUR.

Working in the construction industry, there are four keynotes taking for Gamma: the project-based characteristic, sustainability, safety (accidents at work and building safety), an ethical issue. To validate ethical practice, Gamma has established its code of conduct for internal use and for suppliers. Gamma business strategy is not only a for-profit strategy but a sustainable strategy that is supported by three solutions: increase operational excellence, using the network to leverage collaboration, create an open cooperative working culture.

Gamma SCN is defined by the construction industry, and its roles are dynamically defined by projects. SCN of the construction industry by nature is very fragmented, complex, dyadic, low trust and adversarial (Rezgui and Miles 2009, 558-567; Akintoye et al 2000, 159-168; Korczynski 1996 787-808). For study, a typical construction industry SCN is constructed by the main 5 groups of participants, or 5 tiers: developers, architectures/consultants, main contractors, sub-contractors, suppliers (Balasubramanian and Shukla 2017, 60). If SCN should also count customers/clients, a supply chain network consists of 6 tiers (Figure 11).

Figure 11: Construction SCN (adopted and modified from Balasubramanian and Shukla 2017, 60)
Gamma’s development has a growth on the base of research and innovation. For this significance, research and innovation are established as a function in the organization’s structure collaborated with universities and research institutes, to invent new solutions such as new technologies, new products or services. Digitalization as part of the innovation process in Gamma has been recognized as the company’s core and the future move for not only Gamma but for the whole industry transformation.

Gamma is learning and experiencing new working ways with modern digital technologies such as using Ipad to manage work, 3-D model, track and tracing technologies. BIM (Building Information Modeling) is one bold move adopted by Gamma, which yields high-quality products and efficiency, benefiting both Gamma and customers. This wave is transcending within internal employees, office, and fieldwork, beyond the company’s boundary to suppliers, partners, customers. Because of the new characteristic of digitalization, Gamma does not hesitate to actively expose to new technology with an open-minded attitude for an interesting not-yet-known future.
5. ANALYSIS AND EMPIRICAL FINDINGS

In the case study research method, Simons (2009, 118) states “from the moment you select your research questions and design your study you are foreshadowing issues or indicating frames for analysis”. To better achieve the exploratory purpose and answer this thesis research question, the analysis in this chapter is approached via two directions. The first approach is to investigate each case as a single case where each case is an independent case study (in part 5.1). In this way, the uniqueness of each case is preserved. The second approach aims at exploring by viewing three cases at the same time (part 5.2). Three cases are synthesized, compared, and generalized, resulting in a big picture revealing patterns or new scopes which individual case alone cannot capture.

Eriksson and Kovalainen (2008, 115-136) state that the commonly known and repeatedly used case study research method presents with single case analysis at the front, following by cross-case analysis. This part is structured accordingly, meaning that single case analysis for each case is conducted first, and then viewing three cases together in the cross-case analysis.

5.1 Alpha case analysis

As planned, the analysis of Alpha is broken down into three parts: digital technology development in SCM, digital transformation in SCM, and Lean outcomes. During the interview with the interviewee who is the expert of case Alpha, answers provide interwoven issues that relate not only to a question but others of the question list for interview. Basing on this fact, the analysis is not restricted to one answer of the interviewee but rather synthesized from many answers.

Digital technology development in SCM

Digitalization has been filed as one of the strategies for Alpha for the time being and in the future. The direction of digitalization was set from the Board of Management, detailing in all internal operational activities which SCM has wide coverage relating to digitalization. The provided reason for digitalizing fast by Alpha is to be more responsive to the changing from customers, and the market. In the forestry industry, its final customers are consumers who are using more and more new technologies such as Facebook, smartphone, and caring more about
the biology environment, social sustainability, which force firms to re-invent to serve their customer better. New disruptive technologies coming in such as mobile, faster internet, shaping the market movement in a new way. Also, disrupted technologies allow firms to generate new working ways, which opens chances for Alpha to gain advantages and explore new businesses. Alpha sees digitalization as a must to meet the changing market, and an opportunity to be the forerunner in its industry.

IoT, Big Data, Cloud, Artificial intelligence, automation, robotics, and data analysis are both existing in the case Alpha. The adoption of new digital technologies is very active and innovative. Many examples are given by Alpha’s expert. Robotics are adopted in manufacturing plants and in the documentation. The advanced technology of labeling is replacing manual labeling. Cloud, IoT, and mobile for the faster and cheaper solution of information and communication within corporate and sometimes with external parties. Sensors capture and transfer data, giving a boost to the database for data analysis. The more accurate algorithm is developed to provide better analysis, problem-solving solutions, and prediction. The drone is flying above the forest to monitor, detect forest fire much earlier and safer than the manual method.

The development of digital technology at Alpha is more and more dynamic. Directly related to SCM work, Alpha has developed a smart platform where it integrates information from Alpha and from logistics providers. The platform gathers all necessary information for managing shipment, material flows, which could also call an “all-in-one” platform. Goods flow is now visible in real-time on the global map, which enables faster and accurate information for SCM work. It also suggests a new way of operating and issue of integration which will be presented further in the next part of case Alpha.

The reason behind of technology adoption is strongly related to cost and efficiency. The expert in case Alpha explains:

“We use technology in labeling instead of manual labeling, because the price of labor is increasing, and the price of technology is decreasing. We have to use technology to ensure efficiency and save labor costs. The other example is that in the documentation, you are able to use mobile phones to import documents, and then
use robotic software to process the input data. The process is now more convenient and efficient.”

Alpha’s own willingness to digitalization is clearly explained by the interviewee. There are two points to be taken from the forestry industry. Firstly, the labor-intensive characteristic of the Forestry industry will be influenced substantially once labor cost increases. Technology appears to be the solution to tackle this problem. Secondly, stable operation and network, and a rather predictable consumption are favorable conditions for Alpha to adopt and scale up the digital technology. This second point will be explained further in the description of the digitalization transformation in the below paragraph belongs to this case, and the contrast is mentioned in the case Gamma.

Figure 12: Alpha's technology development

Because of Alpha’s motivation and the industry advantage, the development of technology in SCM in Alpha is abundant and is projected to expedite in the future. Alpha expects the future in SCM in the next 5 years is a process of fully digitalized internally and goes in hand with suppliers, distributors, customers, banks, logistic service providers. More and more processes to be automated, resulting in high speed, efficiency and a need for high-skilled labors. At the same time, Alpha concerns the incompatible facilities and willingness to change of partners but also believe that the fully digitalized future will come once the trend takes place. From the Alpha side, it continues to go faster in digitalization with its best attitude. Alpha’s expert shares:
“We are trying to do whatever the routine work to be automated. We cannot wait for all the routines processed, but we try to automate as much as possible”.

Digitalization in SCM

Before going into the analysis of transformation as set in the conceptual framework. The word transformation in SCM is understood by Alpha is a gradual process of continuous improvement. In other words, there is nothing so-called sudden transformation. Alpha’s expert explains further:

“Every now and then, what we do is to always continue renovating. Because now we can see the process can be repetitive, then we look for technology and ask what technology is possible to do it. Sometimes you test new technology and fail, and sometimes you learn something new and continue.”

It is evidence that digital technology can make the information sharing and integration of related parties much faster, more visible and reliable. A smart platform as mentioned in the technology development part is one typical example of how digitalization works in integration in SCM. The platform integrated information from Alpha, service providers which information of good flows, shipment details are visible in real-time. It allows Alpha to answer customers immediately, accurately. Another example is the future possible integration systems to reduce manual works from documentation of shipments to payment. Manual works, for example, Letter of Credits checking with documentation and courier of original documents, are by far time-costing. Time by manual works will be eliminated, robots and artificial intelligence will replace manual checking with more accurate results. Regarding the current integrated platform, Alpha’s expert said:

“We often face the customer questions where is the shipment? In the past, we had to call the shipping agent or visiting their website to check. Now we and our service provider have developed a platform where you can see the information of where the good is on the global map, or when the goods leave the mills, and you can track the real-time location of the goods. I think digitalization increases the visibility and increases speed and you can inform your customers more correctly.”
Figure 13: Outlook of Alpha's simplified network and SCM digitalization

Alpha is currently trying to explore the potential of using digital technologies to renovate the current SCM integration. As a very nature of integration and digitalization, Alpha needs to work with other companies. Basically, those companies can be suppliers, technology companies, and customers. From Alpha’s point of view, it advocates digitalizing the whole process in which SCM integration is unavoidable, but to current experiences, there are two significant issues: how to link together, and the mindset of management of each participating party. The mindset of the management comes first, and defining how to link comes later.

In terms of SC automation, the existence of robotics, AI embedded in Alpha’s software and digital devices such as sensors, smart labels, allowing Alpha to go automated. The process from both the back office to the front office, and shop-floor areas are supported by automation. The base for automated in terms of tasks is to focus on replacing human repetitive tasks by machine. In Logistic, Alpha’s platform automates the manual process of checking, and AI comes to support faster and more accurate calculations. Regarding this platform, Alpha expert reveals:

"AI calculating the shipping arrival much more accurate data than the shipping agent. Shipping agents have their websites and systems, but they don’t have artificial intelligence to estimate the arrival time of the vessels, so most of the time the shipping lines estimated arrival times are not correct. Because our system, we
integrate AI, it gives you much more accurate information, so customers are very happy because we are giving them the exact time of arrival of the ship. While the shipping agents rely on the shipping lines information, and the information flow goes very slowly.”

In SCM, flows of goods, information and finance will be greatly supported by automation. Alpha expects process automation established from documentation to the bank and to customers because this is by far very manually conducted. The automated process is also applied actively to manage administrative tasks with respect to the law and regulation of each territory.

In the interview with Alpha’s expert, data was mentioned as the available resource of digitalization which enables better analysis, optimization, real-time decision making. Data is captured much easier, transferred faster, and stored at high volume. To Alpha, big data exists as a result of digitalization in Alpha, leads to a new landscape of utilizing data for operational problem-solving, process improvement, and strategic decision making. One exciting example to explain further is given:

“If you can capture the data, then you can improve the lead time. The way we doing this is the process digitalization. Packaging and track and tracing technology improves, and sensor. You know what the shipment time is, and possible delays, which allow you to predict more exact shipment arrivals. This information can be later used to measure the performance of your suppliers.”

Regarding SCM reconfiguration, Alpha has not experienced many current changes causing by digitalization, but it believes the change is foreseen and unavoidable. Following bullet points is a summary of Alpha’s expert opinion:

- The role of SCM department will become more strategic because SCM can capture internal processes and external integration within its supply network once a lot of processes will be digitalized internally and externally.
- Internal organization structure might not have shakeup, but the essence of connection within the organization structure will be faster and more connective and transparent.
- The role of employees will change from doing repetitive work to a more intellectual and data-driven direction. In such a change, traditional works that contain repetitive tasks or data entry jobs will be replaced by data analysts or data scientists.
The inter-organizational network will change to a more complex or simpler one depending on the business or products/services. For some businesses, Alpha will utilize the new capability to connect to more nodes in the network and handle much more complicated relationship than the traditional ways. For others, streamline the network is necessary depending on the business needs.

When mentioning customer voice in the process of digitalization in SCM, Alpha reflexes through the various example of using digital technologies to capture customers’ feedback. Modern ways to collect customer’s opinions are now conducted via mobiles and social platforms. Customer feedbacks are taken at both before and after digitalization implementation decision making. This does not mean that all digital projects need customer voices, but rather the customer’s voice is taken with consideration. The customers’ voice is used to know how the digitalization is going to enhance or add value to customers in certain situations in which the changes connect strongly to customers. Otherwise, changes take place internally shall be kept internally.

**Lean outcomes**

One thing noticed after the interview with case company Alpha is that three main scopes: digital technology, digitalization in SCM, and its effects are interwoven issues. Once mention about one scope, the Alpha’s expert is likely to link with other scopes. Many outcome effects of digitalization are given during answering the interview questions and once again summarized in the last two questions of the interview with Alpha’s experts. This part is taken the shreds of evidence not only from two last questions of the interview but also utilizes rich evidence of other previous parts to clarify the Lean outcomes.

Alpha’s expert described that Lean means more simplifier, faster, responsive, agile to different demands. These aspects go parallel with the effects of digitalization taken place in Alpha. The below paragraphs will be analyzed into two aspects: SCM performance and customer value.

In terms of SCM performance. Planning becomes more accurate because of AI and a more accurate algorithm in the demand planning system, and a new shipment platform with more accurate ETA. Time is improved via shorter lead-time and faster internal processing time. The buyer-supplier relationship is strengthened by more reliable information and transparency.
Risks mitigate with support of problem- detect and prediction system, and evidence of damage or loss of shipment via camera. Quality of cargoes is improved through learning from current and past problems which detected faster than before.

To illustrate better the points of Alpha and to support data for table 5, below narrative extracted from the interview:

“We have a shipment that coming from Europe take many weeks, you are able to give customer exact information of where the shipment is and the most accurate ETA, more reliability.”

“Now you buy something online, you can see the mobile phone, you will know real-time information, more visibility of product flow and improvement of information and financial flow. It means it gives customers more visibility, confidence in delivery and it gives a lot of data information which you can use to improve your operation if your operation is not running well. “

“It helps to monitor performance, longer life cycle of machines by better monitoring system errors and maintenance. Now you know exactly where the machine breaks down or predicts if a machine is at risk. Digital devices also help us to better manage wastes in our operation. In the forest, we use a drone to detect forest fires. All those contribute to reducing wastes and target to improve our sustainability aspects.”

Basing on the provided data in the interview, Table 5 keeps track of evidence of how Lean supply and SCM performance in connection with the academic world.
### Table 5 - Alpha Lean Supply and SCM performance

<table>
<thead>
<tr>
<th>Scope</th>
<th>Author</th>
<th>Criteria</th>
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<th>Yes</th>
<th>Evidently</th>
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<td>Lean Supply</td>
<td>Lamming (1996)</td>
<td>Transparency (open-book)</td>
<td>*</td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Relationship assessment</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>No excuse, no blame</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tortorella et al. (2017)</td>
<td>Lean practices in corporations</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Lean SCM performance</td>
<td>Tortorella et al. (2017)</td>
<td>Supply lead-time</td>
<td>*</td>
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<tr>
<td></td>
<td></td>
<td>Cost with supply &amp; raw materials</td>
<td>*</td>
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</tr>
<tr>
<td></td>
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<td>*</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Delivery service level</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Quality level</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arif-Uz-Zaman and Nazmul (2014)</td>
<td>Plan performance</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Source performance</td>
<td>*</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Make performance</td>
<td>*</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Delivery performance</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Return performance</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sustainability</td>
<td>Toppinen at al. 2013; Newman et al. 2012; Taghikah et al. 2019</td>
<td></td>
<td></td>
<td></td>
<td>*</td>
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</tbody>
</table>

In terms of customer value, digitalization in SCM at Alpha gives the customer more accurate information and faster support, boosting the customers’ confidence in doing business. More transparency brings better quality to SCM, the solution also comes faster, the operation is improved, and better sustainability solution, leading to increase customer satisfaction because customer value is perceiving such added benefits. All improvement from Alpha side shares at some points to customers which embedded in Alpha’s products and services. For Alpha, the value it brings to customers is not yet defined, Alpha’s expert adds:
“You add more value to your business and to your customers. It could be not traditional value, but the new value created by doing business in a new way. The more value you bring to customers, they are more willing to work with you.”

5.2 Beta case analysis

As mentioned above, the analysis of each case will be constructed according to the main conceptual scopes of this thesis and the interview questions’ structure, which finally helps in answering research questions in a systemic manner.

Before going into the analysis of Beta, the interviewee who is called an expert for case Beta disclaims SCM because of its difference compared with normal SCM described in the theory. SCM function in Beta focuses more on the customers’ side and exclude tasks with suppliers. How Beta defines for its SCM department does not mean sourcing and purchasing activities does not exist. Sourcing and purchasing by nature still link and stay as a supporting role for the SCM department to deliver good results to customers. This is a standing point where Beta’s SCM Director answered the interview and the analysis of Beta is viewed, leading to the focus of empirical analysis skewing to the downstream of supply chain.

Digital technology development in SCM

In recent years, works in Beta’s SCM has been transformed substantially thanks to digital technologies. Overall, all mega technologies in the literature are applicable in the Beta case, and all areas of SCM in Beta have the presence of digitalization. As described by Beta’s expert, digitalization brings surprising good support to SCM work such as speed, intelligence, accuracy, etc. The competitive advantage and adaptability to changes from the environment are expected to gain at the big picture.

Going deep into the SCM work, outstanding technologies are mentioned including robotics, AI, mobile as they create impressive changes in the field which the Beta expert shares with concrete examples.

Robotics is named as one of the revolutionary technologies in SCM by Beta. Robotics encompassed physical works in the production sites and administrative processes. In production
sites, robotic arms are used to replace manual works such as in packaging and handling goods. In the office sites, robotics exists in software to support office work in a speedy and accurate manner, called Robotic Process Automation (RPA). RPA can support in processing customer orders, or in matching payment with corresponding invoices, and to help in tracking and tracing goods/material faster. Beta’s expert explains:

“Earlier the customers send their orders for example by emails, and in their emails usually they have an attachment usually in pdf file, so you open the pdf to know customers’ inquiries. Our customer service opens and manually input all info. You usually have to manually find and insert it in the system with product codes, quantity, delivery and so on, and complex system, which is difficult to ERP old-style coding. Now we have robots to automatically read the information in pdf and automatically insert in our system. If information is wrong or something needs attention, it can give alarms to the person in charge. So you basically our service person when the email comes in, they don’t need to anything, they just usually next days they come to the office to read if there is any alarm from email or from the robotics, they send it to you to tell you this order is missing so that basically all the things they need to do with the customers’ orders.”

Together with RPA, AI is used in demand planning, resulting in a decent level of accuracy. Beta has digital tools to analyze the historical data and algorithms to improve the accuracy in predicting and matching with customers’ demand.

In Beta, mobiles and pads are commonly used at work. Mobile phones appear obviously a tool to increase people’s connection. Furthermore, mobile phones in Beta are used as a problem solver in delivery, and production sites. Beta gives examples of how mobile phones are used in production and in delivery:

“Going to the machine, how difficult it is to claim in usually danger and also difficult position and difficult to see what is wrong, but with the mobile tools make their life much easier. Now you just go there with the mobile phone and scan the machine, it can help you to analyze what is wrong with that part.”
“We also developed an app in our phone, when the package in damage, we have label reading (barcode, smart label) all the important information to keep track of products, take pictures, and take actions such as order a new package or new label which is very fast and convenient. It would be very challenging if we do it by computers.”

Interestingly, mentioning about mobile technologies, the pads are considered more advantageous and easier to use at work than mobile phones. Both mobile devices are portable and connecting to the internet, but pads can have more functions for working purposes and a bigger screen to present data and images.

From present to the future, Beta see its expectation as well as possible restrictions. Beta sees digitalization as a fast pace journey where it already accelerated and is going to expedite more in the future. Beta has been actively approached new technologies and expects to gain more transparency in SCM. However, as a manufacturer in the forestry industry, machinery and facilities are expensive to change, pulling related systems to be tied with it. To Beta, this causes setbacks to progress digitalization in Beta compared to other fast digitalizing industries such as automotive or technology producers like Nokia.

For a new technology, Beta is open more and more to learn how to adopt it in its own setting. Blockchain is one example of a new tool for the future in SCM. In Beta, Blockchain is in the early stage existed in pilot projects within the Financial area. This is a tool to provide more transparency, steadiness, and security for not just money flow but for the information flow, not just limited within the financial area but to the SCM as well.

“For us, Blockchain is still at the beginning stage and we are open to learning about it such as exactly what is a blockchain and how it can benefit us. We should be more open with blockchain. It would be great we can develop more applications not only restricted in our financial function, utilizing technologies. It not just about money but the information secured can be a benefit.”

**Digitalization in SCM**

Supply Chain integration in Beta happens in the connection between Beta and customers, and customers’ customers. If Beta can plan better, Beta’s customers can also plan better based on
information provided by Beta to serve customers’ customers. To plan better, Beta needs to understand customers’ orders better than in the old way. Customers’ planning becomes better if they understand Beta’s production and SCM plan. It is a two-way information sharing, which in turn becomes a win-win benefit for all chains of SCM. Digital tools including robotics software, mobile come in a sense that they speed up, increase the accuracy, and refine the information flow. An example of real work experience is described in the first part of the digital technology development of Beta, relating to RPA in processing customers’ orders via email.

Looking deep down into the industry to understand why the above-mentioned planning task becomes so significant that SCM integration has been described as potential and important to expedite with digitalization. The first reason is that Beta has high costs of poor planning production, and it has conditions to support planning. On one hand, Beta’s production needs to be strictly planned and tie with the expensive big machines, and on the other hand, stable conditions of production such as fixed location and machine capacity make planning feasible. The second reason stems from Beta’s SCN. The node that Beta stands in the network is manufacturing or upstream, meaning that there is a far gap to reach the end consumers. This is not only a challenge but also an opportunity for Beta to move beyond its competitors, providing surplus value to numerous of customers standing in several nodes of the downstream of SCN.

Reviewing reconfiguration of SCM since digitalization has been accelerated. Beta sees the unavoidable changes in people’s working way, organizational structure and the potential changes of SCN. Working people should actively change by learning and improving to work in a new digitalization setting, recognizing as one of the most important things in Beta. The organizational structure change would be more flexible in work location arrangement because digitalization can enable people to work at any location where they can connect to the internet. For SCN reconfiguration, it is expected to be simplifier rather than expanding in the Beta SCM digitalization journey. Beta’s expert shares:

“I remember that when I was promoted in the leading role of this organization that handling all our company’s orders, my boss asked how we perceive digitalization. I replied that we were able to reduce those physically handling tasks, put more resources to serve the customers, find more solutions and increase the service level to customers. We have to concentrate more on our people, and this is one of the most important things. I hope everybody understands if we do
"not improve, or not learning how fast the digitalization moves. We have to change, otherwise, we will be changed."

Automation is evident in the case of Beta. Automation, enabled by robotics (including RA and RPA), smart labels, mobiles, transform physically handling tasks in manufacturing as well as office sites. RA replaced physical work in manufacturing, and in the packaging and handling tasks in Logistics. Together with smart labels and mobiles, goods or materials are now possible to track and trace, a visible flow of goods in Beta SCM. In the office, SCM processes are going to be more automated. Order receiving, handling, and fulfilling are strongly supported by RPA.

Analytics in Beta has been actively developed. After analyzing the importance of demand planning and corresponding digital technologies, using big data and analytics is a must. The availability of historical data and real-time data are used with AI, supported by SCM integration, significantly improve the accuracy and speed of SCM planning.

Table 6: Changes in Beta's SCM in connection with digital technology

<table>
<thead>
<tr>
<th>Area</th>
<th>Changes</th>
<th>Technologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCM integration</td>
<td>Two-way information sharing, more integrated, faster to capture data,</td>
<td>Robotics process automation</td>
</tr>
<tr>
<td></td>
<td>more useful data</td>
<td></td>
</tr>
<tr>
<td>SCM reconfiguration</td>
<td>Changing people’s working role</td>
<td>Mobile, mega-tech trends</td>
</tr>
<tr>
<td></td>
<td>Possible flexibility regarding working location</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Simplify SCN</td>
<td></td>
</tr>
<tr>
<td>Process Automation</td>
<td>Replacing physical handling task, manually handling task which has a</td>
<td>Robotics process automation, Robotics arm</td>
</tr>
<tr>
<td></td>
<td>repetitive characteristic, leading to works automated.</td>
<td></td>
</tr>
<tr>
<td>Analytics</td>
<td>Real-time data, historical data, more available data and more accurate</td>
<td>Robotics process automation, AI</td>
</tr>
<tr>
<td></td>
<td>demand planning.</td>
<td></td>
</tr>
</tbody>
</table>
Lean outcomes

The existence of Lean outcomes in case Beta does not form by traditionally by Lean practices but through new benefits. Basing on the way Beta’s expert described the empirical data, customer value basing on Lean philosophy and the SCOR framework to measure supply chain performance of Arif-Uz-Zaman and Nazmul 2014 are the most fitted frame to use for Beta analysis.

Supply Chain performance improvement generally described as faster, more accurate, resource-saving. Empirical data from Beta’s expert matches with all supply chain performance indices, except Source Performance because it is not counted as SCM function in Beta. The most substantial impact locates in plan performance, following by Make, Delivery, and Return Performance.

Table 7: Beta SCM’s performance reflection

<table>
<thead>
<tr>
<th></th>
<th>Beta’s reflection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plan</td>
<td>Demand forecasting is more accurate and speedier thanks to Robotics, AI, improvement in SC integration. Improvement in both customers and Beta in knowing the right time, the right information, and reducing risks of inaccurate planning due to low transparency.</td>
</tr>
<tr>
<td>Source</td>
<td>Not applicable.</td>
</tr>
<tr>
<td>Make</td>
<td>Mobile &amp; robotics support finding a tricky broken part in the production site, saving resources including cost and time and people. Better demand forecasting leads to less waste and higher effectiveness in the master production schedule.</td>
</tr>
<tr>
<td>Delivery</td>
<td>Better control delivery lead time, reducing unnecessary lead time. Better problem-solving in delivery in case of order adjustment or return. Stably serve customer’s demand for delivery and planning time with customers for a better outcome.</td>
</tr>
<tr>
<td>Return</td>
<td>A loyal relationship between Beta and customers. More stability in the quality of delivered goods, fewer damages. Extra value for improving big issues such as sustainability.</td>
</tr>
</tbody>
</table>
On the customer side, customers perceive more accurate information about goods, faster response to solve their problems, better control in terms of cost and time. More importantly, the stability of products over time is one of the most important results of digitalization which keeps customers stay in this industry. Furthermore, Beta’s saving resources coming from reducing manual work is an enabler to locate resources for finding and bringing surplus-value to customers such as improving sustainability and building win-win programs. Another point is that the value spreading like a domino effect from upstream to downstream of SCN. The value customers can perceive from digitalization in Beta is the base for Beta’s customers to offer to their customers.

5.3 Gamma case analysis

Intentionally designed, analysis of gamma case is divided into three parts: Digital technology development in SCM, digital transformation in SCM, Lean outcomes. Working in the construction industry, the Gamma case is substantially different from others. Nevertheless, the focus on the case Gamma itself to answer thesis research questions is the most important mission of this part.

Digital technology development in SCM

Digitalization comes in SCM in the construction industry and Gamma as the opportunity and challenge. Gamma emphasizes the important role of digitalization to solve current inefficient works in the construction SCM field. One outstanding feature of the construction industry is the complex essence of numerous involving players. To Gamma expert’s sharing, the overlap work problem is happening in this industry, in which digitalization can come in as a solution. The scope of work is the same, but many people conduct it, which is not necessary and wasting resources. The reason behind, provided by Gamma’s expert, is the fragmented and local characteristic of SCM in the construction industry. Digitalization is an enabler for a future prospect that one conducts a task which provides the same real-time, same information to many others. The example is given by Gamma:
“Lots of things multiple players, they double works, do the same things in SC. You can cut out unnecessary work or double work. In many organizations, if digitalization develops, only one person does the check-up and many others can use the same data. Now each of the party has to do by themselves.”

Besides the fragmented nature of the construction industry, it is challenging probably because of the level of information sharing. One does the work, and results are to share with others, which needs a condition of information sharing. Without information sharing, double works are not detected, and results are not allowed to be shared. As in the theoretical study of this thesis, digital technologies come as a facility, but digitalization is a way to use the technologies for generating new processes or new business value. Putting digital technologies into solving problems requires a configuration of ways to adopt that can become a real solution for current business practice.

A new perspective is given from Gamma's case that industry can overshadow how advanced the digital technology of a company is. Gamma described itself as not so advanced in digital technologies due to the industry characteristic challenge. While other industries such as electronics, automotive, consumer, they have a spacious landscape to explore and gain benefits from digitalization. Also, industry characteristics mean how fixed is the factory or manufacturing facilities, which matters in digitalization. Details to be explained in the next part of the digital transformation in SCM.

At present, Gamma has tried digital technologies as mentioned in the literature review. The point is that the development of such technologies is not as pervasive and active as other industries. To Gamma, present digital technology adoption in SCM is most advanced and most direct in procurement with the support of software robotics where real-time SC information is available.

Software and track-and-trace technologies are demonstrated as a typical example. Since 2011 system developed on the base of track and trace technologies such as RFID has been proven to have a positive impact in increasing visibility of material flow, which is acknowledged by leaders in construction and called for spreading to the whole supply chain by scholars (Young et al 2011, 983-984). Nowadays, RFID and barcode are described as interesting digital
experience to provide more visibility and support goods flow management in case Alpha. However, those are adopted not for the whole SC, or not for all suppliers.

Despite great challenges, the exploration journey of digital technologies is still going on with Gamma, as digitalization benefits in the construction industry are not any less important. With Gamma, digitalization goes in hand with sustainability. As the construction industry contributes to nearly 40% of the planet’s carbon emission, this industry takes great efforts to reduce carbon emission by looking into carbon footprint and handprint (World Green Building Council, 2017).

Digital technology development should consider embedding sustainability targets. BIM, mentioned in case introduction, has some relates to SCM in a way it centralizes goods or material flows and stages of installation, which results from SCM, and supports SCM in sourcing, planning, supplier selection. When carbon index is embedded into, for instance: materials, it is ways more meaningful for both SCM and sustainability strategy of Gamma. And the more track and trace technologies developed, the better visibility and real-time information the system can provide. This example is described as a typical example of how exciting the journey and benefits of digitalization Gamma can explore in the future.

In a discussion about how digital technology develops, Gamma sees listed technologies in the literature are true, but the focus should shift to when to do what. At the time being, raw data processing is the key to open many doors of digitalization in SCM. As data can be gained through many different sources, but the fact that raw data is very fragmented or unclean that is a current biggest setback. Gamma’s expert describes:

“It takes a lot of time to clean the data, organize it probably, and make it reliable. Once the data is clean, we can use the data like machine learning, AI, or all kinds of analytics that help to utilize big data. It is the most sophisticated work to clean the data. After that, there is a lot of interesting things.”

In the future of the construction industry in general and Gamma in specific, it is important to increase the traceability of goods or materials. At the same time, traceability formed by digitalization in SCM goes in hand with CO2 solutions. Future digitalization in general, Blockchain will play a more active role as stated in the literature. However, it is not really true
in the Gamma case. As said by Gamma’s expert, Blockchain has been used for buying some
residentials, which could be used in the purchasing of SCM, but it is not considered important.

**Digitalization in SCM**

At a glance, motives and shades of digital transformation in SCM in the case Gamma is
influenced by the industry characteristics. Gamma renovates its SCM by digitalization occurred
in both four pillars of digital SCM mentioned in the literature review. Among those four pillars,
SC automation and SC reconfiguration are most active, while SC integration and SC analytics
are kept at a modest level for industry reasons. Insights are to be revealed in the below
paragraphs.

Digital technology, for the industry reason, is adopted at a minimum level in SCM integration.
A new way of sharing information with SCM members exists only under some specific
situations such as using drones, taking photos of the current situation of a construction site, and
sharing with others. A popular phenomenon in Logistics, which visibility of goods flow is
shared in real-time, is not significantly developed in case Gamma.

In the case Gamma, it has the complexity in supply. First, the supplier base is complex due to
a fragmented system, which information of suppliers for the local project kept isolated from
others, and a huge number of suppliers to manage. Second, Gamma’s material sourcing is also
wide in products and big in volume. This complexity is partly solved by digitalization by
centralizing the system for supplier selection, and automated processes of sourcing and
purchasing. From the aspect of task management, double work once mentioned in Gamma’s
industry is obviously to provide the solution, and administrative tasks are possible to automate.
By automation, Gamma is able to handle effectively in SCM and SC process. Gamma gives an
example:

“*You actually can automatize the so-called administrative tasks. We now have
more and more software like cherry-picking. If you need 100 products, the
software can go to many different suppliers to pick up from those who have the
same product and pick up from each supplier the least expensive and add it to the
basket, order it directly i/o one trying to do it manually one by one.*"
SC reconfiguration is seen vividly in Gamma. The way Gamma reconfigures shows in two fields: adjustment in the working role of people; SC network, which is written in the below two paragraphs respectively.

The first idea of SC reconfiguration comes from the result of automation. Automation comes to speed up and cut off the waste of time and manual works caused by repetitive works. Roles of working people whose works are heavily characterized by repetition, for instance: people in an administrative function. In Gamma’s expert opinion, people still keep their jobs, but they just figure out a new way to use technology to facilitate their working for better performance. In a nutshell, not every job will change their role, but jobs with more repetition need to reconfigure. The reconfiguration is not through layoffs but through the new working way.

SC network is an interesting point to analyzed when digitalization is on progressing in SCM. As presented previously, complexity exists in the SC supplier base. It is actually localized and fragmented from upstream to downstream of the SC network. Each project has its own SC network, which is not transparent for others. There are reasons behind why Gamma goes through project-based and de-centralized management, but on the other hand, it has to compromise when the localized and fragmented situation arises. To Gamma, digitalization is an enabler of a new opportunity in which Gamma can simplify and consolidate its currently huge and fragmented supplier base, utilized big volume order for a better purchasing strategy. As a result, the SC network will drive towards more simplifier. To illustrate for this point, Gamma’s expert explains:

“We come from a very decentralized organization. In Finland, we have a few hundreds of construction sites. Before digitalization, it is very difficult to get the transparency which shows who buys from whom. And for example, you could have some certain products like 50 suppliers. Now it is so easy to consolidate your volume and see who you move the volume to get the best performance supplier.”

Analytics is by far discussed by many scholars and the industrial world. However, it is not under Gamma’s prime focus for now. This is at first sound illogical but after consideration, it is a rational choice of Gamma. Again, the industry specificity of construction plays significant roles in driving the focus on analytics or not. Demand forecasting is taken as a typical example. In the construction industry, the market is divided into many small pieces by many players, which
means there is not anyone who holds a major part of the market. If Gamma put effort into the demand forecast, the result Gamma can gain is the inaccuracy of the prediction, turning out to waste. Gamma’s expert illustrates:

“If you compared the forest industry, a few players who have the market. In construction, nobody has more than 2% of the market. In our industry, it only helps when everyone is doing good in forecasting. We can be very good at forecasting, but it does not really help when no one else is good at it.”

Customer feedback is taken not for how to digitalize but using digitalization to facilitate the task of perceiving the customer's voice. The process of taking customers’ opinions in Gamma is more active and interactive. Digital technology is used to provide a new way to communicate with customers via which the customer’s voice is heard. Digitalization enables from open dialogues for building designing phases, capturing customer’s expectations, to keeping track between planning and actuality. As a result of digitalization, a lot of issues important for customers such as sustainability can now be followed up faster and easier.

**Lean outcomes**

Contribute to the understanding of digitalization in SCM, Gamma claims that positive or negative outcomes of digitalization in SCM depend on time factor. Technology price can be very expensive at its early launching stage, but by time price drops. By time, technology is known by more and more people, and somehow people tend to accept new technology more and more. In the past, adopting new digital technology in Gamma can be problematic because of the high cost and extra works of training and a high level of resistance against change. Nowadays, price is more affordable, and it helps to reduce double works in Gamma.

At present, digitalization evidently brings many good effects to Gamma SCM in many cases. To describe the Lean outcomes, Gamma’s emphasize five main effects “speed up”, “fewer errors”, “cost-saving”, “more visible”, “more reliable”. Table 8 is a description of those four effects.
Table 8: Gamma's Lean outcomes

<table>
<thead>
<tr>
<th>Lean outcomes</th>
<th>Evidence in Gamma</th>
</tr>
</thead>
<tbody>
<tr>
<td>“speed-up”</td>
<td>Double works are removed, and repetitive works are automated by software. Digitalization helps to solve problems quicker. If there is an issue somewhere either factories or sites, digitalization helps in scanning (drones or 360 degrees camera) giving a very fast current stage or situation, and it can be remotely solved.</td>
</tr>
<tr>
<td>“fewer errors” &amp; “cost-saving”</td>
<td>Digital technology allows spotting errors and defects in materials/products check-up before use. 360 camera goes in difficult areas (underground, between walls), helping checking errors (if any) of construction without expensive opening cost.</td>
</tr>
<tr>
<td>“more visible”</td>
<td>Digitalization enables the SC network to be more transparent, leading to the future solution of more visible SCM performance to all parties. Therefore, SC network members know where they stand to improve because no one wants to be last on the list.</td>
</tr>
<tr>
<td>“more reliable”</td>
<td>Gamma can easily and promptly provide photos to keep track of the commitments in the plan (quality and time) it promised with customers. As a result of fewer defects, Gamma products to customers are better in quality.</td>
</tr>
</tbody>
</table>

Among all Lean outcomes, Gamma recognizes that reliability is the biggest value it brings to customers, Gamma, and related parties in the SC network. Digitalization enables Gamma to provide products and service as it promised. Digitalization is still a journey to come with Gamma in the future because benefits are evident despite the industry challenge to standardize the processes and the complexity of SCM in construction.

5.2 Cross-case analysis

As the context is an important factor in case study research (Farquhar 2012, 30-48). Single case analysis has already taken context into account while analyzing each scope of research. In the
cross-case analysis, it is useful and necessary to bring both cases’ contextual factors together, so that the comparison and synthesis for analysis can be formulated. The contextual factor in this analysis is defined as other factors than the themes and scopes in the conceptual framework. Basing on how they are mentioned by experts of case companies, relevant factors are chosen.

Table 9: Contextual factor analysis of Alpha, Beta, Gamma

<table>
<thead>
<tr>
<th></th>
<th>Alpha</th>
<th>Beta</th>
<th>Gamma</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Industry specificity</strong></td>
<td>Forestry</td>
<td>Forestry</td>
<td>Construction</td>
</tr>
<tr>
<td></td>
<td>Several main producers hold a big segment</td>
<td>Several main producers hold a big segment</td>
<td>Fragmented. High demand for reducing</td>
</tr>
<tr>
<td></td>
<td>of the market</td>
<td>of the market</td>
<td>carbon emission.</td>
</tr>
<tr>
<td><strong>SCN</strong></td>
<td>Less complex, a long-term partnership</td>
<td>Less complex, a long-term partnership</td>
<td>Complex, many parties involved, fragmented.</td>
</tr>
<tr>
<td></td>
<td>exists. Role: a manufacturer, upstream of</td>
<td>exists. Role: a manufacturer, upstream of</td>
<td>Role: middle of SCN, between clients and</td>
</tr>
<tr>
<td></td>
<td>SCN</td>
<td>SCN</td>
<td>sub-contractors</td>
</tr>
<tr>
<td><strong>Market</strong></td>
<td>Global</td>
<td>Global</td>
<td>European, UK &amp; US</td>
</tr>
<tr>
<td><strong>Infrastructure/facility</strong></td>
<td>Heavily financially invested machines, fixed factories &amp; operational location</td>
<td>Heavily financially invested machines, fixed factories &amp; operational location</td>
<td>Localized and changing depending on projects.</td>
</tr>
<tr>
<td><strong>Management direction</strong></td>
<td>Open-minded &amp; take digitalization as a</td>
<td>Open-minded &amp; take digitalization as a</td>
<td>Open-minded &amp; take digitalization as a</td>
</tr>
<tr>
<td></td>
<td>strategic issue. Expanding possible</td>
<td>strategic issue. Pulling digitalization</td>
<td>strategic issue. despite numerous</td>
</tr>
<tr>
<td></td>
<td>digitalization solution</td>
<td>towards customers</td>
<td>obstacles</td>
</tr>
<tr>
<td><strong>Human resources</strong></td>
<td>Labor intensive</td>
<td>Labor intensive</td>
<td>Labor intensive and high resistance</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>against adopting new technologies.</td>
</tr>
</tbody>
</table>
**Technology development in SCM**

The common points at a general level are shown in three aspects: both mega technologies mentioned in literature are acknowledged; attitudes towards digitalization is very positive; expected benefits and motives for digitalization are a competitive advantage, responsiveness to business environment changes. However, each case has different typical technologies corresponded to the area of SCM they intentionally focus on.

Through three cases, digital development is obviously the base for improvement in SCM which in turn motivates or de-motivate digital development. Besides, the development of digital technologies in SCM is affected by contextual factors. Among all contextual factors, industry specificity, management direction, human, infrastructure are outstanding factors mentioned repeatedly by experts of both case companies. On a micro level, the differences in each case company’s technologies development regulated by the difference in these mentioned points.

To support the above argument, analysis in this paragraph is made. Case Alpha and Beta have more common points in contextual factors, while Gamma’s is substantially different. Alpha and Beta’s technology description in single case analysis, for instance: what kind of technology and area of application, are pretty similar. The differences between Alpha and Beta are probably Alpha is expanding across the whole SCN, but Beta focuses more on the customer’s side of the SCN. Whereas, Gamma's technology development is a very different picture from Alpha and Beta, describing by slow process and most developed in administrative and procurement functions due to its numerous resistance reasons as revealed by Gamma’s expert.

**Digitalization in SCM**

SCM integration has been conducted actively from Alpha and Beta, but not from Gamma. Alpha integrated SCM information in a single platform to share information with related SCM members, providing visibility and reliability to customers. Beta automated with the involvement of Robotics, making information flow faster, increasing visibility for Beta’s SCM, finally pouring benefits to chains of customers. For Gamma, there is nearly no process in digitalizing SCM integration. The reason is clearly explained, which derive from industry specificity and supply chain network characteristics.
SCM automation appears in all case companies, derived from Robotics and AI. The industry specificity and management direction have connections to where automation goes. Both use automation to replace repetitive manual works, to track and trace goods flow for resource-saving, speedy and accurate results. Additionally, Gamma uses automation for another aspect which is to tackle the double work situations which are commonly happened in the construction industry.

The analytics topic is also actively approached by three case companies. Alpha and Beta intensively use Analytics, big data for advanced demand forecasting, real-time decision making for problem-solving in delivery and order handling, and process optimization. Whereas, Gamma does not apply analytics for advanced forecasting, but in improving sustainability and purchasing strategy.

Both Alpha, Beta and Gamma recognized the clearest picture of SCM reconfiguration in the aspect of changing people’s working role. The differences are situated in the organizational structure and SCN reconfiguration. The differences can be explained by contextual factors in which SCN and management have the strongest links. Alpha management attitude is to open for expanding changes of new arising opportunities, SCN reconfiguration of Alpha contains the possibility to expand the network for new products and simplify for its traditional products. In the same industry with Alpha, Beta expects to simplify its SCN, probably it links to the management’s intention. Organizational structure reconfiguration is somehow not well recognized, only Beta has some opinion regarding the re-locating issue.

Customer's voice is described as a two-way with digitalization. Digitalization helps improving customer voice in SCM, and in turn, the customer's voice impacts how digitalization is conducted in SCM. At first, the customer's voice is important, implying how and why digitizing SCM is for. Each case company has very different aspects to view this issue. For Alpha, digitalization brings new tools and new ways to capture customers’ opinions, and it is selective to choose which digitalization projects needed customer’s involvement. Beta sees a need to changes from the traditional approach, the customer's voice is not just limited within traditional survey form. Gamma uses digital tools to facilitate communication with customers, improving commitments to customers, and capturing customer’s opinions into consideration of how it navigates in SCM digitalization journey.
Lean outcomes

Each company has different languages to express Lean outcomes of digitalization brings in SCM. To organize data for comparison, the two sub-themes of Lean outcomes are taken as two categories where descriptions of effects derived from meanings case company experts tried to express. In this part, the analysis is not limited within which elements or outcomes have been mentioned by case companies, but it investigates which outcome appears in which case, and how often it appears.

Table 10 is compiled basing on reading comprehension of Lean outcomes part of single case analysis and constructed based on two sub-themes: Customer Value and SCM performance. The text description of outcomes formulated from meaning shared in interviews, shown in Lean outcomes analysis of each case. The numbers in the table only indicate that the outcome has been confirmed by the case’s expert, but not represent how many times or how strong it is emphasized in the interview. Therefore, the occurrence frequency reflects how many cases an outcome exists. Colors are used in occurrence frequency with green for the most commonly mentioned, orange for mild level, and red for the least common.

Table 10: Lean outcomes cross-case analysis

<table>
<thead>
<tr>
<th>Lean outcomes</th>
<th>Text description</th>
<th>Alpha</th>
<th>Beta</th>
<th>Gamma</th>
<th>Occurrence frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customers' value</td>
<td>Customer value from accuracy</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Customer value from speed</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Customer value from reliability</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Value shared to customer's customer</td>
<td></td>
<td>1</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>SCM performance</td>
<td>Accurate planning</td>
<td>1</td>
<td>1</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Shorter lead-time</td>
<td>1</td>
<td>1</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Faster processing time</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Better time controlling</td>
<td>1</td>
<td>1</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Improve SC relationship</td>
<td></td>
<td>1</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Reliable information</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Transparency increase</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Visible goods flow</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>SCM risks mitigate</td>
<td>1</td>
<td>1</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Quality improvement</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Cost saving</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Resources saving</td>
<td></td>
<td>1</td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>
One important note before going into interpreting the data is that some outcomes appeared only in one case does not mean that it is not the possible outcome of other cases, it rather means that the interviewee’s contribution to understanding better the Lean outcomes.

Commonly recognized by all case companies is that their customers’ value increased from accuracy, speed, and reliability as the results of digitalization in SCM. Gamma emphasizes that reliability is the strongest effect. Reasons for this recognition could link to the industry specificity when building completion schedules and requirements of building design and quality play a key role in construction work, which digitalization is going to improve tracking stages and provide real-time evidence to customers. Only Beta claims that customers value spreading in the SCN to customers of customers, which is to one contribution to understanding the Lean outcomes to customer’s value. Probably, because Beta SCM and management direction focus on the downstream of SCN, containing many chains of customers to the end consumers.

There are many elements reflecting the improvement in SCM thanks to digitalization. The most common ones which hold the frequency of 3, meaning that both cases have in common, are Faster processing time, Reliable information, Transparency increase, Visible goods flow, Quality improvement, Cost saving. Following up elements are Accurate planning, Shorter lead-time, Better time controlling, SCM risks mitigate. The least common elements are Improve SC relationship, and Resource-saving, which contributed by Alpha and Beta respectively. Regarding the differences, starting to appear in elements existing in 1 or 2 cases, reasons are most often stemmed from the difference in contextual factors.

5.3 Findings

The findings are produced basing on the conceptual framework build in the first chapter by comparing empirical analysis with theoretical background, to finally answer the thesis question. Bringing conceptual framework, theoretical issues, empirical study, research question together, Figure 14 provides how findings are generated and rooted.

To connect and compare theoretical background and empirical analysis, a framework in which organized points in all parts is necessary. This thesis is constructed in a way that both theoretical
background and empirical analysis develop on the same ground of three main themes in the conceptual framework: digital technology development in SCM, digital transformation in SCM, Lean outcomes. Therefore, findings are presented in three main themes which are used in the structure of theoretical background and case study analysis.

**Figure 14: Logics from Research questions to findings**

### 5.3.1 Digital technology development in SCM

Coming to the question of why a firm decides to adopt digital technology. According to literature (presented in chapter 2, part 2.1), reasons for adopting digital technologies from firms can be described in various ways which finally ends up in two categories: fighting against the thread of market uncertainty; winning competitive advantage. The empirical case studies affirm these two motives from the theory.

Besides, the empirical study contributes further when discussing adopting digital technologies. In Alpha, it is a decisive factor for technology adoption is that the management level should approve and support first. While Gamma acknowledges the benefits of digital technology with undetachable critical thinking of the industry such as localized business, fragmented network, unstable production site, the human factor. More analysis of contextual factors and digital technology development can also be found clearer in the cross-case analysis. In a nutshell,
management decision is important in deciding new technology adoption, and the contextual factors including industry specificity can affect in a negative or positive way.

Mega-trend technologies (Cloud, AI, IoT, Big Data, mobile) discussed in the literature are acknowledged in the case company. Via case company analysis, within SCM, it is going toward more robotics and automation, typically recognized in SCM of all case companies, which has more common points with the literature in digital supply chain management. Robotics arm replacing physical work in production and delivery, and robotics process automation mostly adopted in the form of software in support for office work. The targets of is to replace physical or manually handled tasks by machine and to automatize processes. Robotics and automation technologies have a high potential in SCM work because of the advocacy of firms toward digitalization and now the technology development is more available and affordable.

Depending on the contextual factors of each case, other technologies and tools have the potential to develop. For instance: Alpha and Beta have used big data, AI for demand forecasting while Gamma saw no significance to develop in this field. Besides, this study also collects current technologies tools using in case of company namely: integrated digital platform, camera 360, drones, smart labels, BIM. Since those technologies are interesting on one hand, but on the other hand applicable or proven in a case, they are mentioned by name as exploration findings of how diverse the technologies are chosen, but not to analyze as in the analysis part already did.

There is no common ground for the future expectation of all case companies whose current development is different. If there is a way to express, basing on what to expect but not to what extend to expect, the future technology development would grow to be more automatized, more digitalized, more visible, and more open-minded for new technologies.

Regarding blockchain, studies show it is still new and a potential in the future of SCM, chosen by trust and adopting in the early phase in an organization. Practice in three case companies confirm the studies: Alpha believes in future with blockchain, Beta and Gamma have experience with blockchain relating to finance. At the moment, it is still a new technology experiencing as financial tools in some pilot projects. The interesting point is waiting for configuration beyond its traditional finance area to SCM, because it would probably the problem solver for cyber-security, a big identified thread while discussing digitalization.
5.3.2 Digitalization in SCM

Digitalized SC integration as studied in chapter 2 is one out of four main changes in digitalization in SCM. Via real case companies, the content of integration already exists, digitalization appears to provide a new method, but the choice to digitalize SC integration depending on the industry and SCN of each case. In the case Gamma, the industry specificity and SCN of the construction industry try to keep information instead of sharing, leading to the fact that digitalize SC integration is not conducted. In case Alpha and Beta, the industry allows a high level of coordination, information sharing, digitalization boosts speed, accuracy, creating a stronger base for planning and prediction.

SC automation in three case companies reveals a pattern. Automation focuses on repetitive works. Both three case companies pointed out the area to be automized are where repetitive works exist. SC automation finds repetitive work and automizes it with technology. Such administrative tasks (text matching and inserting) can be automized by Robotics Process Automation or Robotics software, bringing a faster and accurate process handling result. Physical handling tasks in such warehousing and manufacturing are possible to replace by Robotic arms which is a much safer solution compared to human work.

The reconfiguration in SCM varies depending on each case. A need to adjust people working role to match with a new context when digital technologies come to place is the most frequently discussed by case companies. Despite the theory urges for the needs of changing within organization structure and SCN, whether there is re-structure of organization and SCN or not is under skeptical views with diverse expectations and predictions, but the evidence is not yet to come.

Analytics including advanced forecasting is not just about the availability of data, but how reliable it is. The AI, Algorithms help in terms of technology to collect and process data. However, the accuracy or reliability is most important, often supported by SC integration or how good the firm understand their SCN member and customers. Another point is that data for analytics need to be clean and organized which is the current pressing problem firms are facing. Although the Gamma case discards the advance forecasting, it case contributes to open the findings further to the outside of a firm’s boundary. How good a firm can predict depends on the others in the same industry also.
Firms decide to digitalize their SCM, and customers’ voice matters in SCM, but rather it comes in form of indirect influence (SCM finally targets to serve end-customers, how demands change will influence a digital journey of firms); directly influence (in projects customer directly involve).

Case studies in this thesis also reveal interesting empirical findings:

- Technologies are the start of digitalization, which is undeniable from the literature, but reality reveals that people factor decides how digitalization ends with success or not. Evidence is clearly shown in the case of Gamma and exists in the other two cases.

- 3 important things when talking about digitalization: consideration of how the transformation makes sense in the specific context of the firm (industry is an important contextual factor); stability to adopt (not to waste by dismantle and rebuilt the process); and people.

- When digitalizing SCM, it is not just wrapped within the proposed theoretical framework, but what matters to the industry should be counted in. In Gamma, digitalization in SCM also means how to embed carbon index or how to reduce carbon emission.

5.3.3 Lean outcomes

Through three case studies, many empirical pieces of evidence are found to clarify the Lean outcomes of the whole process starting from digital technology to SCM. The majority points discussed in the literature are brought out to light in the real experience in firms’ SCM work. Whereas, a few have not been recognized in empirical data in this thesis.

As studied in chapter 2 part 2.4, Lean philosophy starts with the switching of focus from product quantity to customers. Customers define the value to which solutions to reduce wastes and increasing value links. Many related studies detailed the outsets of Lean philosophy in SCM which case studies in this thesis show strong evidence (Table 11).
Table 11: Links between known studies of Lean and empirical cases

<table>
<thead>
<tr>
<th>Lean outcomes in case studies</th>
<th>Links to studies written by</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customers' value</td>
<td>Multiple authors in Lean philosophy (in part 2.4.1)</td>
</tr>
<tr>
<td>Customer value from accuracy</td>
<td></td>
</tr>
<tr>
<td>Customer value from speed</td>
<td></td>
</tr>
<tr>
<td>Customer value from reliability</td>
<td></td>
</tr>
<tr>
<td>Value shared to customer's customer</td>
<td></td>
</tr>
<tr>
<td>SCM performance</td>
<td>Arif-Uz-Zaman and Nazmul 2014, 596</td>
</tr>
<tr>
<td>Accurate planning</td>
<td></td>
</tr>
<tr>
<td>Shorter lead time</td>
<td></td>
</tr>
<tr>
<td>Faster processing time</td>
<td></td>
</tr>
<tr>
<td>Better time controlling</td>
<td></td>
</tr>
<tr>
<td>Quality improves</td>
<td></td>
</tr>
<tr>
<td>Cost-saving</td>
<td></td>
</tr>
<tr>
<td>Resources saving</td>
<td>No &quot;Excuse and Blame&quot; by Tortorella et al. (2017, 100-101) &amp; Arif-Uz-Zaman and Nazmul 2014, 596</td>
</tr>
<tr>
<td>SCM risks mitigate</td>
<td></td>
</tr>
<tr>
<td>Improve SC relationship</td>
<td>Tortorella et al. 2017, 101 &amp; Arif-Uz-Zaman and Nazmul 2014, 596</td>
</tr>
<tr>
<td>Reliable information</td>
<td></td>
</tr>
<tr>
<td>Transparency increase</td>
<td></td>
</tr>
<tr>
<td>Visible goods flow</td>
<td></td>
</tr>
</tbody>
</table>

Table 11 aligns the known theory with empirical pieces of evidence collected from cases. This table does not only clarify the linkages between studies but also claim further investigation.

The findings of customer values provided in case companies shape the understanding of elements embedded in customers’ value resulting Lean in digitalization SCM context. In elements of customers’ value, a value shared with customers’ customers is different from the rest in the same group. It opens the perspective to think about customer value, which just not only stands on benefits gathering to one customer or one layer of SCN, but to transfer the value across the SCN.

Generally, points shown in cases go in line with Lean philosophy for which they are listed in Lean outcomes. However, there is no exact link to dive deep into details found in theory relating to Lean in SCM performance to explain elements: reliable information, transparency, visible goods flow. Instead, the links are tightened with literature relating to the Impacts of Digitalization on SCM (part 2.3.3). Another point to notice in this part is that the term
“Transparency” in literature of Lean Supply in part 2.4.2 point out the open-book techniques is different from empirical evidences.
6. DISCUSSION AND CONCLUSION

This research is established based on the recognition that digitalization in SCM and Lean are an important ongoing phenomenon, and that these three areas are where the research gap exists. Furthermore, the ongoing digitalization in SCM recently produces rich empirical pieces of evidence that should be captured for research value. The understanding of how digitalization affects SCM in a Lean way is the prime purpose which research questions are generated and research design aims to. Therefore, this thesis is designed in a way that allows large space for exploration, which also means that it may appear to be broad and difficult in finding boundaries.

Indeed, this study shows a rich empirical study where each case study provides a vividly different picture of how real firms configure their digitalization journey in SCM, and Lean outcomes appear as a natural result of this journey. Besides, cross-case study analysis opens the possibility to generate suspicious points for further investigation, to reveal the significant involvement of contextual factors.

This chapter focuses on reviewing how findings answer the research question and research objectives; which contributions it brings to enrich theory and implications; the limitations and suggestions for future research. Thus, this chapter is structured into three parts: Finding summary; contribution and implications; limitations and suggestions for future research.

6.1 Finding summary

The main research question “How can digitalization support supply chain management in a Lean way?” is answered with positivity and detailed explanation. Figuratively expressing, this study is similar to a tree model: Lean outcomes are fruit/leave, digitalization in SCM is the tree body, context is the root, and digital technology is the intakes to leverage the tree growth. Lean is the proven outcomes, but the insight to understand how and why Lean outcomes appear to lay in the technology development, contextual understanding, and digitalization in SCM part.

This study realizes that digital technology is growing toward more diversity and popularity. Digitalization is an on-going journey that all case companies decide to start and continue to explore regardless of different levels of challenges. The process of reshaping SCM keeps happening in four parts of digital SCM in which it is not evenly distributed. Lean outcomes are
numerous and new value or benefits are generating while exploring digitalization. Industry specificity and the fragmented situation are accountable while analyzing digitalization effects in SCM, because contextual factors hold explanation powers for why digital technology developed to an extent, and how it configured in SCM.

**Sub-RQ1: How has digital technology developed in supply chain management?**

Digitalization is decided to develop in SCM because firms expect many benefits which categories into two motives: fighting against the thread of market uncertainty; winning competitive advantage. How far and how fast the technologies adopted in SCM relate to Management level decision and contextual factors especially the industry specificity.

The current technology development level in three case companies confirmed the existence of mega-trend in technologies. Real experience from case companies mainly focus on discussion of Robotics and Automation, although other technologies (AI, Big Data, integrated platform, mobiles, drones, 360 camera, smart labels, etc.) are also evolved depending on each case, which not only provides picture of main technologies attracting attention in SCM but also enriches the understanding of diversity in digital technology developed at firms.

Future of SCM with digital technologies drives towards more automated, more digitalized, more transparency, and open-minded for new technologies. Blockchain could be the future foreseen move from extending its application landscape from Finance to SCM.

**Sub-RQ2: How has digital technology transformed supply chain management?**

Digitalizing in SCM takes place in four main areas: SCM integration, automation, analytics, reconfiguration. These four areas are taken from literature. In Three case companies, empirical findings reveal that it is not always the case four main areas are changes in digitalizing in SCM. Gamma is evidence of skipping SCM integration because of the industry specificity and fragmented situation in SCN which the integration is not the area to boost by digital technologies.

Table 12 showcases outstanding points from empirical findings for each area of SCM digitalizing.
Table 12: Outstanding empirical findings of four areas of SCM digitalization

<table>
<thead>
<tr>
<th>SCM integration</th>
<th>Process automation</th>
<th>Analytics</th>
<th>SCM reconfiguration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depending on cases and supports</td>
<td>RA &amp; RPA focus on replacing repetitive works in physical handling work (production, delivery, etc.), and office works.</td>
<td>General analytics and real-time data for decision makings are recognized, but advanced demand forecasting is not always applicable due to contextual factors.</td>
<td>Changes in people working roles</td>
</tr>
<tr>
<td>Analytics</td>
<td></td>
<td></td>
<td>Suspicious and diverse opinions of organization structure changes and SCN changes.</td>
</tr>
</tbody>
</table>

Customers’ voice is important by nature to firms. It is shown in general importance to the firm’s purpose of serving customers, increasing customer value, and directly in selected projects where customers directly experience technology changes.

Empirical findings open further to the consideration: people factor, stability for adoption, business-wise, embedded important factors. Details are explained in 5.3.2.

**Sub-RQ 3: What are the effects of digitalization on supply chain management performance and customer value?**

This study confirms the Lean characteristic of outcomes from digitalization to SCM. Numerous pieces of evidence are provided by case companies. In brief, these effects are put into Table 13, organized into two categories: customer value and SCM performance, colors coded derived from empirical cases of this thesis (green = appear in all cases; orange= appear in 2 cases; white = appear in one case). The literature and empirical data may speak different languages but have many linkable and common meanings. Also, empirical studies answer in reach way and in the most detailed way to the research questions.
Table 13: List of effects in customer value and SCM performance

<table>
<thead>
<tr>
<th>Increase customer value</th>
<th>Improve SCM performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer value from accuracy</td>
<td>Faster processing time</td>
</tr>
<tr>
<td>Customer value from speed</td>
<td>Reliable information</td>
</tr>
<tr>
<td>Customer value from reliability</td>
<td>Transparency increase</td>
</tr>
<tr>
<td>Value shared to customer's customer</td>
<td>Visible goods flow</td>
</tr>
<tr>
<td></td>
<td>Quality improve</td>
</tr>
<tr>
<td></td>
<td>Cost saving</td>
</tr>
<tr>
<td></td>
<td>Accurate planning</td>
</tr>
<tr>
<td></td>
<td>Shorter leadtime</td>
</tr>
<tr>
<td></td>
<td>Better time controlling</td>
</tr>
<tr>
<td></td>
<td>SCM risks mitigate</td>
</tr>
<tr>
<td></td>
<td>Improve SC relationship</td>
</tr>
<tr>
<td></td>
<td>Resources saving</td>
</tr>
</tbody>
</table>

6.2 Contributions and managerial implications

This study contributes to the current limited understanding of digitalization in SCM from Lean perspective, consolidating and expanding the current literature regarding this topic. First, it clarifies linkages between technology and SCM, highlights the Leanness of the outcomes of digitalization in SCM. Secondly, it opens details and realistic picture of how digitalization impacts in SCM in a Lean way. These two points contribute to the understanding of the research issues and further to improve the shortage of literature of this on-going phenomenon.

Contributions to literature

Empirical cases in this thesis confirm many points in the literature, modify and open other aspects which literature has not expressed. Theory provides numerous technologies; empirical study specifies the main current focus of technologies in SCM and how diverse technologies are considered. Theory facilitates the general structure of how changes happen, while the empirical study provides understand how firms navigate and how they skip some configurations. Theory of Lean in SCM is enriched by the empirical description of Lean outcomes where
previous literature is not adequate or somewhat outdated to explain, for instance: some points such as open-book techniques and Lean Supply Practices have little relevance.

Via this research, real case companies provide strong evidence and rich descriptive information which firms can refer to and compare with. The comparison is not to measure who goes higher than others but to understand the different contexts and managerial decisions leading to different digital journey experience in SCM. It also clarifies Lean philosophy is a possible approach to combine with digital SCM, for example, a program incorporates Lean, Digitalization, SCM.
### Table 14: Thesis contribution to current literature

<table>
<thead>
<tr>
<th>Thesis contribution</th>
<th>Studies in literature</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Motives for digitalization</strong></td>
<td></td>
</tr>
<tr>
<td>Strengthen literature of two motives for digitalization: react against market uncertainty, and gain competitive advantage</td>
<td>- Beck (2018, 21)</td>
</tr>
<tr>
<td></td>
<td>- Wang et al. (2006, 42-44).</td>
</tr>
<tr>
<td><strong>Digital technology development</strong></td>
<td></td>
</tr>
<tr>
<td>Strengthen literature, and supplement literature in providing a picture of current and future technology in SCM area</td>
<td>Part 2.2 of chapter 2 of this thesis</td>
</tr>
<tr>
<td><strong>Digital SCM</strong></td>
<td></td>
</tr>
<tr>
<td>Confirm and suggest the modification of the framework to fit the context of firms.</td>
<td>Büyöközkan and Göçer (2018, 172)</td>
</tr>
<tr>
<td><strong>SCM automation</strong></td>
<td></td>
</tr>
<tr>
<td>Strengthen and add more points to the emphasis: not only accuracy, but also speed, and replacing repetitive work.</td>
<td>- Büyöközkan and Göçer (2018, 173)</td>
</tr>
<tr>
<td><strong>SCM reconfiguration</strong></td>
<td></td>
</tr>
<tr>
<td>Confirm the possible existence of changes studied in the literature, but details are under questions.</td>
<td>- Büyöközkan and Göçer (2018, 173)</td>
</tr>
<tr>
<td></td>
<td>- Cavalcante et al. (2019)</td>
</tr>
<tr>
<td></td>
<td>- Büyöközkan and Göçer (2019, 1-18)</td>
</tr>
<tr>
<td></td>
<td>- Michel (2019, 24)</td>
</tr>
<tr>
<td><strong>SCM analytics</strong></td>
<td></td>
</tr>
<tr>
<td>Strongly support with respect to the contextual factors. Forecasting is advancing, resulting in a higher accuracy level.</td>
<td>- Büyöközkan and Göçer (2018, 173).</td>
</tr>
<tr>
<td><strong>Customer’s voice</strong></td>
<td></td>
</tr>
<tr>
<td>Support literature and provide details on how customer's voice appears in the digital SCM context.</td>
<td>- Muncaster (2019, 22)</td>
</tr>
<tr>
<td><strong>Impacts of Digitalization on SCM</strong></td>
<td></td>
</tr>
<tr>
<td>Strengthen by providing more pieces of evidence.</td>
<td>Part 2.3.3 of chapter 2 of this thesis</td>
</tr>
<tr>
<td><strong>Lean SCM</strong></td>
<td></td>
</tr>
<tr>
<td>Strengthen and add clarification of relevant elements (details in Table 11)</td>
<td>Multiple authors (Table 11)</td>
</tr>
</tbody>
</table>
Managerial implications

Since the cases analyzed basing on the interviewees who are at managerial level and responsible for digitalization projects, this thesis can be also used to support managers in giving ideas and reviews for digital SCM projects. Because of the evident Lean outcomes of digitalization bringing to SCM, it strongly suggests managers of firms to keep going with digitalization in SCM to gasp the numerous benefits.

![Diagram](image)

Figure 15: Managerial implications

*If everyone goes on the same path, who will hold a competitive advantage in the market?* Future continues with experiments as the nature of new occurrence, but if there is a way to understand better and leverage the development, it should receive attention from the management level. Having a strategy for digitalization in SCM is key to strengthen the process of development in digital SCM.

Studies show that there is no uniform understanding of digital SCM and no truly successful digital SCM case, not to mention strategy to develop digital SCM (Büyüközkan and Göçer, 2018, 164-165). In the empirical study in this thesis, the picture of the digitalization strategy in SCM is opaquely drawn with expectations. A strategy should be developed so that competitive advantage is not just an expectation but a path to gain. If any firm can build a digital SCM strategy will put this firm forward, leaving a big gap with its competitors, or even turning a firm to become the forerunner in the whole industrial world.
This study supports providing points to be considered in building a digital SCM strategy. First, the management decision is prime important to start digitalization in SCM. If a firm expects its partners to digitalize together, it is important to have managers’ involvement and initiatives. Second, the digitalization in SCM conceptual framework used in this study can provide elements to put in the digital SCM strategy. Framework for digitalization in SCM is still in an early phase in the study, it is re-enforced by the empirical study and the most valid and scientifically based reference. Third, the digitalization journey in SCM should not ignore the contextual factors including industry specificity.

6.3 Limitations and suggestions for future research

As planned at the beginning and after conducting research, research scopes are potential but large areas. Despite the defining scopes and boundaries set in the Delimitation (chapter 1, part 1.4), it is challenging to get aligned and put many different real pictures of companies in an organized way. Analysis of this thesis is drawn from the provided empirical data gaining from the head of SCM and Digitalization, which is very comprehensive and strategic. The research is believed to have stronger validity and reliability if there is access to other people from different roles of one firm, which the resources and access of this research have a limit. This limit suggests future research on a bigger scale in terms of time and access.

Via conducting this research, the writer realized the need for a system from literature to organize technologies on which researchers can view and analyze real cases better. This research shows repeatedly the relevance between contextual factors and scopes of research, but it does not have a chance to go further to validate this issue. Therefore, research on the influence of contextual factors on digital SCM experience is an interesting topic and potential field to develop in the future.
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APPENDICES

Appendix 1: Text quantitative data analysis of digitalization impacts

<table>
<thead>
<tr>
<th>No</th>
<th>Issues</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>connection/connect/connected</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>intelligent/smart/smarter</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>visibility, transparency, traceability</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>speed/speedy/quickly</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>scalability.scale</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>productivity, efficiency</td>
<td>2</td>
</tr>
<tr>
<td>7</td>
<td>other related issues: flexibility, cost-saving, value</td>
<td>1</td>
</tr>
</tbody>
</table>

Appendix 2: Co-occurrence network of digitalization impacts
### Appendix 3: List of Lean Supply Practices

(Tortorella et al. 2017, 101)

<table>
<thead>
<tr>
<th>No</th>
<th>Lean Supply Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Kanban or pull system</td>
</tr>
<tr>
<td>2</td>
<td>A close relationship between partners and suppliers</td>
</tr>
<tr>
<td>3</td>
<td>Leveled scheduling or <em>heijunka</em></td>
</tr>
<tr>
<td>4</td>
<td>Efficient and continuous replenishment</td>
</tr>
<tr>
<td>5</td>
<td>Two-way feedback assessment</td>
</tr>
<tr>
<td>6</td>
<td>Value chain management team</td>
</tr>
<tr>
<td>7</td>
<td>Win-win problem-solving methodology</td>
</tr>
<tr>
<td>8</td>
<td>Value chain analysis or Value stream mapping</td>
</tr>
<tr>
<td>9</td>
<td>Keiretsu (suppliers play a strategic role marshaling the efforts of their own suppliers)</td>
</tr>
<tr>
<td>10</td>
<td><em>Kyoryokukai</em> (supplier’s association that enhance lateral communication among suppliers, and act as an extra bulwark against customer opportunism)</td>
</tr>
<tr>
<td>11</td>
<td>Intervention strategy (customer is able to cooperatively intervened in the supplier’s business operation and bring about change for better)</td>
</tr>
<tr>
<td>12</td>
<td>Material handling systems</td>
</tr>
<tr>
<td>13</td>
<td>Standardized work procedures to assure quality achievement</td>
</tr>
<tr>
<td>14</td>
<td>Open-minded and in-deep market research conducted jointly (joint understanding of end-user requirements so that all players can work towards providing customer value)</td>
</tr>
<tr>
<td>15</td>
<td>Open-book negotiation</td>
</tr>
<tr>
<td>16</td>
<td>Inbound vehicle scheduling</td>
</tr>
<tr>
<td>17</td>
<td>Hoshin Kanri (policy deployment and development of a strategy for the supply chain)</td>
</tr>
<tr>
<td>18</td>
<td>Development of supply chain KPIs</td>
</tr>
<tr>
<td>19</td>
<td>Outbound transportation</td>
</tr>
<tr>
<td>20</td>
<td>Establishments of distribution centers</td>
</tr>
<tr>
<td>21</td>
<td>Consignment stock</td>
</tr>
<tr>
<td>22</td>
<td>Functional packaging design</td>
</tr>
</tbody>
</table>
Appendix 4: Supply chain performance indices

(Arif-Uz-Zaman and Nazmul 2014, 596)

<table>
<thead>
<tr>
<th>Plan Performance</th>
<th>Source Performance</th>
<th>Make Performance</th>
<th>Delivery Performance</th>
<th>Return Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Accuracy of forecasting techniques (%)</td>
<td>1. Mutual assistance in solving problems</td>
<td>1. Manufacturing cost</td>
<td>1. Delivery lead time (days)</td>
<td>1. Buyer-manufacturer relationship level</td>
</tr>
<tr>
<td>2. Total cycle time (days)</td>
<td>2. Effectiveness of master production schedule/line/day (%)</td>
<td>2. Ability to response demand</td>
<td>2. Quality of delivered goods</td>
<td></td>
</tr>
<tr>
<td>3. Product efficiency/line (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Product efficiency/line (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Appendix 5: Qualitative and quantitative data sources for case study research

(Farquhar 2012, 65-83)

<table>
<thead>
<tr>
<th>Data</th>
<th>Qualitative data sources</th>
<th>Quantitative data sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary</td>
<td>Interviews (face to face, phone, online), focus groups, participant observation, diaries</td>
<td>Survey, observation, experiment</td>
</tr>
<tr>
<td>Secondary</td>
<td>Minutes of meetings, internal reports, consultancy reports, market research reports, government and EU data</td>
<td>Spreadsheets, graphs, annual reports, external statistics, panel data, UK and EU data</td>
</tr>
</tbody>
</table>
Appendix 6: Interview question list

Section 1

To answer sub-research question 1: How has digitalization developed in Supply Chain Management (SCM)?

To investigate the current development of digitalization relate to supply chain management work.

1. Do you think developing digitalization is important in SCM at your firm? Why?
2. How have you experienced digital technologies adopted in your firm that influence SCM work?
3. IoT, Big Data, Cloud, Artificial intelligence, automation, robotics, data analysis were discussed in many studies. How does it transform your SCM work?
4. How future digital SCM would look like in the next five years?

Section 2

To answer the sub-question 2: How has digital technology transformed supply chain management?

To analyze links and changes digitalization brings to Supply Chain performance and customer perceived value

Section 2

1. How digital technologies support the process of your SCM integration (such as information sharing, coordination and resource sharing with your suppliers/customer)?
2. If your firm adopts the robotics, intelligent & automation process, what kinds of benefits they bring to SCM and customers?
3. Do you see the presence of real-time decision, process optimization, advance forecasting in SCM at your firm? Can you give an example?
4. Do you recognize the changes after your firms applying new digital technologies in: the roles of people working in SCM, organization structure, network structure, connection with your partners (suppliers, customers), supplier & partner selection? How is it in specific?
5. How does your firm think about customer voice in the process of digitalization in SCM?

Section 3

To answer sub-research question 3: What are the effects of digitalization on supply chain management performance and customer value?

To clarify Lean outcomes

1. Do you recognize SCM performance improve after adopting digital technologies? How in specific?
2. What kind of value your customers perceive after you improve your SCM with digitalization?