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SCHOOL OF BUSINESS, ECONOMICS AND LAW

Sustained Competitive Advantage In Industry 4.0 Addressed By An MNE

A Resource Based View

Master's degree Project in International Business and Trade

DIANA METIN

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Supervisor: Johan Jakobsson

SUSTAINED COMPETITIVE ADVANTAGE IN INDUSTRY 4.0 ADDRESSED BY AN MNE – A RESOURCE BASED VIEW

By Diana Metin

School of Business, Economics and Law, University of Gothenburg,
Vasagatan 1, P.O. Box 600, SE 40530 Gothenburg, Sweden

Contact: dianametin@gmail.com

"There has never been a time of greater promise, or greater peril"

Professor Klaus Schwab
Founder and Executive Chairman of the World Economic Forum

Abstract

The emergence of Industry 4.0 is changing the competitive landscape, thus presumably changing the resources commenced by Multinational Enterprises to sustain competitive advantage. By reason of the Resource Based View, prior research has stressed the importance of resources controlled by the firm as producers of sustained competitive advantage, which are consequently assumed *heterogenous* (not available to competitors) and *immobile* (nontransferable). However, additional stream of the Resource Based View recognize resources that are not exclusively controlled by the firm. Through a holistic perspective, this research study has evaluated a case study population in order to find eminent Industry 4.0 trends addressed by Swedish Multinational Enterprises. Consequently, a multiple case study has been chosen including Volvo, Ericsson, and H&M, where identified trends have been cross-referenced to find shared meaning. The findings suggest that, beside internal resources, Multinational Enterprises recognizes external resources and/or resources that do not entirely satisfy the criteria of *heterogeneity* and *immobility* as producers of sustained competitive advantage alike. The identified resources include *Partnerships & collaborations, Synergies, Employees, the Internet of Things, Big Data,* and *Artificial Intelligence.* Likewise, variations within the case study population suggest Multinational Enterprises address sustained competitive advantage in Industry 4.0 by virtue of their technological density. Conclusively, the purpose of this research study is to enhance the knowledge about MNE sustained competitive advantage in the fourth industrial revolution, thus, yield contribution to Resource Based View literature.

Key words: Industry 4.0, MNE, sustained competitive advantage, Resource Based View.

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Diana Metin

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List of abbreviations

RBV – Resource Based View

SCA – Sustained Competitive Advantage

MNE – Multinational Enterprise

AI – Artificial Intelligence

ML – Machine Learning

IoT – Internet of Things

AIoS – AI Innovation of Sweden

DA – Discourse Analysis

1. INTRODUCTION

Chapter one provides a brief introduction to this research study and begins with a general introduction to the background of this study including the theoretical framework as well as to the concept of Industry 4.0. Thereafter, the chapter continues to deliberate on the identified knowledge gap and present the research question. Finally, the purpose and scope of this study, and delimitations are discussed.

1.1. Background

The fourth industrial revolution, also known as *Industry 4.0*, is considered a paradigm shift which engender unprecedented change for all industries consequently producing a myriad of disrupting and unknown territories for the business environment and for the competitive landscape alike. Initially, the term *Industrie 4.0* (Wang *et al.,* 2016) was coined in 2011 by Germany and the country´s initiative to digitize manufacturing (European Commission, 2017), but while the initiative is nearly a decade old it is still considered to be in its infancy. Today, Industry 4.0 is recognized as a buzzword, a concept ranging across countries, and an umbrella term concluding several technologies, ideas, and theories. While it is widely used as a term to describe the emerging fourth industrial revolution, Industry 4.0 remain a complex umbrella term nonetheless and one must be aware of the density of the notion, as it is in fact a concept rather than a finite term. One can say that Industry 4.0 act as an introduction to the cyber-physical ecosystem and hyper-connected technologies (Imran & Kantola, 2019) and what essentially distinguishes the fourth industrial revolution from its predecessor is mainly the possibility of hyper-connected autonomous technologies to improve their own cells (Lasi *et al.,* 2014). This is the era of technologies such as machine learning (ML), artificial intelligence (AI), Big Data, and the Internet of Things (IoT)[1]. For instance, these technologies conceptualize in what is known as the *´smart factory´* where they produce a digital ecosystem (Magruk, 2016); the *´smart factory´* entails of autonomous cells (applications connected through IoT) that acquire Big Data from manufacturing processes, which in turn may require AI to be processed and interpreted; subsequently, once processed and interpreted the autonomous cells can improve their own manufacturing processes (through ML); and so the cycle continues with a focus on improvement (Lasi *et al.,* 2014; GSMA, 2018). Seemingly, the complexity of rising

[1] Due to the extensive list of technologies that may be included in the umbrella term of Industry 4.0 and the difficulty to include or conclude the entire spectrum in this research study I will continue to use these increasingly mentioned technologies when explaining Industry 4.0. However, it is vital to keep in mind that these technologies do not exclusively conclude Industry 4.0 nor ought to be regard as an exhaustive list of Industry 4.0 related technologies.

technologies in Industry 4.0 produce dynamic, albeit challenging, opportunities for the Multinational Enterprise (MNE) and the competitive landscape.

By reason of International Business Theory, a firm becomes a Multinational Enterprise (MNE) when seeking competitive advantage across borders (Rugman, 2010; Hashai & Buckley, 2014). And throughout the industrial revolutions the business environment has been characterized by market leaders that have remained competitive throughout the test of time. According to the Resource Based View (RBV) of the firm, the competitive landscape is championed by companies which attain internal resources that produce sustained competitive advantage (SCA). Early RBV research suggests a firm´s bundle of resources is paramount to firm performance (Penrose, 1952; Wernerfelt, 1984; Barney, 1991) while recognizing *physical-, human-,* and *organizational-capital* as principal assets (Barney, 1991). Furthermore, the fundamentals of which the RBV rests on require a resource to be *heterogenous*, i.e. scarce, and *imperfectly mobile,* i.e. nontransferable, in order to be considered as a SCA producing resource (Rivard *et al.*, 2006; Barney, 1991).

Nevertheless, the fourth industrial revolution may disrupt the accepted competitive landscape and consequently shed light on novel resources considered vital in the unprecedented era of Industry 4.0. For instance, a more recent research stream with a foundation on the RBV concerning competitive advantage and Information Technology (IT) readily contest a direct relationship between the two (Melville *et al*., 2004; Powell & Dent-Micallef, 1997; Clemons & Row, 1991; Ravichandran & Lertwongsatien, 2005). Likewise, by virtue of the emerging landscape, research contest to the fundamentals of the RBV suggesting MNEs may in fact achieve competitive advantage without controlling resources (Lavie, 2006; Wu *et al.,* 2006), thus recognizing external resources as producers of competitive advantage alike. Besides, researchers argue that an MNE can become successful without competitive advantage; whereas SCA is not a prerequisite for an MNE to become successful (Hashai & Buckley, 2014; Sethi & Guisinger, 2002) instead an MNE can exists successfully in a competitive landscape without SCA producing resources. Still, the emphasis of previous research has increasingly taken a reductionist approach, whereas IT capabilities are scrutinized as complementary resources to core capabilities wherefrom SCA is achieved (Mata *et al.,* 1995); or in direct linkage with competitive advantage (Melville *et al*., 2004; Powell & Dent-Micallef, 1997; Clemons & Row, 1991; Ravichandran & Lertwongsatien, 2005). Contrariwise, this research study has taken a holistic perspective thus regard resources as a whole that are greater than the sum of its parts.

1.2. Industry 4.0 terminology

Industry 4.0 is widely used as a term to describe the emerging fourth industrial revolution. However, it still remain a complex umbrella term and one must be aware of the density of the notion as it is in fact a concept rather than a finite term. Numerous sources offer different terminologies and explanations to the vast concept:

> Industry 4.0 combines and connects digital and physical technologies—artificial intelligence, the Internet of Things, additive manufacturing, robotics, cloud computing, and others—to drive more flexible, responsive, and interconnected enterprises capable of making more informed decisions. (Deloitte, 2018)
>
> On the basis of an advanced digitalization within factories, the combination of Internet technologies and future-oriented technologies in the field of "smart" objects (ma- chines and products) seems to result in a new fundamental paradigm shift in industrial production. The vision of future production contains modular and efficient manufacturing systems and characterizes scenarios in which products control their own manufacturing process. (Lasi *et al.,* 2014: p.239)
>
> The Industrie 4.0 describes a production oriented Cyber-Physical Systems (CPS) [15– 17] that integrate production facilities, warehousing systems, logistics, and even social requirements to establish the global value creation networks. (Wang *et al.,* 2016: p.1)
>
> Industry 4.0 will help make smart machines smarter, factories more efficient, processes less wasteful, production lines more flexible and productivity higher. (Ericsson, n.d.a)
>
> The rise of new digital industrial technology, known as Industry 4.0, is a transformation that makes it possible to gather and analyze data across machines, enabling faster, more flexible, and more efficient processes to produce higher-quality goods at reduced costs. This manufacturing revolution will increase productivity, shift economics, foster industrial growth, and modify the profile of the workforce—ultimately changing the competitiveness of companies and regions. (BCG, n.d.)

Seemingly, the comprehension of Industry 4.0 is expansive. Therefore, as to achieve cohesion throughout this research study I have concluded to explain the concept in my own terms. Accordingly, based on the aforementioned explanations of Industry 4.0 and by virtue of the complex concept, I proceed to define Industry 4.0 as:

> The unprecedented era of Industry 4.0 is an introduction the cyber-physical ecosystem of innovative technologies, such as IoT, AI, ML, and Big Data, which advance entire value chains, consequently, disrupting the business environment and competitive landscape alike.

1.3. Problem Discussion

While still in its infancy, the role of Industry 4.0 is driving the business environment suggesting a vital need for firms to develop and advance strategies in order to reap the benefits of the unprecedented era (Ericsson, n.d.a; Vinnova, 2016; Deloitte, n.d.). Resources such as IoT, AI, Big Data, and ML are increasingly discussed as key technologies to implement into one´s organizational construct (Flowers, 2019; Deloitte, n.d.). For instance, Volvo Group concludes on their website:

> The objective of Industry 4.0, the fourth industrial revolution, is to create a smart factory or plant at which everything in production is connected…We have robotic colleagues in prep work on the line, autonomous fork-lifts in logistics and soft robots that can perform straightforward tasks at the office (Volvo Group, 2019a).

While the above statement concludes assimilation to Industry 4.0, it lacks to sufficiently acknowledge key resources. With regards to the RBV, resources that are *Valuable, Rare, In-imitable,* and *Non-substitutable* (VRIN) creates SCA for the firm (Barney, 1991), hence concluding merely assimilation to Industry 4.0 will not illuminate SCA for the firm. For instance, implementing "robotic colleagues" may be *rare* as these specific resources are nontransferable to competitors, however they may not be *in-imitable* because competitors may employ their own "robotic collogues". Consequently, they do not reckon as a SCA. However, the RBV furthermore stipulates that a firm´s bundle of resources may produce SCA for the firm (Penrose 1959, cited in Melville *et al.,* 2004; Powell & Dent-Micallef, 1997; Clemons & Row, 1991; Ravichandran & Lertwongsatien, 2005), even though a separate resource does not. Hence, considered through a holistic perspective, though the "robotic colleagues" may not be deemed a self-sufficient SCA resource, they may be aligned with other resources and consequently produce SCA for the firm. Accordingly, while the implications of Industry 4.0 in the business environment are surging, considering the implications of Industry 4.0 activities for the MNE and the competitive landscape are vital.

Currently, an extensive body of research exists which regards the RBV and competitive advantage (Penrose 1959, cited in Melville *et al.,* 2004; Wernerfelt, 1984; Barney, 1991) and more recent research concerning competitive advantage and IT applications (Melville *et al*., 2004; Powell & Dent-Micallef, 1997; Clemons & Row, 1991; Ravichandran & Lertwongsatien, 2005; Mata *et al.,* 1995); as well as research which consider external resources to the RBV (Cao & Zhang, 2011; Wu *et al.,* 2006; Lavie, 2006). Finally, research exists which concern Industry 4.0 related implementations (Lioukas *et al.,* 2016; Imran & Kantola, 2019) and research which stipulate on MNE competitive advantage (Byrd, 2001; Hashai & Buckley, 2014; Sethi & Guisinger, 2002; Dreyer & Grønhaug, 2004). Yet, to my best knowledge, the field lack sufficient research which associate the RBV to Industry 4.0, and to ultimately assume a link between Industry 4.0 activities and sustained competitive advantage. Accordingly, two essential knowledge gaps prevail. Primarily, research concerning the RBV and the novel concept of Industry 4.0 related activities to competitive advantage is insufficient; and second, research concerning the RBV and the novel concept of Industry 4.0 related activities to competitive advantage by Swedish MNEs is limited. Subsequently, this study aims to gratify the weak theory ties between the RBV and Industry 4.0 by analyzing MNEs´ Industry 4.0 activities that presumably create SCA for the firm. In addition, this research study has adopted a holistic perspective in its evaluation whereas theory and findings are considered as a whole greater than the sum of its parts; as opposed to a reductionist approach, that has previously been a prevalent approach, which assesses specific ties.

1.4. Research question

The discussion from the previous section has produced the following research question:

How do an MNE address sustained competitive advantage in relation to Industry 4.0?

This research study aim to evaluate sustained competitive advantage in Industry 4.0 from an MNE perspective, i.e. how the MNE reflect on recognized SCA resources in the era of Industry 4.0. And as previously indicated, the research question will be reviewed using RBV theory.

1.5. Purpose and scope of the study

The purpose of this research study is to enhance the knowledge about MNE sustained competitive advantage in the fourth industrial revolution. Consequently, RBV theory is considered intertwined with the concept of Industry 4.0. Additionally, this research study aim to answer the research question through secondary analysis, accordingly, publicly available organizational documents have been analyzed in order produce an answer. By virtue of the unprecedented paradigm shift, all industries are considered to be affected by the emergence of Industry 4.0, therefore, a multiple case study has been selected which include companies from different industries; no special attention has been given to a specific industry, rather attention has explicitly been given to the case study population. This case study population is assumed to grow the knowledge of how an MNE address SCA in the era of Industry 4.0.

1.6. Delimitations

It is vital to recognize that this research study is delimitated to certain pertinent factors. First, the multiple case study include *Big companies* (which will be elaborated upon in section *3.4.2 Sampling*) based on the retraction from the Retriever Database Business Search. Second, this study has given no attention to firms outside of the explicit case study population. Third, the technologies repeatedly mentioned in relation to Industry 4.0, i.e. IoT, AI, Big Data, and ML, does not conclude an exhaustive list of Industry 4.0 related technologies, concepts, or terms, rather the technologies recognized throughout this paper are referred to in relation to Industry 4.0, and are considered relevant in this research study due to their repeated importance and reference in the public domain. Table 1 provides an explanation of these technologies (Access Science, McGraw-Hill Education, 2020*).*

Technology	**Definition**
Big Data	The collection, storage, and management of huge amounts of digital information.
Machine Learning	A branch of artificial intelligence (AI) based on the notion that machines (software applications) can learn from examples and can teach themselves how to solve specific problems without being programmed manually.
Artificial Intelligence	The subfield of computer science concerned with understanding the nature of intelligence and constructing computer systems capable of intelligent behavior.
Internet of Things	The concept by which Internet or network connectivity, computing capabilities, and collection and exchange of data extend to everyday objects that are not computers.

Table 1. *Definitions of Industry 4.0 Technologies*

1.7. Outline of the thesis

This study includes six chapters, an appendix and a reference list:

1. Introduction

   This chapter introduces the concept of Industry 4.0 as well as provide a background to this study including the Resource Based View theory and competitive advantage. Thereafter, the knowledge gap is identified and subsequently the research question is presented. Finally, the purpose and scope of the study, and delimitations, are elaborated upon.

2. Theoretical framework

   This chapter presents the principal theories utilized to best address the research question. First, the initial concept of the Resource Based View theory is presented wherefrom a narrative follows to a more modern approach; more recently, the RBV signify a relaxed view of the theory. Finally, MNE and competitive advantage theory is discussed.

3. Methodology

   The methodology chapter presents the research design, and the methods utilized to enforce the research design, to ultimately answer the research question.

4. Empirical analysis

   This chapter presents the findings derived from the data collection. The case study population consisting of three MNEs have been assessed with regards to their Industry 4.0 activities.

5. Analysis

   In this chapter, the empirical findings are discussed and elaborated upon with regard to the theoretical framework.

6. Conclusion

   Finally, the last chapter presents the conclusion of the analysis and answers the research question. Additionally, managerial implications, limitations, and future research are elaborated upon.

2. THEORETICAL FRAMEWORK

This chapter provide a comprehensive introduction to the Resource Based View. First the RBV is discussed in general terms, including a relaxed view of the RBV. Thereafter the RBV with regard to IT is reviewed, as this is presumably related to Industry 4.0 technologies. Additionally, competitive advantage with regard to MNEs is elaborated upon. Finally, a summary of the theoretical framework follows.

2.1. Introduction to the Resource Based View

The Resource Based View (RBV) of the firm, which originated by Penrose (Penrose, 1959, cited in Melville *et al.,* 2004), suggest an organization is a bundle of resources, which in turn make up a firm´s productivity and efficiency. Thus, since firm performance is arguably determined by its resources, firms continually search for new resources and new ways to implement and integrate existing as well as new resources (Melville *et al*., 2004) in order to remain productive and efficient. The combination and alignment of (new and existing) resources is therefore paramount (Melville *et al*., 2004; Wernerfelt, 1984).

2.1.1. What is a resource?

Wernerfelt (1984) describe a resource [at any given time] as a firm´s "(tangible and intangible) assets which are tied semipermanently to the firm" (p.172) for instance technological knowledge, brand name, trade contracts, and machinery. Barney (1991) extended the RBV and described a firm´s resources as "all assets, capabilities, organizational processes, firm attributes, information, knowledge, etc. controlled by a firm that enable the firm to conceive of and implement strategies that improve its efficiency and effectiveness" (p.101). Accepting these descriptions of resources (Wernerfelt, 1984; Barney, 1991) evidently a plethora of resources arise. Barney (1991) furthermore suggest resources to be divided into three categories; *physical capital*, e.g. property, plant, equipment, and location; *human capital*, e.g. training, experience, intelligence of individual employees; and *organizational capital*, e.g. controlling- and coordinating-systems, and formal-, and informal-, intrafirm-relationships; accordingly, these bundle of resources and their alignments are linked with firm performance.

By reason of theory, technology may be considered to place within *physical capital;* as IT resources can be divided into two segments, i.e. infrastructure which compose of the "shared technology and technology services across the organization" (Melville *et al.,* 2004: p.294) and business application which employs said infrastructure (Melville *et al.,* 2004). Likewise, synergies created by virtue of IT fall into the category of *organizational capital.* Finally, as people obtain specific knowledge related to IT resources, IT skill/knowledge/know-how fall into the category of *human capital* (ibid). Accordingly, IT as a resource may be defined as either hard or soft capital, or mutually as both.

2.1.2. External resources

Thus far, the RBV has considered internal resources, i.e. those resources confined to the firm; "assets which are tied semipermanently to the firm" (Wernerfelt, 1984: p.172); "all assets… controlled by a firm" (Barney, 1991: p.101). However, more recent explorations have argued links between external factors and the RBV (Lavie, 2006; Wu *et al.,* 2006) hence assume external resources as valuable proliferations of firm performance. Lavie (2006) refer to strategic alliances in relation to the RBV as *network resources.* Arguably, a firm is not required to proprietarily own nor fully control a resource in order to extract capabilities from it and subsequently produce competitive advantage (ibid).

Moreover, the notion of *heterogeneity* and *imperfect mobility* becomes contested in alliances since alliances do not generally contribute to *heterogenous* and *imperfectly mobile* firm resources. Lavie (2006) argue these preconditions are not especially salient in alliances since "under conditions of pure resource homogeneity, alliances will be formed solely for collusive purposes, rather than to gain access to complementary resources" and "Even when resources cannot be mobilized, alliances enable the transfer of benefits associated with such resources" (Lavie, 2006: p.643). However, while the implication is that network alliances are generators of competitive advantage for the firm, there still exists challenges with this resource, e.g. opportunistic behavior (ibid). Moreover, Wu *et al.* (2006) investigate the linkage between a firm´s supply chain capabilities, IT, and firm performance whereas the supply chain is assessed as the relationship of the focal firm and its partners, and include information exchange, coordination, activity integration, and cooperative responsiveness to environmental changes. The research implies that, albeit a difficult task to incorporate supply chain processes efficiently, IT enhances supply chain processes and consequently create competitive advantage (Wu *et al.,* 2006). Likewise, Cao & Zhang (2011) argue a firm´s competitive stance is improved by the causal ambiguity that arise by embedding IT resources in supply chains.

2.1.3. Sustained competitive advantage

The development of the RBV reflect in addition to competitive advantage also on sustained competitive advantage; whereas the former is when a firm is "implementing a value creating strategy not simultaneously being implemented by any current or potential competitors"; and the latter is when a firm is achieving all of the above including "*and* when these other firms are unable to duplicate the benefits of this strategy" (Barney, 1991: p.102). With the aim of appreciating SCA, two fundamentals of which the RBV rely on are required i.e. *heterogeneity* (no other firm possess the same resource) and *immobility* (the resource cannot be transferred) (Rivard *et al.,* 2006; Barney, 1991). Furthermore, Barney (1991) suggest measuring a resource against a set of criteria called the VRIN-framework—*Valuable, Rare, In-Imitable, and Non-substitutable*—in order to assess SCA capability; provided a (valuable) resource is not accessible to competitors (rare), and even though in the case of availability competitors cannot judge what factors produced success (in-imitable) and therefore cannot replace the resource (non-substitutable). Additionally, besides a resource´s VRIN assessment, the RBV determines a firm´s bundle of resources and their alignment as vital to achieve SCA alike (Rivard *et al.,* 2006).

Additionally, while the categories of *physical-, human-,* and *organizational capital* remain essential, more recently, Lioukas *et al.* (2016) argue that Industry 4.0, which illuminates the need for flexibility and agility due to fast changing environments, require a different human skillset, i.e. *human capital*, than previously needed in order to produce SCA for the firm. The sociotechnical setting of the firm that embodies the relationship between humans, machines, and organizational structures, reason that new human knowledge and skills are required; because organizations are complex structures, introducing new change such as advanced technology without properly changing other parts of the organization will diminish the effectiveness of the initial change. Moreover, Mata *et al.,* (1995) suggest a firm´s competitive advantage is inclined by "invisible assets" such as tacit knowledge (p.493). Accordingly, managerial skills are assumed as tacit knowledge which might produce SCA for the firm (ibid).

2.1.4. Technology and competitive advantage

Seemingly, resources linked to firm performance can assume many forms, e.g. *human-, physical-*, and/or *organizational-capital*. And while technology is assumed vital for the firm, a stream of research grounded on the RBV are increasingly contesting a direct link between technology and firm performance [2] (Melville *et al*., 2004; Powell & Dent-Micallef, 1997; Clemons & Row, 1991; Ravichandran & Lertwongsatien, 2005). For instance, Clemons & Row (1991), which define IT as “equipment, software, services, and personnel” (p.289), acknowledge the importance of IT associated with competitive performance, however, imply little evidence of a direct link between IT and competitive advantage. Likewise, similar findings conclude IT in and of itself does not necessarily produce SCA, but rather IT is used to enhance and leverage core competencies, such as human and business resources (Powell & Dent-Micallef 1997; Ravichandran & Lertwongsatien, 2005). Consequently, Ravichandran & Lertwongsatien, (2005) distinguish between IT resources and capabilities as “Resources are stocks of available factors of production owned or controlled by a firm. Capabilities, in contrast, refer to a firm’s capacity to deploy resources using organizational processes” (p.240). And for the purpose of creating competitive advantage a firm ought to implement efficient *resource-picking,* which is selecting resources more efficient than ones competitor, and/or *capability-building,* which is being more efficient in deploying resources than ones competitor (ibid). Again, IT resources are considered complementary to other resources by its ability to produce competitive advantage.

Yet, it is paramount to establish that while research imply IT resources in connotation with other resources may produce competitive advantage, sustained competitive advantage is seemingly harder to acquire. Accordingly, a question that arise is why IT resources face challenges in exclusively producing SCA? Seemingly, theory suggest that while IT resources are paramount, their availability to competitors pose a challenge for attaining SCA (Clemons & Row, 1991). Though technological advancements in their early stages may be expensive to obtain, develop, and use, the process move swiftly. Subsequently, first-mover advantages are available but short-lived as competitors move rapidly in replicating the technology at cheaper costs erasing the benefits that were once reaped by the first-movers (Rivard *et al.,* 2006). Likewise, by virtue of the current technological world, and the emerging Industry 4.0, many IT applications are considered as *strategic necessities* (Clemons & Row, 1991: p.281); firms must advance technologically in order to survive and stay relevant on the market, which consequently may erase any imperfect imitability that once was achieved (Melville *et al.*, 2004). IT is assumed “fraught with uncertainty and a lack of clarity with respect to the connection between

[2] This theoretical framework includes the stream of research concerning IT in relation to the RBV as it is related to the new technological era, i.e. Industry 4.0, which is principal to this research study.

its application and competitive advantage" (Melville *et al.*, 2004: p.304). Moreover, alliance and supply chain theory argue that IT ought not to be regarded as an individual resource but rather considered as an enhancement (Wu *et al.,* 2006) that creates causal ambiguity (Cao & Zhang, 2011) in alliances and partnerships, which subsequently ought to be considered as resources with regard to the RBV.

However, while research contests a direct link between IT and competitive advantage, the RBV consider a bundle of resources as productions of SCA, nonetheless. Therefore, IT applications may in fact leverage firm performance and thus compose SCA for the firm (Clemons & Row, 1991) for instance when aligned with alliance networks and supply chains (Cao & Zhang, 2011; Wu *et al.,* 2006), or advanced managerial competencies (Lioukas *et al.,* 2016; Mata *et al.,* 1995). By reason of theory, managerial competencies are considered necessary tools to successfully implement resources that contribute to SCA, suggesting the firm ought to develop specific managerial competencies that can handle challenges in the fourth industrial revolution (Lioukas *et al.,* 2016). Moreover, due to the difficulty of sustaining imperfect imitability of IT in the technological era, Mata *et al.* (1995) argue that while IT technical skills and proprietary IT may produce competitive advantages, only managerial IT skills are producers of SCA. On the other hand, Byrd (2001) reflects over IT infrastructure and competitive advantage through flexibility and suggest that employing an IT infrastructure that controls both hardware and software and which can adapt to changing environments (flexibility) is an enabler of SCA. Though the IT infrastructure requires managerial skill to comprehend the changing environment, IT flexibility is in and of itself considered a SCA producing resource.

2.2. MNE and competitive advantage

International business theory defines a Multinational Enterprise (MNE) as an organization that operates across borders, i.e. in multiple countries. And several factors can condition the desire of a firm to become an MNE, for instance Dunning´s Eclectic Paradigm describes *Ownership advantages* e.g. technological-, and managerial-skill*, Location advantages* e.g. country-specific traits, and *Internalization advantages* which consider transaction cost theory, as factors for outward foreign direct investment (Rugman, 2010; Hashai & Buckley, 2014). By reason of theory, *Ownership advantages* may be assumed as a parallel to competitive advantage in the RBV as these concern firm-specific attributes. While a competitive environment foster growth and innovation, a competitive advantage preconditions the existence of firms (Hashai &

Buckley, 2014). However, while the inherent notion of MNEs and competitive advantage is that competitive advantage grows the probability for the development of a firm into an MNE, Hashai & Buckley (2014) argue it is not a necessity. Rather, an MNE can exists without competitive advantage and still create utility in the host country. For instance, MNEs which lack competitive advantages may still outperform firms by deploying ownership advantages (managerial skills) that reduce the liability of foreignness (ibid) by efficiently reading the market (Sethi & Guisinger, 2002). Furthermore, the field of international business has considered flexibility as a vital capability to respond to uncertain and changing environments. Dreyer & Grønhaug (2004) suggests a firm can achieve sustained competitive advantage in uncertain environments by assuming flexibility, which is considered as a firm-specific attribute. Likewise, Byrd (2001) deliberates on the premise that flexibility allow a firm to obtain more control over its external environment and subsequently can better its position on the competitive market.

2.3. Summary

The RBV which has been developed throughout time by various researchers suggest diverse and nuanced viewpoints. Initially, the RBV, which rests on the fundamentals of *heterogeneity* and *immobility,* suggested a firm´s bundle of resources condition productivity and efficiency (Penrose, 1959, cited in Melville *et al.,* 2004) and recognizes internal resources which are controlled by the firm as key producers of firm performance (Wernerfelt, 1984; Barney, 1991). Barney (1991) furthermore developed the RBV into focusing not merely on firm productivity but rather on sustained competitive advantage. Any *human capital, physical capital and organizational capital* resources that meets the criteria of the VRIN-framework are considered as SCA producing resources. However, more recent research streams have nuanced the RBV theory into a more modern context. By way of illustration, a stream of research concerning IT and competitive advantage contest a direct link between the two, suggesting IT by virtue of its imitable capabilities is used as a complementary resource to other core capabilities (Melville *et al*., 2004; Powell & Dent-Micallef, 1997; Clemons & Row, 1991; Ravichandran & Lertwongsatien, 2005). For instance, IT may leverage managerial skills (Mata *et al.,* 1995; Lioukas *et al.,* 2016) wherefrom SCA is achieved. Contrariwise, Byrd (2001) recognize flexible IT, which is adaptable to changing environments, as a producer of SCA for the firm in its own right. Likewise, considering a firm´s bundle of resources as producer of SCA, IT may in fact be recognized as a SCA producing resource (Clemons & Row, 1991; Cao & Zhang, 2011; Wu *et al.,* 2006). Additionally, with regard to the RBV, a stream of research recognize beside internal resources also external resources, such as alliances, supply chains, and synergies, as producers of SCA (Lavie, 2006; Wu *et al.,* 2006; Cao & Zhang, 2011) contesting the notion of *heterogeneity* and *immobility.* Nevertheless, with respect to competitive advantage and the MNE more recent research suggest competitive advantage is not a necessity for success. Initial research imply the existence of an MNE is based on its competitive advantage, however, while this is considered a condition, newer research suggest it is not a necessity (Hashai & Buckley, 2014). An MNE may exists successfully without competitive advantage (ibid) if it is successful in reading the market (Sethi & Guisinger, 2002). Again, flexibility is considered vital for a firm´s success. In fact, it is implied an MNE can achieve SCA by virtue of its flexible capabilities (Dreyer & Grønhaug, 2004; Byrd, 2001).

3. METHOD

This chapter presents the methodology adopted in this research study. First, the chapter elaborates on the abductive research approach as well as the qualitative study approach. Thereafter, the case study approach and the selection of case companies are discussed. Subsequently, the chapter continues to deliberate upon the research design which prepare for answering the research question, including the selection of the case study population and data collection.

3.1. Abductive research approach

There exists three different logics one can assume in a research study. The process of an inductive research approach concern first and foremost observations and findings and then establish a connection to theory (Bryman & Bell, 2011); and suggest an outcome may be true based on the same applicable conditions (Kolko & Kolko, 2010). Conversely, deductive reasoning consider theory first and subsequently its linkage to observations (Bryman & Bell, 2011) as well as suggest the truth is always conditioned by its premises, i.e. if the parameters are valid, the same truth always prevails (Kolko & Kolko, 2010). Both these reasoning stances contain no room for new findings (ibid). An abductive reasoning, on the contrary, is considered as an argument to what might be, i.e. providing the best fit and explanation to an observed phenomena and allow for new findings or innovation (Kolko & Kolko, 2010; Timmermans & Tavory, 2012). While both inductive and abductive research approaches provides an answer to what might be, one can distinguish between inductive and abductive as the former pursues for facts, while the latter seek for theory (Timmermans & Tavory, 2012).

Initially, this study adopted an inductive research approach where theory and findings follow an iterative stance. However, this study developed an abductive research approach as findings and theory were readily assessed in parallel with one another (Timmermans & Tavory, 2012); whereas I, as the author, have continually moved back and forth between empirical findings and theory in order to produce a theoretical framework for this study and to answer the research question. This study began with conducting pilot-discussions (which will be elaborated upon in section *3.4.1 Pilot discussions*) in order to grasp the scope of Industry 4.0 on the Swedish market. Next, existing RBV theory in relation to competitive advantage as well as Industry 4.0 was reviewed which established a knowledge gap and guided the process of this study. A multiple case study design was assumed (which will be discussed in section *3.3 Case study*).

Additionally, secondary analysis using discourse analysis as a technique was chosen. The secondary analysis progressed with an iterative review of the empirical data using the qualitative software analysis tool NVivo (as discussed in section *3.5.4 Data analysis*). Subsequently, findings were analyzed, chosen if relevant to Industry 4.0, conceptualized, cross-referenced within the study population, reviewed, and finally concluded in the empirical analysis. Throughout this process, the theoretical framework was revisited to include vital and relevant theoretical ground to better connect theory to research and to serve the purpose of this study. Ultimately, a holistic perspective have been assumed for this research study when recognizing the theoretical framework and methods utilized to conclude the findings. For instance, a relaxed view of the RBV have been accepted which recognize resources as a whole. And the case study population have been evaluated based on their Industry 4.0 activities as a whole rather than fixating on a specific preconceived meaning.

3.2. Qualitative research method

The general description of qualitative research is that concerning words, as opposed to quantitative research which relates to numbers (Bryman & Bell, 2011) however, the concept is more complex than this. Qualitative studies concern to understand and interpret the behaviors of the studied object and the focus lay in answering *how* and *why* questions (Law, & Martin, 2020). Evidently, the research question for this study, *´How do an MNE address sustained competitive advantage in relation to Industry 4.0?´,* follow a qualitative research strategy. Since the concept of Industry 4.0 is rather novel in relation to theory, I consider a qualitative research strategy to be best suited to grasp the complex notion of this phenomena, to answer the research question, and to ultimately develop insight to theory.

Furthermore, this qualitative research study has adopted an interpretivist positions. Bryman & Bell (2011) explain the epistemological interpretivist position as “the understanding of the social world through an examination of the interpretation of that world” (Bryman & Bell, 2011: p.386). Moon & Blackman (2014) suggest an interpretivist seek understanding to phenomena by evaluating individual cases. This research study aim to evaluate how an MNE address SCA in Industry 4.0 thus acknowledge their own interpretation, thought, and point of view of the concept. Likewise, it is my interpretations as an author to present an answer to the research question. Thus, by looking at three individual Swedish MNEs I seek to understand sustained competitive advantage in Industry 4.0. Furthermore, an ontological constructionist position is readily assumed in relation to qualitative studies. In contrast to objectivism which see an organization as a separate entity of the people who inhibit it, constructionism implies social constructs "are outcomes of the interactions between individuals" (Bryman & Bell, 2011: p.386). If this research study adopted an objectivism ontological position, the MNEs in the case study population would be assumed to autonomously address the concept of Industry 4.0, arguably little variation would be assumed since all MNEs address the same phenomena. However, accepting MNEs as complex structures, they presumably address phenomena diversely by virtue of their perspectives (Moon & Blackman, 2014). Conversely, a constructionism position is better suited for this research study and to answer the research question; since within-case and across-case evaluations are undertaken to evaluate how the MNEs in the case study population address SCA in Industry 4.0.

3.3. Case study

According to Bryman & Bell (2011) the case study design concern "the complexity and particular nature of the case in question" (p.59). And while a case can assume various contexts, such as a single organization, a single location, a single event, or a single person, a multiple case study concern several cases which are "undertaken jointly to explore a general phenomenon" (Bryman & Bell, 2011: p.60). Thus, to explore the general phenomenon of sustained competitive advantage in relation to Industry 4.0, this multiple case study concludes three cases, i.e. Volvo, Ericsson, and H&M, which complete the case study population. Furthermore, because I have adopted an interpretivist and constructionist position, this multiple case study sanction variations across the cases; which acknowledge phenomena may be constructed (by MNEs) in diverse ways (Welch *et al.,* 2010). This allow for the discovery of unique findings as well as general findings across the study population (Bryman & Bell, 2011). Furthermore, this multiple case study is assumed through a holistic perspective. Holism can be explained as " the properties of the parts are influenced or determined by their relationship to the whole entity" (Porta & Last, 2018: pp. A); as well as "the emphasis is on wholeness and integration, rather than separation and compartmentalisation" (Bloom, 2005: pp. A). Hence, while a reductionist approach may assess individual [IT] capabilities with other [IT] capabilities as well as with competitive advantage (Fink, 2011) a holistic perspective offers a different viewpoint.

What´s more, a general challenge that arise with a small case study population is its ability to demonstrate generalization across contexts (Bryman & Bell, 2011; Welch *et al.,* 2010). This has been recognized throughout this case study and addressed by triangulation as well as by providing rich account of all steps undertaken to produce this research (as explained in section *3.6 Quality of research*). Consequently, on account of the research question *´How do an MNE address sustained competitive advantage in relation to Industry 4.0?´* a multiple case study is deemed most appropriate to illuminate findings and yield contribution to theory.

3.4. Selection of case companies

With regards to the RBV, this research study aims to explore how MNEs address sustained competitive advantage in the unprecedented era of Industry 4.0. And as was discussed in section *1.3 Problem discussion* currently two principal knowledge gaps prevail; primarily, the research concerning the RBV and competitive advantage in relation to the novel concept of Industry 4.0 activities; and second, the research concerning the RBV and competitive advantage in relation to the novel concept of Industry 4.0 activities undertaken by Swedish MNEs. While it is vital to take into account that MNEs are complex international organizations transpiring across borders, this research study has chosen Swedish companies, i.e. MNEs with headquarters (HQ) located in Sweden, to explore. Sweden aspire to become a global innovative leader and has thus undertaken strategies to strengthen its position in the digitalized era (Vinnova, 2016), e.g. the governmental initiative AI Innovation of Sweden elaborated on later in this section proves as an example. Therefore, Sweden is an attractive country of choice. Moreover, the selection of Swedish MNE is considered to add cohesion to the sampling method.

Since Industry 4.0 is still at an early stage this research study is supported by pilot-discussions conducted at Volvo Group and AI Innovation of Sweden, which act as a starting ground for analyzing the stage of Industry 4.0 activities on the Swedish market. These inventories have been helpful in assuming how to approach the concept of Industry 4.0 and based on the information retrieved from the pilot discussions ´Big companies´ have been chosen as part of the case study population; as they are considered wealthy enough to engage in Industry 4.0 activities likewise big enough to be affected by it. Following, the pilot discussions are presented as part of the case company selection process. Subsequently, the sampling of case companies are presented.

3.4.1. Pilot discussions

In preparation for this thesis and due to the novelty of the subject matter of Industry 4.0, pilot discussions with leading firms have been conducted to better understand their interpretation of the subject matter as well as the scope of integration of the subject matter. I met with a foresight manager at Volvo Group (hereafter Volvo) which is "one of the world's largest manufacturers of heavy-duty trucks, construction equipment, buses and heavy-duty diesel engines as well as a leading supplier of marine and industrial engines" (Volvo Group, n.d.a). And I met with AI Innovation of Sweden (hereafter AIoS) which is Sweden´s leading Innovation agency in AI.

Foresight Manager at Volvo Group

In preparation for the subject matter of this thesis [Industry 4.0], I met with a foresight manager at Volvo Group (Volvo) to better understand what a large global complex MNE consider about the subject matter and what is currently being undertaken with regards to the subject matter. Upon discussion with the foresight manager findings conclude that Volvo is in fact less proactive with regards to Industry 4.0; rather the subject matter is at an infant stage at the company. For instance, currently, Volvo is collecting Big Data from connected vehicles/trucks and is currently refiguring how to generally interpret the collected data and how to monetize such large datasets. Since this technology is relatively new at the company no concrete affirmations have yet resulted. Subsequently, the foresight manager could not provide me with further information on how this process may unfold. Conversely, Volvo is more proactive with regards to tapping into external knowledge, for instance through Open Innovation as well as reaching unexploited knowledge that currently reside within the organizational structure; presumably, this field within the company is gaining more future traction, though the "not invented here" syndrome still prevail internally. Conclusively, one may say that Volvo is engaging in Industry 4.0 activities, i.e. collecting Big Data, however the gathered datasets have proven hard to monetize; even though the datasets are considered valuable, without proper utilization it is difficult to assume derived value. With regards to the RBV, the task for Volvo remains to appropriately use the gathered dataset in a way that produce SCA. By reason of theory, bundling this resource with e.g. managerial resources (Lioukas *et al.,* 2016), may produce SCA.

Node Manager at AI Innovation of Sweden

AI Innovation of Sweden (AIoS) is an initiative created by the Innovations department of Sweden and Västra Götalands region and is tasked to lead Sweden in the global innovation race. And so, in preparation for this thesis, I met with the node manager of AIoS to discuss what they are currently undertaking as an effort to lead in the race and what outcomes are produced as a result. Upon discussion with the node manager, findings conclude that the role of AIoS is to condition discussions between firms (or partners as they call them) and develop knowledge sharing among firms and across industries to condition competitive advantage for the country as a whole. Thus far, AIoS has managed to initiate talks between firms through breakfast seminars, however no firms have actively shared their information with one another. When asked what success rate the initiative has accomplished thus far in pushing Sweden towards its leading role, the answer remain "it is too early to conclude". Still, the goal seems to be to initiate dialogues between firms that are currently developing Industry 4.0 modules into their businesses; for instance, companies like Volvo Group and their Big Data resource. Nevertheless, though collaboration between firms circumvent "reinventing the wheel", other major challenges remain such as sharing proprietary information with a competitor. Based on the discussion with the node manager, I conclude the initiative to be at a very early stage, despite the fact that AIoS have been up and running since the beginning of 2019. Evidently, more dynamic efforts ought to be in place in order to lead Sweden in the innovation race. Conclusively, Industry 4.0 is at a very early stage and AIoS struggles to engage cross-company and cross-industry information sharing.

3.4.2. Sampling

Based on the information retrieved from the pilot-discussions, it was determined that MNEs are to be considered in this research study. Therefore, a purposive sampling technique was adopted where participants are not selected on a random basis but rather chosen based on a set of criteria that are relevant for the phenomenon in focus (Bryman & Bell, 2011). To additionally provide cohesion to this research study, it was decided to include Swedish MNEs. Accordingly, the *Retriever Database* (Retriever database, n.d.) was used to find adequate companies available on the Swedish market; and for the sake of tranquility, the preset criteria of "Big companies" have been used which include (1) the number of employees and (2) total sales or total assets (see table 2).

Companies	Big companies
Employees	250 - ∞
Total Assets	430 million SEK >
Location	All of Sweden

Table 2. *Criteria for "Big Companies", compiled by author.*

Subsequently, the three largest production companies on the list (excluding holding and consulting companies because of the Industry 4.0 focus) were identified (presented in descending order) which complete the case study population:

1. Volvo AB
2. Ericsson
3. H&M Group

Evidently, the companies completing the case study population are operational in diverse industries, i.e. heavy-duty trucks and equipment, information and communication technology (ICT), and fashion retail. Thus, it is assumed that the companies in the case study population vary in terms of technological density. For instance, Ericsson´s focus is on technology, while H&M´s concentration is on retail, and Volvo ´s attention is on trucks and equipment. This element has been taken into account throughout this research study as, presumably, Ericsson may demonstrate more technological advancements than e.g. H&M. However, the fourth industrial revolution is a paradigm shift purportedly affecting all industries; trucks and equipment, ICT, and retail alike. Thus, this case study population is concluded complete as it will represent different aspects of MNEs and how they address sustained competitive advantage in the era of Industry 4.0. At the very least, I believe the incongruent companies in the case study population are elevating the aim of this research study which is to assess key Industry 4.0 trends in the new era through a holistic perspective.

3.5. Research design

This research study aspires to answer the research question *´How do an MNE address sustained competitive advantage in relation to Industry 4.0?´* and accordingly the research design has been selected to best yield knowledgeable contribution to answer the research question. Consequently, secondary analysis of two sources has been included in this study. First the companies´ websites have been analyzed. Next, the companies´ annual reports have been assessed in order to conceive findings and to answer the research question. Furthermore, discourse analysis has been selected as a technique to approach and comprehend the collected data.

3.5.1. Secondary analysis

While secondary analysis is not the norm for qualitative studies this research method has accrued growing consideration (Bryman & Bell, 2011). In contrast to quantitative studies, qualitative secondary analysis concern language in secondary sources as opposed to numbers. Consequently, in order to answer the research question, I sought the public domain for relevant information; more specifically, publicly available organizational documents which are made available by the company, such as annual reports, as well as material in printed form on the company website (Bryman & Bell, 2011), have been assessed. By reason of triangulation (Bryman & Bell, 2011) two sources of data were chosen; the company website, and company annual reports from the three previous years (2017-2019). According to triangulation, using two sources of data "results in greater confidence in findings" (Bryman & Bell, 2011: p.397). Likewise, using annual reports for the duration of several years allow for evaluation within-case, in addition to across-case, which furthermore strengthen triangulation.

The company website was chosen since it acts as the face of the company to the external world and the language displayed here demonstrates what image the company want to portray. Likewise, annual reports express what actions are being undertaken with regards to Industry 4.0 and what goals and future prospects are channeled, and subsequently what direction the company design to take in the new era. By analyzing these repertoires, one can get a sense of what the company considers of Industry 4.0 and what they address is their role in the fourth industrial revolution. Likewise, what resources, competencies and strengths the company possess in the fourth industrial revolution reveals their belief of what makes a SCA resource. It is noteworthy to mention that a company´s website and annual reports are carefully conscious expressions of language, however, it is not the purpose of this study to determine the truthfulness of the expressed language, but rather to evaluate what Industry 4.0 activities are being realized by the MNE, with regard to the RBV, which subsequently are assumed to produce SCA for the firm; and to answer the research question *´How do an MNE address sustained competitive advantage in relation to Industry 4.0?´*.

3.5.2. Discourse analysis

Discourse analysis (DA) is the study of communication "other than talk" (Bryman & Bell, 2011: p. 525) and relates to the notion of language which is put in a way that affects the world around it, rather than being a product of it. Likewise, in cohesion with an interpretivist and constructionism position adopted in this research study, *How* one expresses oneself is of essence for DA (Bryman & Bell, 2011). In this research study, DA has been used as a research design technique to comprehend the language of the secondary data collection. Bryman & Bell (2011) suggest that three questions are to be answered as part of DA and accordingly guide the way the gathered data is being comprehended:

> (1) what is this discourse doing? (2) How is this discourse constructed to make this happen? and (3) What resource are available to perform this activity? (Bryman & Bell, 2011: p.526).

Consequently, analyzing the case study population through DA provide a holistic view to what the company consider of the fourth industrial revolution; what is the role of the company in the new era; how are they supporting said role; and most importantly with regards to the RBV, what resources are available for the company to reach SCA for the firm. To fully realize the value of DA, this study explores various public documents made available by the study population, i.e. annual reports and company website language, that relates to Industry 4.0 activities. By analyzing the documentation, within-case and across-case variations appear. Consequently, trends within the company as well as trends across the companies develop, which provide a holistic aspect of Industry 4.0 activities commenced by the case study population as a whole. Hence, by focusing on an individual case, I am presented with incongruent interpretations across the cases (Ball & Wilson, 2000) while also being aware of the holistic approach undertaken in this research study; this assumes DA for this case study. For instance, I have evaluated the annual reports of Ericsson (within-case) and in conjunction with the annual reports of H&M and Volvo (across-case); *vice versa*. Wherefrom, by analyzing the results across-case, I have generated congruent trends related to Industry 4.0. This search for shared language is vital for assuming emerging trends (Coupland, 2005) in relation to Industry 4.0.

3.5.3. Data collection

As previously indicated, two sources of data have been analyzed as part of this research study, (1) the company website, and (2) the company annual reports, and have been considered as part of triangulation purposes. Likewise, the annual reports for each company for the duration 2017-2019 have been assessed to assume triangulation within-case as well as across-case. Since this research study has adopted an abductive approach, the gathered data has been examined through a holistic perspective and initially began with the company website before continuing with the company annual reports, still the data has been assessed interchangeably. The gathered data has been filtered in the qualitative software analysis system NVivo which will further be elaborated upon in the section *3.5.4 Data analysis.*

3.5.3.1. Company Website

Throughout this research study, key Industry 4.0 related terms, i.e. IoT, Big Data, ML, and AI, have been assumed in relation to Industry 4.0, due to their profound reference in the public domain (as was mentioned in section *1.5 Delimitations*). Therefore, these key terms have been selected to represent the umbrella term of Industry 4.0 activities when collecting relevant data from the company website; the abbreviations as well as expansions of the terms have been used in order to improve the findings. First, the company website´s own search engine has been used to search for the Industry 4.0 related terms and key words in order to create cohesion. Evidently, the results varied amongst the companies in the case study population. It is noteworthy to mention that, in my assessment, two of the three companies lacked a refined search engine which may have affected these findings; nevertheless, other sources of data have been assumed for triangulation purposes (as was discussed in section *3.2 Quality of research*). Following the key terms´ assessment on the search engine, the websites were analyzed as a whole in order to find relevant Industry 4.0 language.

Search Terms Used in Company Website Data Collection

- Industry 4.0
- IoT
- Internet of Things
- Artificial Intelligence
- AI
- Machine Learning
- ML
- Big Data

3.5.3.2. Company Reports

In addition to the company websites, the case study population´s Annual Reports from the past three years (2017-2019) have been analyzed in an attempt to further understand the companies´ progressions of Industry 4.0 activities and ultimately recognize key resources. The abductive analysis process began with the latest available year, i.e. 2019, and worked reversely in order to identify Industry 4.0 related trends and to clearly conclude which year to assume as the starting year for this research study. Consequently, the analysis process begins in year 2017 as this year is deemed relevant enough as a starting point for estimating Industry 4.0 related inclinations. Likewise, information retrieved from the pilot-discussions which confirmed the novelty of Industry 4.0 on the Swedish market add to the relevance of 2017 as a starting point and of the three year period. Because the company websites testified of varied results regarding Industry 4.0 terms, the company reports have been evaluated more through a holistic perspective; the reports have not been searched for with respect to the terms used in the company websites, instead they have been read thoroughly and extracted of Industry 4.0 related activities (which will be elaborated upon in section *3.5.4 Data analysis*). This data collection began with evaluating the annual reports of the year 2019 for each company, and worked reversely, i.e. next, the annual reports of 2018 were examined, and lastly the reports of 2017 were assessed.

3.5.4. Data analysis

As discussed in section *3.1 Abductive research approach* this study has adopted an iterative stance, where empirical data and theory has been assessed in relation and parallel to one another; while the data was gathered, theory was built upon to better remain relevant to the findings as well as to conclude the relevance of the findings. Initially, the data analysis concerns the case study population´s websites which have been evaluated based on the numbers of search results of the search terms discussed in section *3.5.3.1 Company Websites.* Subsequently, the data gathered and interpreted from this source has supported the data retrieved from the annual reports; accordingly, it was decided to approach the annual reports with respect to Industry 4.0 activities rather than searching for key terms.

The data analysis process have followed a systematic approach whereas the selected data, i.e. the data sources, have been enclosed in NVivo. First, within-case evaluation has been conducted whereas the gathered data from the website has supported the data collection retrieved from the annual reports. Each company in the study population has been assessed individually, and for each year, with regard to Industry 4.0 activities. As discussed in section *3.5.3.2 Company reports* the analysis of the annual reports began with the year 2019 and concluded with the year 2017 thus adopted a retrospective approach. The annual reports have been scrutinized of Industry 4.0 related activities and relevant language has been extracted and coded into a system node called "Industry 4.0". Thereafter, I began to profoundly revisit the "Industry 4.0" node of Industry 4.0 related activities wherefrom trends began to emerge for each company and each year creating specific ´trend´ nodes, such as "Connectivity" or "Synergies". And finally, the information retrieved from ´trend´ nodes have been revisited and cross-referenced amongst the study population (across-case) in order to find shared meaning and emerging trends. Subsequently, the shared meaning has been grouped into Industry 4.0 related trends assumed by the case study population concluding IoT, Big Data, AI, Partnerships & Collaborations, Employees, and Synergies (see appendix I).

3.6. Quality of research

For the purpose of establishing quality in research studies two important criteria are readily assessed, namely *reliability* and *validity*. However, these criteria are more applicable to quantitative studies (Bryman & Bell, 2011) over qualitative studies. Likewise, they pose challenges for discourse analysis (Crooks, 1990; Cheek, 2004). In this research study, in addition to an interpretivist and constructionist position, DA has been used a technique to consider *how* the case study population address Industry 4.0 rather than to "seek closure in terms of producing the only possible reading" (Cheek, 2004: p. 1147), therefore using definite quality checks such as *reliability* and *validity* pose challenges in assessing quality. Conversely, qualitative research acknowledge the existence of more than one absolute reality, thus the quality criteria used for qualitative studies are *credibility,* and *transferability* which considers the content, and *dependability,* and *conformability* which considers the methods utilized (Bryman & Bell, 2011).

3.6.1. Credibility

Credibility can be assumed to parallel with *validity,* which is validating the information of respondents (Bryman & Bell, 2011). However, since this research study has adopted secondary analysis of data no respondents have been approached and thus, in this sense, this criteria is not applicable to this research study. However, Guba (1981) suggest there are several aspects of credibility e.g. observation, peer debriefing, and member checks, but while these are not applicable to this research study by virtue of a single author and limitations of time and resources, the constructs of *triangulation* and *cohesion* are instead applicable. This research study has readily assessed two sources of data, i.e. the company website and company annual reports, by virtue of triangulation purposes. As I have assessed the annual reports for the duration of three years, the data considers not only across-case but also within-case in an attempt to produce thick description and to further strengthen triangulation. Likewise, as I have assumed an interpretivist position, this research study aim to interpret the data to arrive at logic and *cohesion* (Guba, 1981). By adopting systematic approaches within-case and across-case, for instance using the exact same search terms in the company website as discussed in section *3.5.3.1 Company Website* and approaching the annual reports with an interpretivist and constructionist position to extract Industry 4.0 activities, I have attempted to achieve content cohesion throughout this research study.

3.6.2. Transferability

The quality criteria of *transferability* can be assumed to parallel with the quantitative studies quality criteria of *external validity*. Accordingly, external validity concerns the "degree to which findings that can be generalized across social settings" (Bryman & Bell, 2011: p.395). However, it is assumed that generalization in qualitative studies which have adopted a case study approach is posing a challenge due to the small sample population. While I am aware that a larger case study population would have strengthen the validity of this research, the construct of transferability instead concern depth, or ´thick description´, over quantity. Therefore, as an attempt to address this challenge I have profoundly discussed and demonstrated how the case study population have been selected (Bryman & Bell, 2011) as seen in section *3.4.2. Sampling*. Accordingly, a purposive sampling which have been utilized in this research study support generalization (Guba, 1981). Nonetheless, I assume the incongruent companies concluding the case study population to be relevant representations of companies in Industry 4.0; since, presumably, the fourth industrial revolution will affect all industries. Subsequently, producing detailed discussions and descriptions of the collection of data throughout this research study (Guba, 1981) results in a rich archive which allow other researchers to make their own "judgments about the possible transferability of findings to other milieux [sic]" (Bryman & Bell, 2011: p.398). For instance, collecting thick description of data by assessing the company website and annual reports across-case as well as within-case; and the production of data (Guba, 1981) e.g. by demonstrating the findings in detail.

3.6.3. Dependability

Dependability is similar to reliability which considers whether the research findings are repeatable, i.e. whether the same test of the same object can repeat the same results (Bryman & Bell, 2011). Guba (1981) suggest dependability can be assumed for a qualitative study through implementing an "audit trail" (p.87). Consequently, to ensure dependability this abductive qualitative case study aim to explain in great detail the procedures and methods taken (as discussed throughout in chapter 3) to produce findings. Likewise, the data collection (which will be elaborated upon in section *4.2 Data collection*) is presented in transparency by acknowledging full accounts of data that have been utilized to conclude the empirical findings (Bryman & Bell, 2011). Subsequently, I have demonstrated how I have used the qualitative software analysis system NVivo to group findings and conclude shared meaning (as was discussed in section *3.5.4 Data analysis*). Finally, the scientific methods utilized in this research study have been defended in an opposition symposium which furthermore strengthen its dependability.

3.6.4. Confirmability

Lastly, the doctrine of confirmability has been assumed, which concern whether the researcher has permitted her values to interfere with the research (Bryman & Bell, 2011). While perfect objectivity is assumed difficult to obtain (ibid) I have acted in good faith and attempt to remain near objective by being transparent and assessing findings as objectively as possible. Likewise, by virtue of triangulation purposes (Guba, 1981) and the production of thick descriptions I have attempted to lessen my presumed subjectivism. Additionally, confirmability may be strengthened by the fact that I have no accountability with any of the companies in the case study population which may or may not have affected my objectivity towards them.

3.7. Ethical considerations

This research study has been entirely guided by fundamental ethics principles assumed by the author. For instance, since this research study concern secondary analysis of organizational repertoires, i.e. the company websites as well as annual reports available on the public domain, I have not conducted in any unethical procedure while accessing the documents nor used proprietary, copyright, or trademarked information in an unethical stance. Likewise, the publicly available retrieved information has been used in a proper form, i.e. given full acknowledgement if referenced. Moreover, though this research study does not account for respondents, ethical considerations have been given to sources outside the context of the empirical research; while approaching Volvo and AIoS, where pilot-discussions were conducted I acknowledged in full my purpose for the meeting, i.e. to discuss Industry 4.0 with the specific company by virtue of my university master thesis. Additionally, I asked for acceptance before inscription reports during the meeting. As discussed in section *3.4.1 Pilot discussion* the retrieved information have been used to assess the density of Industry 4.0 on the market and not used as any data collection or findings.

4. EMPIRICAL ANALYSIS

This chapter presents the data that has been gathered and elaborates on the empirical findings. First, the companies in the case study population are presented with brief introductions to provide ground for the collected data. Thereafter, the collected data from the organizational documents which have been assessed are presented in two stances; first the company websites, next the company annual reports are deliberated upon. Subsequently, the empirical analysis deliberates upon the findings, and lastly, this chapter summarizes and discusses the identified trends.

4.1. Company background

4.1.1. Volvo AB

Volvo Group (hereafter Volvo) was founded in 1927 and have since established a leading position on the global market including numerous brands in their portfolio, such as Volvo, Volvo Penta, and Renault Trucks, and continues to develop solutions in the field of electromobility, autonomy and connectivity. Currently, Volvo is "one of the world's largest manufacturers of heavy-duty trucks, construction equipment, buses and heavy-duty diesel engines as well as a leading supplier of marine and industrial engines" (Volvo Group, n.d.a). Accordingly, product development is advanced to increase uptime for customers which drives value, and the company stipulates having a broad product offering allow for economies of scale in production and development. Moreover, with headquarters in Gothenburg, Sweden, Volvo has presence in 190 countries, production in 18 countries, and employs 104,000 people globally (Volvo Group, n.d.a). In 2019, Volvo´s net sales amounted SEK 432 billion (Volvo Group, 2020).

4.1.2. Ericsson

Ericsson was founded in 1876 by virtue of providing communication access to the masses. Today, the Information and Communication technology (ICT) company, which reside headquarters in Stockholm, Sweden (Ericsson, n.d.f.; Ericsson, n.d.g.), is "creating game-changing technology" (Ericsson, n.d.g.). With a rigorous portfolio, including telecommunication networks and services, the emphasis is on 5G technology, IoT, and automation. Ericsson serves customers in 180 countries and estimates to employ 99,000 people. Moreover, the company has 54,000 patents globally (Ericsson, n.d.h.). In 2019, the company´s net sales amounted roughly SEK 227 billion (Ericsson, n.d.c.).

4.1.3. H&M Group

The fashion retail company H&M was founded in 1947 in Västerås, Sweden, and has since grown to a global industry leader with presence in 74 markets, as well as 51 online markets, totaling 5,053 stores globally (H&M Group, n.d.d.). The company´s portfolio includes various brands, such as H&M, Arket, Weekday, and COS, amongst others (H&M Group, n.d.e.). The company is increasingly advancing its efforts to incorporate sustainability throughout their value chain as well as acknowledging "Expansion is taking place online"(ibid). In 2019, the company´s net sales amounted SEK 233 billion. And the company employed 179,000 people globally (H&M Group, n.d.a.).

4.2. Data collection

4.2.1. Company websites

Based on the technologies adopted as interlinkages with Industry 4.0 in this research study (as was discussed in section *1.6 Delimitations*), a set of key terms have been used as search terms on the company website. Table 3 (Volvo Group, n.d.b.; Ericsson, n.d.i.; H&M Group, n.d.f.) demonstrates the search terms utilized as well as the results drawn from them. While using the company website´s own search engine, the results indicate divergent results. The data suggest while Ericsson has adopted the term "Industry 4.0" entirely, Volvo and H&M have not. Nevertheless, as has been declared in this research study before, Industry 4.0 activities, such as AI, Big Data, IoT, and ML, fall under the umbrella term of Industry 4.0 hence are acknowledged as Industry 4.0 activities even though the companies lack to specify the term itself.

Key Term	Volvo Group	Ericsson	H&M Group
Industry 4.0	28	324	641
IoT	0	2464	0
Internet of Things	0	1182	1974
Artificial Intelligence	0	442	11
AI	427	780	366
Machine Learning	5	506	57
ML	2	89	3
Big Data	15	317	271

Table 3. *Search Terms Used in- and Results Derived from the Company Website; compiled by author.*

4.2.1.1. Volvo AB (Volvo Group)

Volvo´s search engine (Volvo Group, n.d.b.) lacks refinement. While 28 results appear from searching the term “Industry 4.0” very few of the results were related to the fourth industrial revolution and activities alike. Nevertheless, the company explain, “The objective of Industry 4.0, the fourth industrial revolution, is to create a smart factory or plant at which everything in production is connected” (Volvo Group, 2019a). Moreover, results of Industry 4.0 ponder on the company´s technological plant in Umeå, Sweden, stating “With all the technologies that are now rapidly developing within Industry 4.0 we see enormous possibility of even further development in our already modern plant” (Volvo Group, 2018b). Likewise, results show Volvo is involved in a partnership which the objective “to work and develop Industry 4.0 solutions together with other companies” (Volvo Group, 2019c). Furthermore, the search term “AI” concluded results that included the word “air” and thus was insufficient; the same occurs for the search terms “Machine Learning” and “Big Data”. Instead, I reside to browse the company website for Industry 4.0 activities. The company website house a section called “Innovation” where Industry 4.0 activates are described. The “Innovation” section is comprised of three subsections: Automation, Electromobility, and Connectivity. Although the concepts suggest Industry 4.0 activities, the term “Industry 4.0” is excluded in these sections, and the same holds true for the other search terms.

4.2.1.2. Ericsson

Upon entering Ericsson´s website (Ericsson, n.d.i.) the company´s exhilaration for the technological future is apparent. While the emphasis is on 5G technology, interlinkages with Industry 4.0 activities are deliberated:

> Combining revolutionary levels of efficiency with higher capacities to send data: that's 5G. Not only will it tangibly benefit you, it's here to improve societies across the globe, and it's equipping industries to do many things which – not too long ago – they could only envisage. Better yet, this new era of advancement is just getting started (Ericsson, n.d.b.).

Evidently, the 5G network is what powers Industry 4.0 activities such as IoT and AI. The company has a very refined search engine on their website, as the results appear with specific and relevant information with regards to the search term. Ericsson repeatedly expresses the term "Industry 4.0" as well as other Industry 4.0 related terms, such as IoT, Big Data, AI, and ML, on their website. Because of the massive search results and due to the holistic approach adopted in this research study an in-depth analysis will not be realized.

4.2.1.3. H&M Group

H&M´s website (H&M Group, n.d.f.) display their ambition of becoming fully sustainable, however lacks the technological input with regard to Industry 4.0. The website´s own search engine lacks refinement; when searching for the term "Industry 4.0" several hundred results appear however with no resemblance to the term itself, but rather to the word "industry"; the same remain true for the search terms "Internet of Things", "Machine Learning" and "ML". Nevertheless, the term "Artificial Intelligence" results in slim relevant searches; for instance, the company contest to have bridged a collaboration between academia and the private sector when accepting a robotics and AI professor, Danica Kragic Jensfelt, to their board (H&M, 2019b) in order to help leading the way into these fields. In an interview available on the H&M website professor Kragic Jensfelt explain that she hopes her work will help the company to better understand how to "automate different types of logistics processes" and offer "better customer experience using data based methods and artificial intelligence" (H&M, 2019a). Furthermore, she explains that AI becomes successful when applied to the company as a whole in order to create synergies instead of being used in silos (ibid). She also stipulates H&M has progressed in the work of AI concluding a 10-20 year plan already in place before her arrival and the company is "definitely on the right track of doing the transformation" (ibid). However, based on the company´s website, there is little to no evidence of the company working with Industry 4.0 activities. Instead, the search terms "Artificial Intelligence" and "AI" produces overwhelming and slightly relevant results. Likewise, merely one relevant search result for the term "Big Data" appear explaining the company have incorporated Wi-Fi at test stores to collect data from the connected shoppers in order to analyze and "optimize store experience" (H&M, 2019c).

4.2.2. Company reports

The caste study population´s annual reports produce more detailed implications of technological activities than do the websites. Similarly, in the reports as in the websites, some explicit Industry 4.0 related terms are slim while other advanced technologies are increasingly mentioned. Nevertheless, it is vital to remember that the reports are analyzed through a holistic perspective rather than an in-depth analysis. The following inductive secondary analysis data collection is presented through a chronological timeline, from 2017 to 2019, in order to clearly provide a progression of Industry 4.0 activities throughout the selected period and consequently identify trends.

4.2.2.1. Volvo AB (Volvo Group)

4.2.2.1.1. 2017

In their *Annual and Sustainability Report 2017* (Volvo Group, 2018a), Volvo discuss technology and technological transformations in an Industry 4.0 perspective without explicitly mentioning the term; the company reason, "We are at the start of a paradigm shift in transport that will reshape the industry and the society we live in" (p.34). During 2017 the company has "demonstrated new technologies and innovations within automation, connectivity and electrification" (p.6), and several technologies related to these three areas were introduced.

Synergies

Indeed, the transition towards new technologies is to be realized through the extensive knowledge, assets, as well as customer-, supplier-, and partner-relations the company has in their platform. These assets make up a system of synergies which the company refer to as CAST (Common Architecture and Shared Technology). However, due to the belief that the new technologies "will take time before we can fully utilize these opportunities" (p.34), CAST is essentially an effort to create synergies in the company´s well-known technologies as it "will free up capacity and resources for new technologies while mastering the existing" (p.12).

Still, the investments in automation, connectivity, and electromobility are vital as they "will be the foundation on which to further improve customer success by leveraging on the new technologies" (p.15). Volvo reason the convergence of the technologies will "radically transform transport" (p.34). Evidently, three focus areas are recognized with regards to Industry 4.0 activities, while some more than others. Since electromobility relates to the technology of electricity and electric batteries which has not been the focus of this paper, the technologies of automation and connectivity, and related activities thereof, will subsequently be emphasized.

Connectivity

Ultimately, emerging into new technologies create new business models and Volvo ponders the future focus will be on relishing profit from services rather than selling hardware. Accordingly, connectivity solutions drive the emphasize towards services. In 2017 Volvo estimated to have the largest connected fleet in the world with roughly 700,000 connected vehicles. Through the connectivity solutions customers are offered efficiency, e.g. uptime solutions, and optimization, e.g. preventive maintenance. Seemingly:

> And uptime, in the world of commercial transport, is what everyone is chasing. It means avoiding unplanned stops, which we can help our customers achieve by monitoring vehicles and predicting when they will need maintenance, assign a technician and schedule a visit to the service station at a time when the truck is not operational (p.38).

Moreover, connectivity allows vehicles to communicate with one another in an attempt to optimize traffic solutions, for instance, avoiding traffic hazards. Ultimately:

> Information is a means of competitiveness in the transport business. Keeping track of a fleet is necessary to maintain a clear overview of the operation. The bottom line is increased revenue through improved utilization, and lower operating expenses through fuel control and optimized administration (p.67).

Automation

Another area of focus in the changing transport industry is automation. While automation is nothing new—the company has successfully worked with autonomous technology for several years in their product range—the spectrum of automation is rapidly evolving. Volvo deliberates:

> As automation advances, new solutions and services and an evolving business model are the inevitable result. The automated solutions currently being developed place the human very much at the center. The technology might involve replacing the characteristics of a human with those of a machine, but the focus is totally based on the customer experience (p.65).

Thus, the company reflects “We believe that automation will redefine the commercial transport solutions that most of us rely on every day” (p.36). Yet, the company confess that the use of autonomous vehicles in complex areas are believed to take significantly longer time to realize.

Partnerships and Employees

What´s more, Volvo acknowledge the key to success in the changing landscape is by establishing partnerships throughout the whole value chain, from supplier to customer as well as with external parties such as universities and companies (p.27). Likewise, the company consider the human factor to still be of a significant importance in the changing man/machine landscape hence attracting and maintaining the right talent is principal. This is believed to make possible through establishing a commitment to the communities in which the company operates (p.68). Albeit the company´s modest description of Industry 4.0 activities, experiments into advanced technologies are recognized. For instance, in collaboration with a partner, Volvo has tested an augmented reality lens that is assumed to be used by Volvo operators in quality controls (p.35). Also, the company has implemented 3D printing in some operational areas within the value chain (p.40).

4.2.2.1.2. 2018

Moving into 2018, Volvo has assumed a more aggressive approach towards the changing landscape. The switch from delicately touching upon the paradigm shift in 2017 to now explicitly suggesting technological business models is evident. The company ponders in their *Annual and Sustainability Report 2018* (Volvo Group, 2019b) that technologies which once were merely discussed are now becoming a reality. Despite the lack of explicitly expressing the term Industry 4.0, the company now is incorporating other Industry 4.0 related terms into their language:

> we live in a hyper connected world with multiple technologies, the internet of things (IoT) and the cloud. In 1995 about 1% of the world’s population had an internet connection – today around 40% of the population is connected and the number of IoT connected devices will continue to increase at a high pace during the next few years. Digitization sparks transformation across industries and it impacts all aspects within our industry – from how we create customer value to how we develop, produce, work and interact (p.11).

And equally to what was reported in the *Annual and Sustainability Report 2017,* in 2018 Volvo is emphasizing three focus areas, i.e. Electromobility, Automation, and Connectivity:

> New technologies enabling autonomous, electric and connected vehicles will deeply impact the transport, logistics and construction industries – among others. The effect will be particularly strong at the convergence of these technologies as it affects vehicles, assets as well as infrastructures, and potentially opens the way for a paradigm shift (p.110).

Though the company is clearly tapping into Industry 4.0 technologies, such as autonomous and connected vehicles, they deliberate "However, the speed of the transition is uncertain and we will therefore need to balance our product development investments between well-known and new technologies" (p.48). And further states, "Automation, electromobility and connectivity have huge potential to raise productivity and safety and to reduce the environmental impact, but it will take time before we can fully utilize these opportunities" (p.48). Nevertheless, contrasting the annual reports of *2017* and *2018* a trend towards several principal capacities in the new era manifest.

Synergies

The CAST system which leverages synergies is still believed to be of essence:

> The paradigm shift is happening now and we are actively shaping the new landscape. we have a strong platform to grow from in terms of the Group's technology and assets, our long-term customer relations and our skilled people with deep knowledge of our customers' operations (p.9).

Connectivity

In 2018, Volvo has over 800,000 connected assets (p.53), which is estimated to be the largest connected network in the industry; which effectively incorporates a network effect. Through intelligent software, connectivity allows Volvo vehicles to connect to Volvo Connect, a transport control center, in order to gain access to advanced analytics as well as preventive analytics (p.28). The data that is being transmitted provide valuable insights on how the asset is being used, and essentially is utilized to help customers become more efficient with productivity and profitability. The goal of the connectivity solution is to increase uptime, improve fuel efficiency, and make the roads safer. Additionally, connectivity allows Volvo assets to "talk" to each other while in traffic in an attempt to improve safety and alert one another of traffic hazards (p.27).

Autonomous Vehicles

Additionally, during the year Volvo verified groundbreaking results with their autonomous solutions. For instance, in collaboration with Skanska, Volvo launched the project Electric Site, a fully electrified and autonomous value chain which presented results of "98% reduction in carbon emissions, a 70% reduction in energy cost and a 40% reduction in operator cost" (p.24). Evidently, automation bring forth optimization opportunities, such as greater vehicle utilization, safer procedures, as well as decreasing leisure time in operations. Though Volvo assert, "we believe that automation will redefine the commercial transport solutions that most of us rely on every day" (p.51), the company still initially consider automation to be a reality in commercial operations, and "For more complex environments, such as city traffic and mixed traffic at higher speeds, we believe that it will take significantly longer time before this is possible" (p.51); a statement that was likewise argued in 2017. What´s more, during the year, Volvo incorporated the new technologies, i.e. autonomous, connectivity and electromobility, into one solution and created the first fully electric, autonomous, and connected vehicle, called Vera, in commercial purposes (p.9).

Partnerships and Employees

The company´s push for advanced technologies are commonly made in collaboration with partners, major companies such as FedEx and Skanska, and customers. In addition, the company acknowledge the importance of partnerships throughout the entire value chain, from supplier to customers; "The future is about close collaboration and co-creation with partners and essential to stay competitive" (p.58). For instance, during the year:

> The company became among the first in the world to trial 5G-enabled technologies at a test site in Eskilstuna, Sweden as part of a collaboration with mobile operator Telia. For Volvo CE this means new solutions for autonomous machines can be tested and that increase safety, productivity and uptime (p.96).

Moreover, Volvo recognize the importance of attracting talent in order succeed in the digitalized era and to realize relevant market opportunities as well as maintaining a competitive employee fleet by providing the tools necessary. Other than using new technologies to create value for customers through solutions, Volvo is exploring how to incorporate technological changes into their own operations in an effort to "meet the rapid development of emerging technologies and the new manufacturing landscape" (p.62). The company state:

> Digitization and automation are major trends influencing how we set up our manufacturing for the future. We are working to understand the challenges and prepare our facilities and employees for the changes and investing in modern production equipment (p.60).

For instance, the company has already investigated "the scope and way of working in the future industrial worker environment" (p.60), e.g. with autonomous teams in three Swedish plants. In a company plant in France, service technicians work in virtual reality (VR); man, and machine work alongside as co-workers; and in a company plant in Brazil the employees wear exoskeleton suits to receive enhanced strength in heavy lifting (p.57).

4.2.2.1.3. 2019

The trend resumes in Volvo´s *Annual and Sustainability Report 2019* (Volvo Group, 2020) whereas the company suggest Industry 4.0 activities without mentioning the term per se. The company instead refer to the new technological era as "our industry is undergoing what is perhaps its greatest transformation ever" (p.6); and "changing landscape" (p.7). Evidently, the subtle referral to the fourth industrial revolution takes a holistic perspective rather than explicit expressions. Nevertheless, the referral to Industry 4.0 is apparent also in this year´s annual report:

> We live in a hyper connected world with multiple technologies, the internet of things (IoT) and the cloud. In 1995 about 1% of the world's population had an internet connection – today over half the population is connected and the number of IoT connected devices will continue to increase at a high pace during the next few years (p.9).

Furthermore, the company has identified several trends that are taking shape in the new era, "Population growth, urbanization, digitalization and a continuously expanding middle class are trends leading to increased transport needs and we must meet these increased needs sustainably…through new technologies" (p.6). By reason of this, the company continue to focus on the three key areas identified that are vital in the new transformative era: connected, electrified, and autonomous vehicles. Accordingly, Industry 4.0 related activities have been recognized throughout the *Annual and Sustainability Reports 2017, 2018,* and *2019.*

Synergies

As was mentioned in the previous *Annual and Sustainability Reports (2017, 2018)* Volvo´s system CAST (p.49), which incorporating knowledge from all of the company´s areas, from construction- and industrial-equipment to connectivity, and from buses to marine engines, continue to have a central role in preventing reinventing the wheel and instead create synergies throughout the whole organization to enjoy economies of scale. Additionally, though Volvo is acknowledging the importance of new technologies compliant with the transformative era, such as connectivity and autonomous vehicles, the company reasons "there is still huge potential for improving the well-known technologies" (p.48) such as engines technology and fuel-efficiency.

Connectivity

In 2019 Volvo reports over 1 million (and growing) connected vehicles and machines across the globe and is thus a self-renowned market leader in connectivity (p.9). The large connected fleet is constantly transmitting data to the company, which in turn read and interpret the data, and which is ultimately utilized to help the customers to "improve productivity by increasing vehicle and machine uptime, reducing emissions and noise, as well as improving traffic and site safety" (p.73), which ensure greater value. Volvo reason the gathered data is used to implement new service offerings and will ultimately gain the company market share. Indeed, the ways in which the company can use the data is endless:

> For example, we can understand how a vehicle is being driven, how it is being used, what is consuming excessive fuel and then we can advise the driver and operator on how to be more efficient (p.31).

Moreover, the connected vehicle can itself download data, e.g. about traffic restrictions and emission zones; can connect with other vehicles; and upload data about itself in preventive measures (p.30). In fact, the company has established Uptime Centers in Europe, North America, the Middle East, and Africa, which "provide solutions to problems before they happen" (p.60). Being able to detect problems in advance is a solution the company bets heavily on, however due to human error "some malfunctions have been difficult, if not impossible, to predict" (p.60). Therefore, the company is amplifying its range; "With Artificial Intelligence (AI), Volvo Trucks is taking the next step in predicting and preventing unplanned stops, improving uptime even further. Think of it as a truck's sixth sense" (p.60).

Autonomous vehicles

Connectivity enable autonomous vehicles, which is another key area of Volvo. The company argue, "The use of self-driving vehicles is expected to allow the industry to provide greater safety, fuel savings, and transport efficiency" (p.9). Several autonomous solutions have already proven extremely feasible; for instance, the Electric Site Project mentioned in previous year.

Ultimately, Volvo is shifting from merely offering a product i.e. an autonomous vehicle, to "providing a complete transport solution or transport service in which we also manage the operation" (p.7). Evidently, the company see great future potential in automation:

> We at the Volvo Group believe that automation will redefine the commercial transport solutions that most of us rely on every day. Automation will create real-life benefits for both our customers and the society in terms of productivity and safety as well as energy and fuel efficiency (p.25).

Partnerships and Employees

Finally, a repeated area in Volvo´s report regard strategic partnerships. The company acknowledge the importance of partnerships as "To be able to offer our customers the best solutions in this changing landscape, it will be decisive to work together with partners" (p.7). The company argue they need to conform partnerships with other companies, universities, and suppliers to ultimately "use the knowledge and insights we get from connectivity in strategic alliances with customers and other partners to speed up the innovation cycle" (p.30). For instance, Volvo has initiated a long-term partnership with NVIDIA on the development of an AI decision-making system for autonomous transport solutions; and with Samsung SDI on battery packs and battery technology. Likewise, Volvo has partnered with several customers, such as DFDS (p.26). In June 2019, The two companies launched an integrated logistics solutions from APM Terminals port in Gothenburg, Sweden to a DFDS logistics center, a route where the fully autonomous electric Volvo truck Vera operates to ensure a continuous flow of goods. Evidently, it appears as Volvo has recognized great importance in partnerships:

> Together with our supply chain partners we are facing a paradigm shift in the transport industry. Change is coming faster with shorter development cycles than ever seen before. To remain competitive in all areas in a sustainable way, we need to collaborate and co-create, and how we do that has changed a great deal. 2019 marked the year when choice of strategic partnerships were of utmost importance (p.54).

Several suggestions in the *Annual and Sustainability Report 2019* imply the company is preparing for the new era. For instance, Volvo is increasing its R&D employee fleet with 1000 new forces, in order to strengthen skills in key areas such as AI. Arguably, Volvo is organizing to handle the "future industrial worker environment" (p.57) in order to build skills and "to meet the rapid development of emerging technologies and the new manufacturing landscape" (p.57).

4.2.2.2. Ericsson

4.2.2.2.1. 2017

Ericsson´s *Annual report 2017* (Ericsson, n.d.c.) attest of several Industry 4.0 activities, in fact, the company is explicitly expressing relevant terms. However, unlike the website which act as a posterchild of the fourth industrial revolution, the *Annual Report 2017* is more modest in its language. In the new era, Ericsson reason customers ought to go "truly digital to enable faster service provisioning, faster network configuration and to make services easier to use" (p.6), thus the company is creating solutions to meet these new demands. Evidently, Ericsson is initially offering 5G solutions and adjacent technologies, such as IoT, in order to create greater customer value. And during the year, the company has invested in networks in order to strengthen their position as a 5G company and take the lead in the innovation race. For instance, in one of their business functions, *Emerging Business*, the company is scaling up investments in IoT, and begun investments in AI and automation. The company reason:

> To capture opportunities from new technologies and business models we invest in becoming a leader in data- and analytics-driven operations enabled by automation, machine learning and artificial intelligence. By doing so we will be able to further improve our profitability and increase the value we provide to our customers (p.3).

Employees

Evidently, during the year investments in several areas manifests. And since the mobile usage periphery is constantly increasing, which suggest there are growing opportunities to explore, the company is strengthening its employee fleet in an attempt to brace for the new era. More specifically, investments in their R&D fleet is considered principal as to secure and gain future competitive advantage:

> We will continue to recruit for the future. By recruiting in priority areas of the business, we will both increase the pace of product development and lead in future technologies. In 2017 we recruited 3,800 R&D engineers (p.3)

Synergies

Moreover, Ericsson´s assimilation of Industry 4.0 activities in several business areas, from 5G implementation to IoT services, has sanctioned leveraged synergies. By reason of this, the company has assumed competitive advantage:

> It is a competitive advantage for us to be able to combine the different offerings from the business areas into customer solutions that address each customer's unique needs, while keeping the scale advantage within each business area (p.7)

4.2.2.2.2. 2018

In their *Annual Report 2018* (Ericsson, n.d.d.) Ericsson amplify the discussion about several Industry 4.0 activities (in contrast to previous year). The company reason the technological shift in society, in addition to 5G and IoT capabilities, have brought forth new business opportunities. Likewise, 5G is identified as an enabler to the new technologies. The company argue:

> Smart cities, virtual reality, autonomous cars, industrial IoT, fiber-over-the-air, digital health. All very exciting prospects. But they will not happen without 5G (p.7).
>
> Artificial intelligence (AI), augmented reality (AR), and blockchain are all expected to gain traction. We believe though that the main technology 2019 trends will be 5G and the Internet of Things (IoT). They are also catalysts for, and interlinked with, the other technology trends (p.7).
>
> 5G goes beyond mobility, and beyond the wider information and communications technology (ICT) industry, 5G has the potential to facilitate new and sustainable use cases across all sectors of business and society towards enabling a connected digital society and driving the fourth industrial revolution (p.7).
>
> 5G will serve consumers, enterprises and take the Internet of Things to the next level, where superior connectivity is a prerequisite (p.15).

Technology Investments

Seemingly, the language used in the *Annual Report 2018* suggests 5G technology to be the pillar of Industry 4.0 activities, which are increasingly gaining momentum. The company has recognized that "Mobile data and cellular IoT connections are estimated to continue to grow at a high pace" (p.10). Likewise, "5G, virtual reality/ augmented reality, big data and AI are trends driving growth in new value pools by smart manufacturing, IoT and edge computing" (p.22). Furthermore, the company predicts that 40 percent of the global population will have access to 5G by 2024, with "…1.5 billion 5G enhanced mobile broadband subscriptions, and 4.1 billion cellular IoT connections" (p.2). Thus, Ericsson continues to invest in R&D in order to be able to follow the trends and to grasp the opportunities that arise with 5G as well as to meet consumer expectations and demand. Likewise, the company is aiming to scale up several business units and functions in order to adhere to the technological shift. For instance, *Managed Services* is developed to "take the next steps through investments in artificial intelligence and automation" (p.3) and "explore ways to leverage connectivity to create new revenue streams for our customers, such as IoT and the fourth industrial revolution" (p.9). Similarly, the unit *Emerging Business and Other* is developed "to capture new revenues through rapid and disciplined innovation building on 5G and IoT" (p.3). This unit focuses on investments that lay outside the company´s core business, for instance, "Major initial investments areas are Internet of Things platform (IoT Accelerator), Connected Vehicle Platform, and edge computing through Ericsson Edge Gravity, offering a Unified Delivery Network (UDN)" (p.22). Ultimately, Ericsson is betting big on the growth of the fourth industrial revolution and "Investments will be made in automation and analytics as well as AI driven offerings to support 5G, IoT and cloud" (p.21). Additionally, the company consider having a leading role in the shift towards the new era, consequently deliberates:

> Our main competitive advantages are a strong domain competence in telecom networks and IT technology and operations; the volume of data processed from operations and investments in automation and artificial intelligence (AI) (p.21).

Collaborations

Albeit the great capabilities of 5G and IoT, Ericsson identify several challenges that must be adhered to in order to push forth the new era:

> Delivering the economic and personal benefits of 5G will see huge data increases in networks. Handling that in the best way means more spectrum is required. Additional spectrum is therefore a must for 5G and IoT to truly drive global economic growth. Network security is another big and important topic. We believe that these topics must be addressed, answered, agreed upon and potential 5G engagers reassured (p.7).

Nonetheless, Ericsson argue the roll-out of 5G and IoT must happen now in order to fully tap into the technological changes and opportunities. Therefore, essential talks between key actors, such as governments, regulators, policy makers, and companies need to be established. To make the shift towards the new era a reality sooner rather than later, Ericsson is collaborating globally with several stakeholders, such as leading telecom operators, technology institutes, 40 universities, and 20 industry partners (p.15).

4.2.2.2.3. 2019

In the *Annual Report 2019* (Ericsson, n.d.e.) Ericsson continues to largely discuss Industry 4.0 activities. The term IoT is repeatedly professed and the company states that in 2019 investments in this technology increased and reason "With 5G our industry will move beyond connecting people; it will also connect machines and things" (p.10). The company reason the 5G network is expected to reach 2.6 billion users within the next six years (p.7) as well as 5 billion cellular IoT connections (p.3), thus "This is an innovation platform so powerful that it will be the driving force behind the next big shift in society – the fourth industrial revolution" (p.3). Whereas, the shift is expected to affect all industries, and with investments in linked technologies, the company is expected to tap into the growing market. Already, Ericsson is the self-proclaimed global leader in 5G technology as they have "the world's leading patent portfolio in cellular technology" (p.3) and "the most devices certified to work on our equipment" (p.3). Ericsson claim, "To put it simply, from technology leadership to performance in the field, there is no one ahead of us in 5G" (p.3).

Technology Investments

By reason of the *Annual Report 2019* it is evident that Ericsson is incorporating the work towards the fourth industrial revolution in several business functions and throughout the company. For instance, the company´s *Operations Engine* consists of AI and data driven services that "enhance customer experience, drive agile service creation, and optimize costs" (p.10). The unit *Managed Services* work in implementing and utilizing Industry 4.0 activities, such as AI and automation for customers. Likewise, Industry 4.0 activities are evident in *Emerging Business* which include core business operations and R&D, as well as *Other Segments* which include "Major initial investments areas are IoT offerings, Industry 4.0 and automotive" (p.22). Ultimately, the company´s strategic priorities include:

> Industrialization and mass-deployed AI and automation to drive continued efficiency in the service delivery organization. Investments to continue in R&D for AI, automation and data driven offerings to support 5G, IoT and cloud (p.21).

Though investments in Industry 4.0 activities are clear, the company recognize additional investments in IoT are needed.

Collaborations

Because the fourth industrial revolution is assumed to affect all industries, the company´s strategy is to gain market share and extend their portfolio by working with customers in several fields. Potential business is reached by selling through telecom operators and go-to-market models (p.15). Likewise, the company declare M&A strategies as an enabler for potential growth as well as to stay competitive on the market. Nevertheless, Ericsson deliberates that the initial target group for the 5G network will be the consumers, i.e. Eriksson's´ customers´ consumers, while also enterprise businesses and/or B2B are essential. During the year the company set out to test these advanced technologies on consumers in cluster-areas; for instances, in collaboration with eSport stadiums and gaming developers, clusters where advanced technologies such as Virtual Reality (VR) or Augmented Reality (AR) are desired were tested (p.15). Adhering to consumer behavior and preferences are vital for Ericsson´s future business since "Customer support and software upgrades typically continue to generate sales for Ericsson after delivery of the initial solution" (p.20). Thus, moving forward, the company´s focus is to generate a higher portion of income through software solutions driven by the shift towards cloud- and automation technologies, e.g. IoT.

Workplace advancement

What´s more, Ericsson identify the environmental benefits of Industry 4.0 activities:

> In Ericsson's factory in Estonia we have implemented 5G, augmented reality, industrial IoT and machine learning, thus increasing our operational efficiency and workplace health and safety. Average fault detection time has been reduced by 15%, and factory heating costs are potentially reduced by up to 20% (p.22).

Albeit the company´s progressive work towards the fourth industrial revolution, more is yet to come; "Emerging technologies such as edge compute, zero touch, artificial intelligence and virtual and augmented reality are researched, and 6G is already being explored" (p.17).

4.2.2.3. H&M Group

4.2.2.3.1. 2017

In the *Annual Report 2017* (H&M Group, n.d.c.) H&M Group (hereafter H&M) attest to a changing landscape in the fashion retail industry without explicitly referring to Industry 4.0 activities (as was also evident by their website language). Rather, the changing landscape seem to be a product of growing digital components, i.e. online shopping. The company write in their *Annual Report 2017:*

> Fashion retail is in rapid change. To succeed when digitalisation is changing customer behaviour and the competitive landscape is being redrawn requires speed, innovation and continued

> transformation. We are now accelerating our transformation to seize the opportunities offered by a large and growing market (p.14).

Due to the changing landscape, agility and flexibility becomes increasingly important in order to remain competitive on the market. The company stipulates, "This shift also means that the competitive landscape is being redefined, with new operators coming in and profitability in the industry being squeezed by the fierce competition" (p.66). While the language used in the report lacks to explicitly specify Industry 4.0 or reference to the fourth industrial revolution, the company is subtly referring to such activities:

> The efficiency of our supply chain has always been one of our strengths, but it must better mirror our customers' fast-changing behaviour and needs. We are therefore investing further to become even faster, more flexible and more efficient. We will invest even more in advanced analytics and AI (p.14).

Technology Investments

Ultimately, consumer preferences and changing behavior is the driving force of H&M´s digitalization practices. In order to adhere to the changing landscape, the company is working towards a more agile and flexible business model. As a result, the company is increasingly investing in advanced analytics and automated processes to support the business model throughout the entire value chain, from supplier and product development to end-consumer interaction (p.18).

Technology Integration

Additionally, as the online shopping experience is gaining traction, mainly due to mobile solutions, the company is increasingly integrating the physical and online stores to provide a seamless solution. For instance, as a response, the company has implemented a tool called *Image Search*:

> Image Search is a tool that helps customers move directly from inspiration to purchase. Powered by image recognition technology, it uses self-learning algorithms to recognise styles from the user's own photos or from downloaded images, for example from social media (p.32).

Likewise, other advanced technologies are introduced as part of the company´s aim to meet the changing landscape, such as the cloud; 3D printing (p.15); and Radio Frequency Identification technology (RFID) which provide a product with a digital price tag that allow for real-time tracking throughout the entire supply chain as well as "also makes the work involved in stocktaking and product handling quick and easy – freeing up time for staff to spend with customers" (p.33).

4.2.2.3.2. 2018

Moving into 2018, the company recognize the shift in the retail landscape made up by changing consumer behaviors. In the *Annual Report 2018* (H&M Group, n.d.b.) H&M acknowledge the shift that ultimately create new shopping patterns. Responsively, the company is developing and progressing their business model to meet this new retail environment and to "offer customers a shopping experience that is as complete and seamless as possible" (p.25).

Technology Integration

Primarily, the progress concern integrating the physical stores with online channels. Yet, in order to meet consumer expectations in a fast paced environment, the company is increasingly incorporating AI into their operations:

> Thanks to our vertically integrated business model we are able to build an AI model with algorithms designed to address the entire product flow: from trend detection to quantification, allocation, pricing and personalization (p.7).

In addition to using AI as a tool to create an efficient supply chain, H&M is also "utilising the company's global presence and economies of scale, combined with new technology and advanced analytics, to support its creative work and business processes" (p.36). Likewise, during the year other Industry 4.0 activities have been sustained into the company´s business operations; for instance, 3D technology is used in the design process which results in fewer scrap materials (p.8); and RFID is used to locate products and their availability (p.8).

4.2.2.3.3. 2019

Equally to the previous annual reports, H&M´s *Annual Report 2019* (H&M Group, n.d.a) suggest certain Industry 4.0 activities while not mentioning the term per se. It is apparent that the company acknowledge an "ongoing transformation" (p.8) and a "shift in the industry" (p.39) towards a more digitized world, however, the transformation appears to recognize mainly online- and mobile shopping. What´s more, in 2019 the company accepted a new CEO (external to the founding family Persson) in Helena Helmersson. Helmersson´s previous position was chief operating officer (COO) responsible for expansion, logistics, production, IT and

Advanced Analytics & AI and Insights & Analytics (p.10); this might emphasize the position and importance of the advanced technological functions in the company´s future.

Technology Integration

H&M recognize several challenges that arises in the new digital era of retail, for instance, physical stores are expected to take a toll, and customer preferences are changing rapidly, while sustainability is gaining significant importance. In order to meet these challenges and ultimately triumph competition, digitalization is helping the company to integrate the physical stores with an online presence to meet customer demand faster and doing so in a sustainable way (p.5).

Synergies

Nevertheless, H&M admit to investments in digitalization- and Industry 4.0 activities, such as “new logistics centres and logistics systems, and in tech infrastructure, advanced analytics and AI” (p.8). For instance, the company aim to cross-function several units into one Business Tech function, compiling the silos of IT, Advanced Analytics & AI and Business Development to create synergy.

Value Chain

Moreover, the report suggests the strategic focus of the company is “to ensure the best customer offering, a fast, efficient and flexible product flow, a stable and scalable tech infra- structure, and adding growth” (p.39). Thus, the focus concerns two key areas, the product offering or product range, and the shopping experience. Mainly, the company use advanced analytics and AI to advance the value chain, i.e. “Make the supply chain even faster, more flexible and more efficient” (p.10) and “to ensure that we always have the right product in the right place at the right time” (p.11). H&M reason:

> Using AI and advanced data analytics, we can create a more relevant offering for the individual customer, personalise communication and develop new services such as custom-made garments – all of which help use resources more sustainably (p.12).

Additionally, the company is continuing to advance an AI algorithm that can be used throughout the entire value chain, “from trend detection to quantification, allocation, pricing and personalisation. This also creates the conditions for more resource-efficient and sustainable production, and thus reduced climate impact” (p.40).

4.3. Empirical findings

To understand the scope of Industry 4.0 activities and to find shared meaning, similar patterns, and/or shared language, initially the study populations´ websites were evaluated. Accordingly, the data demonstrate three incongruent companies with regards to Industry 4.0 activities. While Ericsson explicitly reference “Industry 4.0” and discuss the fourth industrial revolution, H&M and Volvo implicitly denote the concept. Seemingly, the results vary significantly, and one company particularly stand out in the Industry 4.0 related language, namely Ericsson. In contrast, the Annual Reports for the duration 2017-2019 of the case study population suggest complementary results and further attest to Industry 4.0 activities that are being undertaken by all of the companies in the study population. By reason of the gathered data, several collective Industry 4.0 areas have been identified. Though the companies diverge in their technological language, they do converge in some instances. Evidently, the Industry 4.0 activities concerned in this research study are touched upon in the annual reports, and while some activities are explicitly deliberated upon, some are delicately referred to, whereas some are subliminally cited. As deliberated upon in section *3.5.4 Data analysis* the data collection has been cross-referenced across the cases in the case study population in order to find shared meaning (see appendix I) wherefrom the following shared trends have manifested.

4.3.1. The Internet of Things

Throughout the companies´ Annual Reports for the duration 2017-2019 one trend remained principal for the case study population, i.e. connected things or the Internet of Thing (IoT). Although the technology is explicitly absent in H&M, the persistent and fundamental inclination of the technology in Ericsson and Volvo make it safe to suffice the significance of it and thus deem it as an Industry 4.0 trend. Ericsson and Volvo are increasingly investing in IoT making it a significant technology for these industries, as well as fuel on the belief of its future importance. Volvo deliberates about connectivity and connected vehicles as part of their technological trio—connectivity, automation, and electromobility—which also act as enablers of one another. In 2019, Volvo´s connected vehicle fleet amounted 1 million connected vehicles (Volvo Group, 2020), and counting, which provide valuable data insights to the company, and accordingly improve their solutions. Likewise, Ericsson which is initially considered a 5G company repeatedly deliberates on IoT as part of their principal solution range. The bet on 5G technology is supported by the belief of increasing IoT applications throughout society, from gaming to businesses to end-consumers. Ericsson ponder “5G will serve consumers, enterprises and take the Internet of Things to the next level, where superior connectivity is a prerequisite" (Ericsson, n.d.d.: p.15). Subsequently, during the years 2017-2019 Ericsson is increasingly investing in growing IoT applications to "…explore ways to leverage connectivity to create new revenue streams for our customers, such as IoT and the fourth industrial revolution" (Ericsson, n.d.d: p.9). Evidently, the two major industry players are staking big on IoT technology. Still, it is important to understand why IoT is gaining momentum and what truly is gained by such activities. Currently, Ericsson and Volvo are taking advantage of the technology in diverse comportments. While Ericsson is primarily leveraging on IoT applications to push forth their main technology, i.e. 5G, Volvo on the contrary is using IoT, or connected vehicles, in order to utilize the data, i.e. Big Data. Ultimately, both companies suggest using IoT in order to gain Big Data which is a value creating source. Still, both companies appear to be at an early stage of this technology.

4.3.2. Big Data

Big Data is information gathered by e.g. IoT applications and utilized to advance solutions. Though Volvo and Ericsson are explicitly suggesting Big Data applications, H&M is merely mentioning such practices in their website but not in the annual reports. The most apparent Big Data application may be Volvo´s large connected vehicle fleet—from 700,000 in 2017 to over 1 million in 2019—(Volvo Group, 2018a; Volvo Group, 2019b; Group, 2020). The solution, which provide valuable insights to the company, appears to have been perfected in more recent years. In 2017, the company suggest working with connectivity to improve e.g. consumer uptime solutions. While this remain constant well into 2019, in more recent years the company is also working with Big Data to enhance their solution offerings as well as to realize new ways to capitalize on the gathered data. Likewise, Ericsson which acknowledges IoT as a principal solution is predictably tapping into Big Data solutions. The company states:

> Our main competitive advantages are a strong domain competence in telecom networks and IT technology and operations; the volume of data processed from operations and investments in automation and artificial intelligence (AI) (Ericsson, n.d.d.: p.21).

More specifically, the company recognize a growing trend of Big Data solutions that will support increasing value propositions as well as future sales. In contrast to Volvo and Ericsson which deliberate on Big Data in their Annual Reports (Ericsson, n.d.c.; Ericsson, n.d.d.; Ericsson, n.d.e.; Volvo Group, 2019b.; Volvo Group, 2018a.; Volvo Group, 2020), H&M suggest such activities on their website, explaining the company have incorporated Wi-Fi at test stores to collect data from the connected shoppers in order to analyze and "optimize store experience" (H&M, 2019c). Thus, H&M is using the consumers´ devices (smart phone) as an IoT application instead of self-producing such activity to realize Big Data.

4.3.3. Artificial Intelligence

Throughout the case study population, the consideration of Artificial Intelligence (AI) becomes increasingly apparent; the discussion about the technology amplifies entering into 2019. Ericsson and H&M deliberate on the concept of Artificial Intelligence or AI on their websites, while Volvo exclude the concept. However, in the annual reports, all companies put emphasize on this advancing technology. For instance, in their *Annual and Sustainability Report 2017* (Volvo Group, 2018a) Volvo deliberates that the human factor is very much in center of operations. However, emerging into 2019 (Volvo Group, 2020), the company instead acknowledge the "human error" and thus the possibilities AI may illuminate; the company contest "With Artificial Intelligence (AI), Volvo Trucks is taking the next step in predicting and preventing unplanned stops, improving uptime even further. Think of it as a truck's sixth sense" (Volvo Group, 2020: p.60). Likewise, in 2019 Volvo enter into a long-term partnership with NVIDIA with regards to developing an AI system for their autonomous solutions. And finally, during the year the company deliberates on strengthening their R&D employee fleet with 1,000 new forces in order to focus on business areas and solutions such as AI. Seemingly, the focus towards AI technology is at an early, though aggregated, stage.

Moreover, though Ericsson´s main focus seemingly is on 5G and IoT technology, the company also deliberate profoundly on AI technology both on their website as well as in the Annual Reports 2017-2019 (Ericsson, n.d.c.; Ericsson, n.d.d.; Ericsson, n.d.e). In 2017, the company contest to scaling investments in AI technology in order to tap into growing market opportunities. Likewise, in 2018 the company continue to imply profound significance to this technology and its implication in driving new value growth. As a response to the predicted value growth the company establishes greater importance in the business function *Managed Services* which aim is to "take the next steps through investments in artificial intelligence and automation" (Ericsson, n.d.d.: p.3). Ultimately, investments in AI is an effort to grow and drive the key solutions, i.e. 5G and IoT. Moving into 2019, the company is capitalizing on AI solutions and continue to emphasis on this area:

> Industrialization and mass-deployed AI and automation to drive continued efficiency in the service delivery organization. Investments to continue in R&D for AI, automation and data driven offerings to support 5G, IoT and cloud (Ericsson, n.d.e.: p.21).

Moreover, H&M, which appear to emphasis more traditional technology, e.g. online- and mobile-shopping, is evidently also tapping into AI technology to improve their value chain and to provide a seamless solution for their customers. In 2017 (H&M Group, n.d.c.), the company amplifies investments into AI technology; for instance, the tool *Image Search* uses a self-learning algorithm which support customers to move from inspiration to purchase. In 2018 (H&M Group, n.d.b.), AI is used throughout the product flow, and in 2019 (H&M Group, n.d.a.) the company is continuing to invest in this technology to improve their value chain. What´s more, in 2019 (H&M Group, n.d.a.) H&M accept Helena Helmersson as a new CEO, whom previously occupied principal functions within the company including IT and Advanced Analytics & AI and Insights & Analytics. Likewise, Danica Kragic Jensfelt (H&M, 2019b), a professor of Robotics and AI, was accepted as a new board member during the year. These new additions may contest to the company´s future belief of AI technology.

4.3.4. Partnerships & Collaborations

Another seemingly important activity being undertaken by the study population is incurring partnerships and/or collaborations with actors throughout the value chain, from suppliers to customers, as well as with external partners such as companies and universities. Apparently, succeeding in Industry 4.0 activities require collaborations intra-, and inter-industries. For instance, Volvo has partnered with several industry leaders (Volvo Group, 2020), such as NVIDIA, FedEx, Skanska and Telia, in order to realize Industry 4.0 activities; the company´s Electric Site and the truck *Vera* are evident of such successful collaborations. The company ponders “The future is about close collaboration and co-creation with partners and essential to stay competitive” (Volvo Group, 2019b: p.58).

Ericsson, on the other hand, takes a more modest approach to collaborations and instead suggest initiated discussions between governments, regulators, as well as companies in order to fully capitalize on the potential of the 5G technology and the opportunities that will arise. Yet, Ericsson is partnering with several key actors around the globe, for instance universities, industry partners, institutes and telecom operators in an attempt to roll out the network faster (Ericsson, n.d.d). The company´s approach in partnering with diverse parties support their conviction that the fourth industrial revolution will impact all industries, thus providing potential business for Ericsson in various industries. Finally, while H&M have established partnerships with various actors, throughout their value chain as well as with external partners, such as Google, the explicit Industry 4.0 factor lacks thus making it difficult to associate it to such specific activities (H&M Group, n.d.a.).

4.3.5. Employees

Notwithstanding the importance of employees that all companies in the study population contest to, two companies in the study population explicitly acknowledge the importance of their employee fleet in relation to the new technological era. In the *Annual and Sustainability Report 2019* (Volvo Group, 2020) Volvo express it is increasing its R&D employee fleet with 1,000 new forces, in order to strengthen skills in areas related to AI. Likewise, Ericsson contest in their *Annual Report 2017* (Ericsson, n.d.c.) to a continuous recruitment of R&D employees in order to "lead in the future technologies" (Ericsson, n.d.c.: p.3); during the year the company recruited 3,800 engineers. Conversely, while the importance of a talented employee pool is also principal to H&M, the company does not explicitly recognize IT skill recruits with regards to Industry 4.0. Instead, H&M has engaged in managerial recruits such as that of CEO Helmersson (H&M Group, n.d.a.) and AI and robotics professor Kragic Jensfelt to their board (H&M, 2019b).

4.3.6. Synergies

Synergies, which I consider as the collection of assets that collude to create a smooth machine of shared knowledge in order to reach optimization, are largely declared throughout the annual reports by all companies in the case study population; in the form of partnerships and collaborations (as previously discussed) as well as technologies. Here, the synergies are evaluated through an Industry 4.0 perspective. Accordingly, the study population regards synergies as an essential function in the new era as a way to avoid ´reinventing the wheel´ as well as to create economies of scale and scope. Throughout the *Annual and Sustainability Reports 2017-2019* (Volvo Group, 2019b.; Volvo Group, 2018a.; Volvo Group, 2020) Volvo reflects on their system CAST (Common Architecture and Shared Technology), which brings together assets and knowledge from several business areas to create synergies throughout the whole organization and which ultimately will function in the transition towards the new technologies. Initially, CAST is utilized to define the well-known technologies in order to free capacity for the new technologies, thus the product of this system relates to the new technologies. Volvo repeatedly confess to the significance of synergies, for instance the company deliberates on the new technologies, i.e. electromobility, automation, and connectivity:

> The effect will be particularly strong at the convergence of these technologies as it affects vehicles, assets as well as infrastructures, and potentially opens the way for a paradigm shift (Volvo Group, 2019b: p.110).

Evidently, synergies have been realized and resulted in e.g. the fully electric, autonomous and connected vehicle *Vera* which incorporates several technologies into one.

Moreover, though Ericsson´s principal focus is 5G technology seemingly the company work with several Industry 4.0 technologies such as AI and IoT, amongst others, and have been able to produce valuable synergies throughout the entire organizations and the different business functions. The company ponders:

> It is a competitive advantage for us to be able to combine the different offerings from the business areas into customer solutions that address each customer's unique needs, while keeping the scale advantage within each business area (Ericsson, n.d.c.: p.7)

Likewise, since 5G is considered an enabler of the other technologies naturally their business functions interlink, e.g. 5G and IoT, creating synergies and scale economies. Moreover, in the *Annual Reports 2017-2019* (H&M Group, n.d.a.; H&M Group, n.d.b;. H&M Group, n.d.c.) H&M contest to the changing retail landscape as well as to the fast changing consumer behavior and expectations. Therefore, in order to remain competitive, the company deliberate on the profound implications of a fast and agile value chain. Responsively, the company is integrating the physical stores and online channels to provide a seamless customer solution which require integrated technologies and thus operational synergies. For instance, in 2019 the company aim to cross-function several units into one Business Tech function, compiling the silos of IT, Advanced Analytics & AI and Business Development to create synergy.

4.3.7. Summary

Conclusively, several trends appear in the case study population across-case. While two of three companies are more adept to use Industry 4.0 related language as well as profoundly demonstrate Industry 4.0 activities, one of three companies lack the refinement of Industry 4.0 related language. Nevertheless, the Industry 4.0 activities being undertaken by the case study population are producing clear trends suggesting key Industry 4.0 resources demonstrated in table 4. Accordingly, three apparent trends manifest which suggest key Industry 4.0 activities being commenced by all of the MNEs in the case study population in the unprecedented era of

Industry 4.0; i.e. *Big Data, AI*, and *Synergies*. Since one of three companies in the study population, i.e. H&M, use ambiguous and vague language of the resources *IoT*, *Partnerships & Collaborations, and Employees* with regards to Industry 4.0, their significance is more difficult to assume; contrariwise, two of three companies in the study population put particularly strong emphasis on these areas. Nevertheless, as discussed in section *3.4.2 Sampling* the companies in the case study population demonstrate different levels of technological density, wherefrom these results presumably vary. Since Industry 4.0 is considered a paradigm shift disrupting all industries, the identified trends are deemed relevant for the case study population as a whole.

Trends	Volvo	Ericsson	H&M
IoT	√	√	(√)
Big Data	√	√	√
AI	√	√	√
Partnerships & Collaborations	√	√	(√)
Employees	√	√	(√)
Synergies	√	√	√

Table 4. *Industry 4.0 Activities Producing Trends In The Case Study Population; compiled by author.*

5. ANALYSIS

This chapter analyzes and reflects on the findings from the previous chapter. Through a holistic perspective, the identified trends are deliberated upon in relation to the RBV in order to reference empirical findings with theoretical ground and ultimately arrive in reasoning to answer the research ´How do an MNE address sustained competitive advantage in relation to Industry 4.0?´

5.1. Resources as producers of sustained competitive advantage

The empirical findings presented in the previous chapter clearly suggest several trends that are being commenced by the case study population, i.e. *Partnerships & Collaborations, Employees, Synergies, IoT, Big Data,* and *AI*. In order to answer the research question the trends are initially evaluated as resources, and, next, assessed based on their SCA producing capabilities drawing on the VRIN-framework (Barney, 1991); provided a (*valuable*) resource is not accessible to competitors (*rare*), and even though in the case of availability competitors cannot judge what factors produced success (*in-imitable*) and therefore cannot replace the resource (*non-substitutable*). Still, because this research study has adopted a holistic approach, ultimately the resources will be regarded as a whole to the organization. Accordingly, a relaxed view of the RBV will be assumed. Supplementary, more recent research suggest competitive advantage is not exclusively a precondition for the existence of MNEs, rather an MNE may become successful by its ability to efficiently deploy resources (Hashai & Buckley, 2014) as well as by its capacity to read the market (Sethi & Guisinger, 2002), and by its responsiveness or flexibility to changing market conditions (Dreyer & Grønhaug, 2004; Byrd, 2001). These aspects has been taken into consideration when assessing the capabilities of the identified trends in relation to Industry 4.0.

Furthermore, by virtue of their novelty, I consider the technologies *IoT, Big Data,* and *AI* harder to assess based on the same criteria as *Partnerships & Collaborations, Employees, Synergies*. On one hand, they may be defined as *physical capital* based on their infrastructure and business application elements (Melville *et al.,* 2004; Barney, 1991). On the other hand, if one considers them as *physical capital*, their complexity may be diminished and predetermined. A stream of research imply the main challenge with IT capabilities as producers of SCA (of which these resources are initially considered) is that they are inherently uncertain and imitable and therefore ought to be considered as complementary resources (Melville *et al*., 2004; Powell &

Dent-Micallef, 1997; Clemons & Row, 1991; Ravichandran & Lertwongsatien, 2005). Contrariwise, Byrd (2001) suggest that employing a flexible IT infrastructure that controls both hardware and software and which can adapt to changing environments is an enabler of SCA. Based on their novelty, complexity, and causal ambiguity, I argue the importance of *IoT, Big Data,* and *AI* ought to be considered based on their physical components as well as on the process it embarks since the physical component is an enabler for the soft capital it produces. Likewise, the empirical findings suggest these resources should not be treated as separate resources due to their capabilities to affect several components of the organization (similar to synergies); e.g. Volvo connected vehicles (external IoT) produce insightful data (Big Data) which the company utilizes (presumably through AI).

5.1.1. Partnerships & Collaborations

Based on the empirical findings, the case study population commence *Partnerships & Collaborations* within their value chain, e.g. with suppliers and customers, and also with external agents such as companies and universities. Yet, the case study population suggest across-case variations. Volvo, for instance, emphasize cross-industry collaborations with key actors, such as NVIDIA, to realize Industry 4.0 activities. While the RBV initially recognizes internal resources that are controlled by the firm (Penrose 1959, cited in Melville *et al.,* 2004; Wernerfelt, 1984; Barney, 1991), this partnerships would not conform to the theoretical framework as a resource. However, since the formation of a partnership relies on collusive resources more recent research suggests a firm´s proprietary ownership or control of a resource is not a necessity for enabling competitive advantage (Lavie, 2006). Therefore, Volvo´s partnership may recognize as a *network resource* (ibid). Moreover, the empirical findings suggest Ericsson engage in closer collaborations with universities and governments as well as with intra-industry actors such as telecom operators. These relationships commenced between two or more parties contest to the notion of *heterogeneity* and *imperfect mobility* (Rivard et al, 2006; Barney, 1991) which are the fundamentals of the RBV. However, while the resources deployed by the relationship may be contested as a SCA producing resource, the relationship in and of itself may be assumed to drive SCA based on causal ambiguity (Cao & Zhang, 2011). Seemingly, internal and external *partnerships & collaborations* circumvent ´reinventing the wheel´ by seeking those resources or expertise not necessarily controlled by the firm in order to enjoy its benefits. Conversely, adopting a relaxed view of the RBV allow for external resources to be recognized. In this instance, the firm need not control the resources in order to produce competitive advantage (Lavie, 2006; Wu *et al.,* 2006). While Volvo and Ericsson emphasis inter- and intra-firm partnerships and collaborations, H&M emphasis value chain collaborations such as those with suppliers; however, the connotation to Industry 4.0 is vague.

Subsequently, *Partnerships & Collaborations* as a resource are evaluated on the criteria of the VRIN-framework (Barney, 1991). Accordingly, these *valuable* relationships are considered *rare* by virtue of their specific nature e.g. there remain only one specific partnership which may not be available to outsiders; *in-imitable* and fairly *non-substitutable* as, on one hand, it cannot be imitated, while on the other, it may be substituted if it includes some of the initial parties. Therefore, while the case study population seem to recognize the importance of *partnerships & collaborations*, it is vital to recognize the challenges that supplement such relationships, e.g. opportunistic behavior or asymmetric information, which can make any SCA short-lived.

5.1.2. Employees

Lioukas *et al.* (2016) argue that Industry 4.0 which illuminates the need for flexibility and agility due to fast changing environments require a different human skillset than previously needed in order to produce SCA for the firm. Suitably, the empirical findings suggest the case study population is growing their talent pool by hiring technologically skilled workers and engineers. In 2019, Volvo increased their R&D fleet with 1,000 new forces (Volvo Group, 2020), and Ericsson estimates in their *Annual Report 2017* to hiring 3,800 engineers (Ericsson, n.d.c.) to focus on future technologies. These employees are the embodiment of know-how, skills, and experience thus define as *human capital* (Barney, 1991). Likewise, they are considered *heterogenous* and *immobile* (Rivard et al, 2006; Barney, 1991) as people cannot be at two places at the same time (this assumes as an opportunity cost). Furthermore, research suggests the relationship between human capital and IT can improve firm performance (Powell & Dent-Micallef 1997; Ravichandran & Lertwongsatien, 2005). For instance, IT skilled employees and engineers may be more efficient in *resource-picking* and *capability-building* (Ravichandran & Lertwongsatien, 2005) which may lead to competitive advantage. Still, Mata *et al.* (1995) argue that while IT technical skills and proprietary IT may produce competitive advantages, only managerial IT skills are producers of SCA by virtue of tacit knowledge. Conversely, while H&M does not explicitly recognize hiring IT skill, the company do acknowledge principal managerial employment such as that of CEO Helmersson which previously held principal function in IT and Advanced Analytics & AI, and Insights &

Analytics (H&M Group, n.d.a.); and that of AI and robotics professor Kragic Jensfelt to their board (H&M, 2019b).

Consequently, *employees* as a resource are considered *valuable* and *rare* (due to the opportunity cost). Moreover, employees may be *in-imitable* on the basis of tacit knowledge, e.g. through efficient *resource-picking* and *capability-building*, or by the ability to be flexible. On one hand, considering the engineers and IT skilled workers that were sought for by the case study population as basis of tacit knowledge they do conform as SCA producers. On the other hand, considering them as IT skilled workers based on explicit knowledge contest to their ability of SCA production. In this occurrence, only H&M´s managerial skills are recognized as SCA producers. Consequently, employees may be *non-substitutable* by virtue of tacit knowledge, e.g. managerial skill; yet, also considered as substitutable by virtue of explicit knowledge.

5.1.3. Synergies

Predicated on the empirical findings, the case study population increasingly identify internal synergies, e.g. integrated systems and business units. Volvo´s internal system CAST which incorporates several business functions imply an internal synergy and thus may identify as an *organizational capital* (Barney, 1991; Melville *et al.,* 2004). This is a complex construct created by the firm and incorporated into the organizational matrix. Likewise, Ericsson has been able to combine vital business functions and technologies, such as IoT and 5G, into synergies that create scale economies. Consequently, no other firm can obtain the exact same system, and therefore, these synergies are pondered *heterogenous* and *immobile* (Rivard et al, 2006; Barney, 1991). Also, H&M is identifying synergies as *organizational capital* by cross-functioning several units into one Business Tech function, i.e. compiling the silos of IT, Advanced Analytics & AI and Business Development to create synergy. These synergies may produce flexibility to changing environments which arguably may produce SCA for the firm (Byrd, 2001). Additionally, H&M recognize external synergies in accordance with their supplier-relationships commenced in their value chains, as previously indicated. While external resources does not conform with the initial RBV, however, accepting a relaxed view of the RBV these resources are considered to improve the firms competitive stance by virtue of causal ambiguity (Cao & Zhang, 2011).

Evidently, across-case variations prevail. The case study population engage in both internal and external synergies. Based on the VRIN-framework (Barney, 1991) synergies may be assumed *valuable* and *rare* because they are specific to each firm and its complex structure. They are *in-imitable* as they are hard to imitate, since it would require the exact same resources, assets, units, alignments, etc., to create the precise synergies; likewise, they may create causal ambiguity. And finally, synergies are *non-substitutable* since the system of synergies may have a specific role, i.e. to create synergies within the organizational construct as well as in the value chain, thus it cannot be substituted by a competitor with another system as it would lose its meaning and function.

5.1.4. The Internet of Things

One seemingly profound resource discoursed by the case study population is IoT, which is defined as "The concept by which Internet or network connectivity, computing capabilities, and collection and exchange of data extend to everyday objects that are not computers" (Access Science, McGraw-Hill Education, 2020). While Ericsson and Volvo indicate strong emphasis on this technology, H&M lack to reference this resource. Presumably, the MNEs technological densities may be responsible. Nevertheless, the special emphasis on this technology by the case study population presumes its significance in Industry 4.0. For instance, Volvo has over 1 million connected vehicles in 2019 which may be assumed as *physical capital* due to their composition of infrastructure as well as their business applications (Melville *et al.,* 2004). Conversely, the connected vehicles may be deemed as *organizational capital* based on the synergies they creates (ibid), i.e. their implication on Big Data. Likewise, IoT is part of Ericsson´s primary solution range as it is an enabler of 5G technology. In this stance, the company´s IoT may be considered as physical capital. On the contrary, as discussed in the previous section *Synergies,* Ericsson is utilizing IoT in conjunction with 5G to create synergies, thus this IoT may also be recognized as an *organizational capital* (Melville *et al.,* 2004).
While both companies assume IoT as a *physical capital* and *organizational capital,* they are leveraging IoT diversely. Volvo is primarily using IoT to collect Big Data and subsequently improve their solutions. Ericsson, on the other hand, is increasingly leveraging IoT to drive their 5G technology.

Considering both categorizations, based on the VRIN-framework (Barney, 1991) IoT may be considered *valuable* since connectivity allows for efficiencies throughout the value chain.

Likewise, the resource may be pondered *rare* in the form of firm-specific IoT, e.g. connected Volvo vehicles are scarce to the company´s competitors. On the contrary, IT is considered inherently uncertain as it can be imitated (Melville *et al.*, 2004) thus *homogenous* (Rivard *et al.,* 2006; Barney, 1991), while it is also readily available to competitors concluding *mobile* (Rivard *et al.,* 2006; Clemons & Row, 1991; Barney, 1991). Contrariwise, IoT may be *in-imitable*; while the specific process created by the connected objects may be in-imitable as it would require the same components, i.e. causal ambiguity; yet, a competitor could employ similar connected devices. Finally, while the IoT infrastructure can be imitated by a competitor, the business application and the process it embarks may be profoundly harder to imitate thus concluding *non-substitutable.*

5.1.5. Big Data

While IoT has increasingly been contemplated by the case study population, Big Data has received a more modest presentation. Nevertheless, IoT is in fact an enabler of Big Data, which attest to Big Data´s underlying importance. Big Data identifies as "The collection, storage, and management of huge amounts of digital information" (Access Science, McGraw-Hill Education, 2020). Evidently, Volvo´s connected vehicle collects Big Data, which is stored in a center where it is interpreted and utilized in order to improve the company´s solutions, such as uptime, and consequently customer efficiency. Therefore, based on its infrastructure and business application capabilities, this Big Data can be assumed as *physical capital* (Melville *et al.,* 2004). Ericsson indicate utilizing Big Data as a way to secure future profits in addition to being part of their competitive advantage domain. H&M attest to pilot projects whereas Big Data is collected in their stores as an effort to optimize customer experience. Seemingly, the case study population is utilizing Big Data to improve solutions, hence embarking on its business application. Likewise, Ericsson attest to utilizing Big Data to generate future sales. And H&M is utilizing Big Data to optimize customer shopping experience. Ultimately, Big Data is valuable information generated by the MNE, for the MNE.

Based on the VRIN-framework (Barney, 1991) Big Data presumes *valuable* since it provides for insightful information, and *rare* since no other firm may have the same resource, i.e. *heterogenous* (Rivard et al, 2006; Barney, 1991); for instance, the data which H&M collects of its customers who shop in their stores is exclusive to the company. Contrariwise, research argue IT is readily available to competitors (Melville *et al.*, 2004; Rivard *et al.,* 2006; Clemons &

Row, 1991). Therefore, competitors could simulate the processes and produce similar data which contest to the notion of *in-imitable* (Rivard et al, 2006; Barney, 1991). For instance, if the Big Data which Volvo generates from their connected vehicle fleet concerns external factors e.g. traffic conditions then the data would not be scarce as it can be replicated by a competitor. Thus, it would not be assumed as *non-substitutable.* However, since Big Data is collected in real time, and due to the laws of time and space, it may be considered as *non-substitutable,* nonetheless.

5.1.6. Artificial Intelligence

Finally, AI define as "The subfield of computer science concerned with understanding the nature of intelligence and constructing computer systems capable of intelligent behavior" (Access Science, McGraw-Hill Education, 2020). The empirical findings suggest the emphasis on AI is apparent across the case study population. Volvo imply using AI as an effort to battle "human error" in their vehicle uptime solutions. Seemingly, the company utilizes the soft capital processes AI produces. Thus, based on its business application, AI is considered as a *physical capital* (Melville *et al.,* 2004). Additionally, the company has engaged in a valuable partnership with NVIDIA which will develop an advanced AI for the company´s autonomous solutions. Here, AI is considered as an external resource and contest to the notion of *heterogeneity and immobility* (Rivard et al, 2006; Barney, 1991). Ericsson increasingly remark on AI technology as a way to leverage their other technologies, e.g. IoT and 5G, as well as to tap into growing market opportunities. Therefore, the company identify AI as *physical capital* (Melville *et al.,* 2004). In contrast to Volvo, Ericsson recognize AI as an internal resource thus attest to the notion of *heterogeneity and immobility* (Rivard et al, 2006; Barney, 1991). Furthermore, H&M leverages AI to improve their customer experience by offering a seamless shopping solution and to improve value chain operations. Conversely, based on its purpose, AI may also be considered as *organizational capital,* i.e. if its purpose is to create synergies. However, theory argue that in the case of synergies, IT ought not to be regarded as an individual resource but rather considered as an enhancement (Wu *et al.,* 2006) that creates causal ambiguity (Cao & Zhang, 2011).

Seemingly, across-case variations exists. With regard to the VRIN-framework (Barney, 1991) AI may be considered *valuable* due to its immense capabilities. Likewise, firm-specific AI, such as that exploited by Ericsson to leverage core technologies, or AI utilized by H&M to enhance customer solutions, may be considered *rare* thus *immobile, in-imitable, and non-substitutable* (Penrose, 1959, cited in Melville *et al.,* 2004; Barney, 1991; Rivard et al, 2006). Another possible explanation may confirm AI as part of *network resources* when used in strategic alliances (Lavie, 2006) e.g. the AI developed by NVIDIA for Volvo. For instance, being involved in partnerships and collaborations recognizes AI as an external resource. Nevertheless, a firm need not control a resource in order to extract capabilities from it and subsequently produce competitive advantage (Lavie, 2006). Hence, in this case, AI may be considered *rare.* Yet, AI may not fulfill the criteria of *non-substitutable*, however, here, the notion of *heterogeneity* and *immobility* (Rivard et al, 2006; Barney, 1991) loses significance.

5.1.7. Summary

Initially, only resources controlled by the firm have been recognized as SCA resources due to their *homogeneous* and *immobile* nature. However, newer research contest the conditions of *homogeneity* and *immobility* as SCA producers, thus accepting external resources as SCA producers alike. Therefore, analyzing the identified resources *Partnerships & Collaborations, Employees, Synergies, IoT, Big Data,* and *AI* recognized by the case study population through a holistic perspective, and accepting a relaxed view of the RBV, conform as (internal and external) competitive advantage resources. Although their capabilities can be contested based on the VRIN-framework, which is a criteria for SCA producing resources, accepting a relaxed view of the RBV attest to their competitive advantage capabilities.

Furthermore, while the identified resources are recognized by the case study population as a whole, across-case variations exists. A reason for this may be the MNEs incongruent technological density. For instance, Ericsson and Volvo emphasize the incorporation of external resources to a greater extent than do H&M, which may be considered as less technologically inclined than its case study population peers; as its focus is on fashion retail in contrast to ICT, and, vehicle and machinery. Nevertheless, the analysis confirm flexibility undertaken by the case study population as they recognize both internal and external resources as part of their competitive stance. Conclusively, with respect to the RBV in relation to Industry 4.0 which presumably is changing the competitive landscape, the identified (internal and external) resources may be presumed as principal competitive advantage resources.

6. CONCLUSION

This final chapter concludes the findings and analysis discussed in previous chapters and ultimately answers the research question ´How do an MNE address sustained competitive advantage in relation to Industry 4.0?´. Subsequently, managerial implications are elaborated upon, and this research study´s limitations and suggestions for future research are summarized.

The objective of this multiple case study was to evaluate how an MNE address sustained competitive advantage in the era of Industry 4.0, grounded on the Resource Based View, with the purpose to enhance knowledge about sustained competitive advantage in the fourth industrial revolution. The objective was attempted through a holistic perspective, which consider the research as a whole rather than on its individual parts. Accordingly, the analysis process began with secondary analysis of the gathered data in order to identify trends embraced by the case study population. Thereafter, the trends were analyzed with regard to the RBV in order to identify their SCA capabilities or lack thereof.

Accordingly, the main findings of this study indicate that the resources *Partnerships & collaborations, Synergies, Employees, IoT, Big Data,* and *AI* are increasingly being assumed by the case study population in the era of Industry 4.0. While the original RBV argue for internal resources as exclusively producer of SCA, recent research has adopted a more relaxed view of the RBV thus suggesting external resources to be considered as competitive advantage producers alike, contesting to the notion of *heterogenous* and *immobile* resources. Seemingly, based on the RBV the findings suggest that while in some instances the identified resources do not entirely satisfy the criteria of SCA, their capabilities, conversely, may be considered as producers of SCA. By virtue of this, the research question for this case study *´How do an MNE address sustained competitive advantage in relation to Industry 4.0?´* is answered. In relation to Industry 4.0 an MNE address sustained competitive advantage by the (internal and external) resource´s capabilities; suggesting the resource´s facilitation of production is principal to its *heterogeneity* and *immobility;* thus, the ability to be flexible to changing market conditions prevail. Furthermore, the cases included in the case study population suggest across-case variations in addressing sustained competitive advantage in relation to Industry 4.0. While all companies acknowledge the identified resources *Partnerships & collaborations, Synergies, Employees, IoT, Big Data,* and *AI* in one way or another, variation in specific resource emphasis has transpired across-case. Presumably, the company´s technological density may provide an explanation to this. For instance, a company like Ericsson which is technologically dense put particular emphasize on the technologies *IoT, Big Data,* and *AI* thus address SCA in Industry 4.0 by these capabilities. On the other hand, a company like Volvo which may be considered as a technological-production hybrid put strong emphasis on *IoT, Big Data*, and *Partnerships & collaborations*. Conversely, a company like H&M which is production heavy and perhaps not as technologically focused as its case study peers emphasize *AI,* and *synergies* thus address SCA in Industry 4.0 by these capabilities. Conclusively, *how* an MNE address SCA in Industry 4.0 is, in addition to assuming the resources capabilities, may also be conditioned by its technological density.

By virtue of the fourth industrial revolution, societies are progressing, and the business environment is changing. As a result, MNEs operating in the competitive landscape of Industry 4.0 are beneficial of knowing how to address sustained competitive advantage. Hence, drawing on the RBV, this case study shed light on resources and their capabilities as producers of SCA deemed principal by an MNE in the fourth industrial revolution. Subsequently, the weak theory ties associating the RBV to Industry 4.0 are strengthened. With a special emphasis on Swedish MNEs, a link between Industry 4.0 activities and sustained competitive advantage is assumed. Supplementary, while assuming a holistic perspective, as opposed to a reductionist approach which has been prevalent in existing research, this study is complementing holistic research. Conclusively, this research study yield contribution to the RBV by building valuable insight to theory. The findings contribute to competitive advantage implications while suggesting internal and external resources are to be recognized as SCA producers; the production of the resources´ capabilities are prevalent to the notion of *heterogeneity* and *immobility;* and the technological density of an MNE may affect how it address SCA.

6.1. Managerial Implications

The changing business landscape may require new competitive strategies, hence managers or decision makers in an MNE may use the findings put forth in this research study as means to address sustained competitive advantage in the unprecedented era of Industry 4.0. Findings indicate managers ought to be flexible to changing environments and recognize resources based on their capabilities instead of emphasizing their controlling potentials, i.e. *heterogeneity* and *immobility*. Hence, incorporating external resources in addition to internal resources. Likewise, findings conclude the technological density of an MNE design variations in resource emphasis.

For instance, technologically dense companies emphasis advanced technologies such as *AI, IoT,* and *Big Data* when addressing SCA; whereas less technologically dense companies emphasis *Partnerships & Collaborations*, and (internal and external) *Synergies*. Ultimately, this knowledge may provide managerial implications of how to address SCA in relation to Industry 4.0 in their organization.

6.2. Limitations

As was discussed in section *1.6 Delimitations,* this case study has solitarily considered the companies of the case study population, thus no attention has been given to companies outside the case study population. Additionally, this case study has assumed principal technologies in relation to *´Industry 4.0´,* however the referenced technologies do not conclude an exhaustive list of Industry 4.0 related technologies, concepts, or terms, rather the technologies recognized throughout this paper are referred to in relation to Industry 4.0, and are considered in this research study due to their repeated importance and reference in the public domain.

What´s more, this research study was conducted during the pandemic outbreak of COVID-19[3]. While the pandemic has not limited my research in a particular way—I have conducted secondary analysis of publicly available documents which are available despite the pandemic outbreak—however if one would want to conduct a similar research through other qualitative constructs, e.g. interviews, the pandemic outbreak would pose as a limitation.

6.3. Future research

The discussed limitations suggest additional research is available with regard to this topic. By virtue of this research study´s qualitative stance, generalization is compressed. Thus, including a greater number of cases in the multiple case study, i.e. companies in the case study population, may elevate the transferability of this research, and accordingly, its ability to be generalized across settings. This would provide broader and more in-depth understandings to the topic. Likewise, this subject can be approached by analyzing a case study population in a context different to Swedish MNEs.

Furthermore, while this research study focus on how an MNE address sustained competitive advantage in Industry 4.0, the emphasis has been put on the MNE as a point of analysis. It

[3] The pandemic outbreak of COVID-19 originated on December 31, 2019, in Wuhan, China (WHO, 2020) and has lasted for the duration of this research study. Globally, various countries have been on lock-down or quarantine constraining ones movement. In Sweden, where this research study has been conducted, one´s movement has been constrained to the degree of no personal meetings unless necessary.

would therefore increase valuable knowledge in resource management (Sirmon *et al.,* 2008) if the point of analysis were shifted to internal considerations. Subsequently, in relation to the RBV, future research may investigate *how*, or *why*, managers align or deploy the identified resources to achieve SCA. Likewise, one might consider what role the firm or management has in the decision making process linked to the resource recognition in Industry 4.0.

Moreover, while analyzing the case study population´s repertoires I observe the companies adopt push and pull strategies while recognizing Industry 4.0. This would allow for a different perspective of *how,* and possibly *why,* MNEs address sustained competitive advantage. Another interesting aspect regard the emphasize by the case study population to offer customers ´solutions´ as opposed to ´products´; i.e. instead of merely selling a product, companies advertise a solution where the customer engagement takes place even after point of sale. This would provide valuable insight to synergies, value chains, as well as customer theory.

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Appendix

Appendix I

The computation process through the software analysis system NVivo, compiled by author