LUND UNIVERSITY

SCHOOL OF ECONOMICS AND MANAGEMENT

Master's Programme in Innovation and Global Sustainable Development

Understanding the emergence of AI innovation in Sweden

The role of old National Champions

by

Gustaf Henrik Johan Renman

gu1612re-s@student.lu.se

Abstract: Artificial intelligence is a topic that receives large amounts of interest from all parts of society as it promises to have a wide impact on all parts of society ranging from the ways people work and live, to the economy and progress to the sustainable development goals. Following from this, the technical prospects of AI innovations, and their potential for societal impact have received a lot of scholarly attention, but not the systems that support innovations in this emerging technology. As such, this study seeks to examine the state of the Swedish Artificial Intelligence innovation system with a focus on the roles played by Sweden's corporate national champions, and their connections to other actors. This study relies on published corporate data such as annual reports and press-releases to analyse activities and relationships in the innovation system. The literature suggests that resources and innovation networks are important to support emerging technologies like this one, which corresponds well with the findings from this study.

Programme Code: EKHS34
Master's Thesis (15 credits ECTS)
May 2021
Supervisor: Devrim Göktepe-Hultén
Examiner: Olof Ejermo
Word Count: 15956

Acknowledgements

Many thanks to Dr. Devrim Göktepe-Hultén of The Department of Business Administration at LUSEM for her guidance, without which this thesis would not have been possible.

The researcher thanks Dr. Elli Siapkidou and other previous colleagues at Equileap for their previous guidance in effectively researching corporate documents, which was of much help in the work for this thesis.

Table of Contents

List of Tables

1. Introduction

1.1 Research problem

To innovate is a loosely defined practice that generally refers to the attempts to bring an invention into practice and onto the market (Fagerberg, 2005). The original invention is generally a result of research and development, that can be done by a variety of types of actors, ranging from the military, universities to private businesses or inventors (Nelson & Rosenberg, 1993). To go through this process, turning an invention into an innovation requires a set of skills, resources and a selection of preconditions that may not be avaliable when the invention is first envisaged, which is why there may be a time gap until the invention is commercially avaliable and becomes an innovation (Fagerberg, 2005). Kline and Rosenberg (1986) stressed the fact that innovating is a slow and potentially unpredictable process, as an innovation may go through a series of changes and refinements over their lifetime, a process which may see an innovation drastically change in its appearance and quality. In addition, as society changes, the innovation's significance to its users and the economy may also change in the time it takes for it to come to market. In addition to being an invention brought to market from continous research and development, it may also be considered as the commercialization of a new combination of pre-existing ideas and knowledge, applied in a different manner and context (Hill & Rothaermel, 2003). Both recombination of pre-existing ideas, and new research may yield innovations that are radically new and different, or incremental improvements to existing technologies. Similarly, when an emerging technology starts to become a useful innovation, Adner and Levinthal (2002) argued that it more often than not emerges from previously established knowledge. It may have been improved and applied in new ways and contexts, which helps distinguish it as a separate, emerging technology.

Innovating is important in its own right, as new technical innovations enable people and businesses to do new things, and create new knowledge using the new innovation (Nelson & Rosenberg, 1993). However, innovation also has a tremendous and debated connection to the economy, where both are impacted by the other (Antonelli, 2009). Verspagen (2005) argued that the relationship between economic growth and innovation is complicated. However, he argues that organizational and technological innovations have been responsible for the recent long period of accelerating economic growth. He notes that while the main theories disagree on foundational issues, they do agree on the importance of innovation for economic growth, as well as that governments may have a significant impact on this. Following from this connection, it is understandable that innovating is seen as desirable, and something that should be promoted, which helps explain the actions of governments in relation to the universities and companies that help make innovation happen. As the nation state makes policy, regulation and provides funding for innovation, they are an actor in a system that supports the development of new, emerging technologies, innovation, a national innovation system.

Artificial Intelligence, abbreviated as AI is an expansive concept and collection of theories with a foundation in the disciplines of statistics, mathematics and philosophy (Buchanan, 2005). It refers to technology that can do intelligent thought, and act based upon that. Currently there is a lot of interest in AI from all parts of society, both industry, policy makers, researchers, and society at large. It is believed that together with related technologies AI has the potential to dramatically change the ways people live, work, and do business (Brynjolfsson & McAfee, 2017; Wang & Siau, 2019). At the same time, there are many misconceptions about how soon AI will be able to have a major impact on society. Ever since the 1950s, scholars have regularly predicted that AI will be virtually indistinguishable from human intelligence within a few years, and so far none of these predictions have been correct (Haenlein & Kaplan, 2019).

Sweden has a long history of being a highly innovative country, with its industrial sector producing inventions that became very successful exports in the past, ranging from the adjustable wrench in 1893, to wireless Bluetooth technology in 1998 and many others in-between (Sandström, 2014). In recent times, Sweden has had a period of high innovation activity since the mid-1990s, which is confirmed by Sweden placing second in several global innovation indices (Andersson, Anokhin, Autio, Ejermo, Lavesson, Lööf, Savin, Wincent & Ylinenpää, 2013). This strong innovation performance has continued, with Sweden placing second in Europe only behind Switzerland in the 2020 edition of the European Innovation Scoreboard (European Commission, 2020). In digital high-tech industries, Sweden and in particular Stockholm has an impressive track record of innovation, producing more high-tech 'unicorns' per capita, than any other city outside silicon valley (Knowledge@Wharton, 2015). Beyond this, Sweden is considered to be one of the most digitized countries according to the OECD (2018), which notes that both businesses of various sizes, and individuals across age, income and education levels are highly digitalized. This means that all parts of society use digital technologies such as computers and the internet to a large extent in their business and daily life. This follows the findings by Gürdür, El-khoury and Törngren (2019), who in their study of over 100 Swedish companies across several industries found that they were generally well prepared, and show a high level of readiness for further digitalization in most areas.

This history of innovation and high levels of digitalization combine to make Sweden well prepared for AI, and the other digital technologies of the fourth industrial revolution. Already, there are large expenditures on AI software and hardware in the private sector, a total of 5.6 billion SEK in 2019, mostly from large companies with over 250 employees (Statistics Sweden, 2020). This is accompanied in these companies with a wide interest in staying ahead of the curve in the technological development, and in particular the business opportunities that come with this. Statistics Sweden (2020) also found that the public sector also leverages AI to a large extent, with the most common use case being to their internal processes.

The interest from the private sector manifests itself through initiatives to further AI development in Sweden such as WASP, the Wallenberg AI, Autonomous Systems, and Software Programme. There, one of Sweden's most influential families is coming together with industry and universities in order to make a big push for into AI research in order to catch up with other countries and to keep Sweden's companies competitive (Billing, 2019). Likewise, Sweden's most prominent research universities, including but not limited to: the Royal Institute of Technology, Lund University, Chalmers, Uppsala University, and Umeå University are all key partners to Swedish AI research initiatives (AI Sweden, 2020b; WASP, n.d.a).

This positive attitude towards AI in Swedish companies and public sector extends to Swedish government policy according to a study of Swedish policy documents by Toll, Lindgren, Melin and Østergaard Madsen (2019). They found that the public sector sees plenty of opportunities to improve efficiency and services to citizens, and while risks are mentioned and recognized, they do not characterize the attitude towards AI. Ranerup and Henriksen (2020) examined the implementation of an AI driven process automation for social services decisions, in the first Swedish town to adapt such a system. They found that it has a positive impact on the practices and values of the civil servants who use the system.

The fourth industrial revolution is still in its early stages, with an expectation that a variety of digitalization technologies will have a significant impact on how people work, and the ways companies do business (Wang & Siau, 2019). This indicates that Swedish companies and its public sector should be relatively well prepared to engage with and leverage AI innovations, as digitalization is seen as a neccesary step in order to effectively utilize AI in organizations (Brock & von Wangenheim, 2019).

While there is a significant amount of literature on artificial intelligence, most of it is focused on either the technological aspects and prospects it has, or the existing and anticipated consequences it will have on society. It has been argued that while it may have a positive impact on the economy, increased use of AI may exacerbate inequalities, and have a mixed impact on progress to sustainability (Vinuesa, Azizpour, Leite, Balaam, Dignum, Domisch, Felländer, Langhans, Tegmark & Fuso Nerini, 2020). However, there has only been a very small selection of studies on AI innovation, and the systems that help make innovations in this emerging technology happen. Two recent studies on China's Artificial Intelligence innovation system represent much of the published work dedicated to this specific topic. A study by Yu, Liang and Wu (2021) of China's AI innovation system has revealed how the actor relationships in the innovation system are shaped by data, and the access to it. Furthermore, Arenal, Armuña, Feijoo, Ramos, Xu and Moreno (2020) examined the unique role that the different levels of government plays in the Chinese AI innovation system.

1.2 Aim and scope

While there have been other studies on innovation systems supporting emerging technologies, both specifically in Sweden and around the world, there is still no detailed exploration of Sweden's innovation system supporting AI innovations, which is the main aim of this study. In particular, the goal of this study is to gain descriptive insight into, and to provide a holistic overview of the current state of AI innovation in Sweden. This includes identifying what are the types of projects and endeavours characterize AI innovation among large, incumbent actors.

Furthermore, the goal is to gain insight into what types of relationships and partnerships help make these AI development endeavours happen, both to other large actors as well as to start-ups, universities and governmental agencies. This will help fill the apparent research gap into AI innovation systems, which persists despite large and growing investments into AI research and development on a global scale (Furman & Seamans, 2019).

1.3 Outline of the Thesis

The remainder of this thesis is split into four main sections. Firstly, the literature review introduces innovation systems and their key components, as well as the current state of AI. This is followed by a detailed description of the qualitative methodology used for this study, the data used for this study, and how the particular case was chosen. This is followed by the findings that expand on the state of AI innovation in Sweden. After this, the thesis ends with a conclusion that considers the limitations and implications of this study

2 Literature Review

2.1 Innovation systems and their key actors

The broad innovation system framework helps us understand how technical change and innovation itself happens (Edquist, 1997). In particular, the innovation systems approach can help us describe, understand and explain the processes that are involved in making innovation happen, this understanding may then be leveraged to influence and shape the direction and pace of innovation. Lundvall (1992) argues that innovation is closely tied to learning, and therefore is an interactive process which happens as gradually, as pre-existing ideas and knowledge is recombined into new combinations. Following from this understanding of innovation as an interactive and cumulative process, it becomes natural to examine it as a system (Edquist, 1997). Furthermore, using a system to disentangle and understand how innovation happens allows us to break it down into components and relationships, and therefore we understand how the system can turn inputs into outputs through its interactions and activities (Granstrand & Holgersson, 2020). The innovation system can be defined to include "all important economic, social, political, organizational, institutional, and other factors that influence the development, diffusion, and use of innovations" (Edquist, 1997, p.14). As such, we can consider an innovation system as a network of institutions and actors, both private and public, who initiate, modify, import and diffuse new technologies through their actions and interactions. and through this they guide the direction of society's technological change (Alkemade, Kleinschmidt & Hekkert, 2007).

The general innovation systems view can be accompanied by a qualifier that lets us examine it in more detail. This also indicates which institutions and actors are the most relevant ones in the system. The most prominent and commonly used qualifiers are national innovation systems, regional innovation systems, and sectoral innovation systems (Granstrand & Holgersson, 2020). A sectoral innovation system limits the system to those actors that develop and make a sector's products, and those who use the technologies from this particular sector (Malerba & Nelson, 2011). Meanwhile, a geographic qualifier like a regional innovation system examines the economic and institutional setup within a region and is driven by spatial factors. This considers location and physical proximity which is relevant when considering how the innovation diffuses into society, as well as the locations of where the research and development takes place.

The particular concept of national systems of innovation, NSI is extensively used by both scholars and policy makers when examining innovations and the systems that support them (Lundvall, 2007). As the name suggests, a national system of innovation considers a system bound by a nation state and relates to those who act in a system within this nation. A core feature of NSI is that innovating is interactive practice, where feedback from the national market impacts how an innovation develops, rather than the linear process of research and development to invent a product that was commonly accepted in the 1970s and 80s (Lundvall, 1999). These relationships between the firm and other actors, and the interactions help the firm learn and further develop the innovations, so that they are better suited to the context of society and other relevant technologies and innovations (Lundvall, 1999). In addition to this market feedback, the firms interact with knowledge infrastructure such as universities, which may help support and guide their innovations. However, the universities like the firms themselves are subject to policy action, primarily from the nation state, which also guides and directs the innovation, but the firm is the driving force in the innovation process, as they are the ones who take risk (Lundvall, 2007). Beyond this, firms also interact with each other in non-market relationships, or organized markets that are not based on pure exchange and trade, instead these relationships are characterized by power, trust and loyalty and Lundvall (1999) claims that they help innovation happen.

The Triple Helix, TH, of university-industry-government relations emerged as a complementary model rather than an alternate model to understand the research system by examining functions and interactions between the three actors. Compared to the industry focus of NSI, the triple helix model does not give preference to one of the spheres, but instead the three parts and their interactions all shape the innovation process (Etzkowitz & Leydesdorff, 2000). Leydersdorff and Meyer (2003) argues that this helps better capture the reality of the situation, as the different systems are subject to constant reconfigurations and changes in their conditions, coming from international agreements like the EU, or a flow of new technological innovations, and this in turn constantly changes the relationships between the actors. Furthermore, Etzkowitz (2002) suggests that networks of innovations such as incubators or research schemes are a manifestation of the triple helix. In these, academic and industry actors can interact and organize among themselves to share researchers and the knowledge held by these researchers, to make better use of them. In addition, these networks contain a variety of firms which helps disseminate the innovations, and in these arenas, there are actors from different industries, which helps cross-pollinate ideas and knowledge, furthering their status as a manifestation of the triple helix model.

As an alternate example, further developments in artificial intelligence may come from an industry and university partnership, funded by a governmental initiative. This progress in a particular direction may open for potential negative consequences, which causes the government to act, changing regulations to prevent abuse, which changes the trajectory and direction of future research. This example shows how the three spheres may interact and influence each other's trajectories, which all set the stage for future developments in different directions.

While the different frames to understand the research system as whole gives different priority to the different categories of actors, the different types of actor relationships can further help explain the details of how the research system functions. The large incumbent actors that are at the centre of this study relate to other firms, both large and small that may be competitors, suppliers, clients or partners. Large firms may have strong collaborations with universities, as a notable source of knowledge they use for innovations, whereas small and medium enterprises, are significantly more reliant on their clients and suppliers as a source of knowledge and have relatively few partnerships with universities (Corral de Zubielqui, Jones, Seet, & Lindsay, 2015).

All actors relate in some ways to the public sector, either through the funding it provides, or by being subject to the regulations that to some extent restricts their work. The state can leverage these mechanisms to guide the direction and speed of innovation. Gregersen (1992) likens the role of the public sector in innovation systems with a pacer in a bicycle race, who needs to remain connected to the innovation system to keep an optimal pace, and may be able to direct it, to keep the pace of innovation high. The role of governments government in the innovation system may come as support through research funding in particularly strategic areas, as well restrictions in the form of regulations that shape the direction of innovation (Nelson, 1993). These restrictions may come in the form of regulations that protect the environment or privacy, which demands further innovations to ensure that the products can meet the stricter regulations, or achieve their goals without breaking the boundaries set by the regulation (Ashford & Hall, 2011). Additionally, the public sector can combine multiple types of policy measures to simulate innovation in an area, where taxes are raised on a conventional option, while funding and subsidising is provided for a new option, to speed up a transition to a more strategic or favourable technology, such as renewable electricity (Gregersen, 1992).

2.2 Key components of Innovation Systems

This section will examine the three most crucial components of innovation systems for the purpose of this study, and to expand on their roles in the system. These are firms, and in particular incumbent actors, and their relations to start-ups, the role of resources for innovation, and the importance of innovation networks and other infrastructure in facilitating innovation.

2.2.1 Firms and their role in innovation

Different frameworks for understanding how innovation happens places an emphasis on different actors as central to the process, Fagerberg and Sapprasert (2011) argued that the firm has been declining in popularity among scholars in comparison to system based approaches. However, Lundvall (2007) argued that firms are at the very centre of an innovation system, and that they are the most important actor as are responsible for innovation in their interactions with other firms and knowledge infrastructures such as universities. The firms are the actors who take risk trying to conduct research and commercialize the new technologies stemming from that research (Lazonick, 2005). As such, there does not need to be a tension between the firm being the most prominent actor in innovation, and the relevance of system-based approaches.

When a firm engages in innovation, that means that they dedicate their time and resources in order to conduct research and development, engage with certain actors, and search in order to accomplish innovation in a particular direction, field or area (Laursen, 2012). This attempt to innovate is an inherently uncertain and risky process, as what needs to be learnt about modifying existing technologies, and learning how that in turn fits into the market can only be learnt by the innovation process itself (Lazonick, 2005). The riskiness of this stems from the prospects of an innovation not fitting in to the market, meaning that the firm cannot recuperate its investment into research and development.

Incumbent companies are established firms that have been working with existing technologies, and are embedded in the networks and systems that surround those technologies (Hill & Rothaermel, 2003). These incumbents generally do not bring radical new innovations to market, instead this is done by new entrants who have played a part in developing the new technology. Facing a new technology that competes with their existing ones, they are at risk of becoming irrelevant as new entrants rise and may be successful at commercializing the new technology. The traditionally rational response by incumbent actors has been to invest in further development of technologies that they are already working with, as they have human and physical resources invested in the technology that they want to continue to make use of (Hill & Rothaermel, 2003).

From the perspective of new entrants and start-ups, they are trying to break into a market that is dominated by existing technologies and incumbent actors. To overcome that barrier, they are incentivised to invest in developing a new technology, which can set them apart from what already exists on the market (Hill & Rothaermel, 2003).

In high-tech industries, the pace of innovation that is needed to remain relevant with the technology developments that take place in the innovation system requires constant work to innovate, which poses a challenge to large, incumbent companies that also has many other parts of their business to maintain (Wagner, 2010). Meanwhile, small companies and start-ups that are relevant actors in the innovation system solely because of their involvements with new technologies, but they struggle with organic growth in the long term.

Hill and Rothaermel (2003) argued that incumbents may thrive in this dynamic, if they are able to adapt and exploit the shock of new technology on the market. Additionally, they argue that if an incumbent establishes an autonomous unit within itself that conducts research or forms alliances with new entrants, it may provide the environment that they need to properly absorb and utilize the new technology. Wagner (2010) suggested that one path forward that may help solve the issues that both the incumbent and start-up faces is acquisition. From the point of view of the incumbent companies, he argued that it may be neccesary as there are organizational factors that prevent large companies from engaging in innovative activity, or that they acquire companies to gain market-share. On the opposite side he argued that there are significant reasons for small companies to benefit from the acquisition, such as getting hold of complementary assets that the incumbent holds, that are neccesary to continue to grow.

2.2.2 Role of resources in innovations

A crucial aspect of innovation is to have the neccesary resources and funding to go engage in the innovation process, and hopefully bring a new innovation to the market (Lindgaard Christensen, 1992). Financing is at the core of the resources that are needed for innovation to happen, as cash flow is a neccesary component for research and development to continue, both for physical spaces and equipment, but also to maintain a staff skilled researchers who bear human capital in the form of their knowledge and expertise (Kerr & Nanda, 2015).

With all research and development, there is a risk that it will not be fruitful, however governments operate at such a scale that they are able to spread their risk and finance new exploratory research, with less consequences the research does not yield the desired outcomes (Lindgaard Christensen, 1992). Similarly, when large firms conduct risky research endeavours, they are generally able to finance it internally given their scale and the associated risk diversification. However, small and medium sized companies are however much more reliant on external financing to conduct their research, as they have less capital to draw on. When it comes to high tech development, Lindgaard Christensen (1992) notes that the shorter lifecycles and more expensive research may result in even large companies relying on external resources to hold the necessary pace of development.

Other resources that are neccesary for innovation may not be managed and acquired as easily as finances but are still crucial inputs for the innovation process. Firstly, and potentially most important is knowledge: skilled human capital and ideas, this as new knowledge is often built on new combinations of previous knowledge, and skilled staff with ideas is needed to explore and realize innovations (Johnson, 1992). Romer (1992) emphasized the importance of separating the notions of ideas, that are a non-rival good, and human capital which is a rival good. He argues that the two are very strongly linked, as ideas are neccesary for the creation of new human capital, and human capital itself is needed to create new ideas. And while it is tempting to consider them together, he stresses the importance of keeping them separate, as they are different types of goods in their economic nature. Another relevant resource for innovation is property rights, both as a motivating factor to innovate, but also having proprietary rights to use certain knowledge (Fisher, 2001). Wagner (2010) argued that since property rights can prevent an actor form innovating in a field, they serve as an incentive for firms to either innovate in unique areas, or to collaborate with others to successfully innovate.

For an innovation to be competitive and unique, the resources should be valuable, rare and non-substitutable (Moultrie, Nilsson, Dissel, Haner, Janssen & Lugt, 2007). These qualities help explain why good access to data is crucial to innovation in AI. In particular, it is neccesary to have large sets of high quality data to conduct AI research and to train machine learning models, the main area of current AI advances (Kaplan & Haenlein, 2019). In addition to the data itself, an actor needs the capabilities and resources to process the data in order to use it for AI innovation (Yu, Liang & Wu, 2021). Here, data and the ability to analyse it can be considered as two complementary resources. Teece (1986) argued that those who hold a neccesary complementary resource may often be those who profit from an innovation, rather than the inventor or firm that realized the innovation.

2.2.3 Innovation networks and infrastructures

Innovations do not happen on its own or in a vacuum, and it is well known that feedback from other actors and the market is crucial to make innovation happen. While these types of collaborations between firms may be in the best interest of all the involved actors, they may need something to incentivise or facilitate their connection (Connell & Voola, 2008). Innovation networks and clusters are a form of infrastructure, a setting in which this type of collaboration can happen, where the member firms can collaborate, share their knowledge, and innovate further and faster together than they would be able to in isolation (Connell, Kriz & Thorpe, 2014). The industry cluster concept is closely related to science parks which serve a similar function by providing a space for companies to collaborate and receive inputs from other actors such as universities (Díez-Vial & Montoro-Sánchez, 2016).

Science parks are strongly related to the notion of an innovation cluster, but they have a clearer role for interactions between universities and companies, they help university researchers commercialize their products by linking them with companies (Quintas, Wield & Massey, 1992). This comes through formally established links and partnerships between the different university researchers and companies that are meant to help technology transfer. The science parks, are as the name suggests a physical space where the companies and universities are geographically close together which means that they can share resources such as labs that are needed to conduct some forms of specific research and development (Quintas, Wield & Massey, 1992). Díez-Vial and Montoro-Sánchez (2016) stressed the fact that the spill-overs that can happen in a science park are not a given, but are instead highly dependent on the relationships that the companies form with universities and other companies through the science park.

Science parks have been receiving large amounts of attention from policy makers all around the world for a long time because of their role in facilitating and promoting innovation (Quintas, Wield & Massey, 1992). Sweden's governmental agency for innovation financing, Vinnova has a national incubator programme that finances 29 science parks around the country, investing 350 million SEK in 2020-2023 (Vinnova, 2020a).

Large companies can also establish their own infrastructure that helps facilitate and speed up the interaction process with small companies and start-ups through founding their own accelerators (Kanbach & Stubner, 2016). These corporate accelerators generally go beyond venture capital investments into the participating companies, and instead aim to provide more comprehensive support to enable the small companies to thrive and develop their technologies (Pauwels, Clarysse, Wright & Van Hove, 2016). This model is different from traditional capital investments by focusing on providing more intangible knowledge through intensive mentoring, often combined with an amount of venture capital for equity in the start-up (Pauwels et al., 2016). These accelerators are attractive options as they do more than provide life-support to start-ups, instead the type of assistance that they give help speed up the start-up journey, and failure or sustainable growth comes sooner through this model (Pauwels et al., 2016).

2.3 Emergence of Artificial Intelligence as New Technology

2.3.1 State of AI

Artificial intelligence, while having a long technological history with a foundation in other disciplines it has historically not had much of a significant impact on society, as the expected abilities have not arrived (Buchanan, 2005). There have however been notable achievements and advancements in recent years, particularly regarding AI as a problem solver. This includes AI being successful in the games of Chess and Go, and recognizing images to detect cancer, and understanding human voice (Brynjolfsson & McAfee, 2017). These advancements, and much of the contemporary progress in AI which spans different technological domains and industrial sectors is largely driven by Machine Learning, ML, which is currently the most used application of AI (Howard, 2019) ML refers to the ability of a machine to independently learn from a dataset, rather than being fed a set of rules that have been set by an expert. After this, the AI can make judgements on its own, based on the rules it has created. This follows from how the intelligence aspect in artificial intelligence is defined, as a "system's ability to interpret external data correctly, to learn from such data, and to use those learnings to achieve specific goals and tasks through flexible adaptation" (Kaplan & Haenlein, 2019, p.17). This definition helps set AI apart from related technologies that are also part of the fourth industrial revolution, such as the Internet of Things and Big Data, as they lack this intelligent aspect. However, they do serve important roles for AI innovation, in part as they collect and organize data, a necessary resource for AI development and applications (Kaplan & Haenlein, 2019). As they help connect more products and devices, these products can both be used as a source of data, but they can also be made intelligent and adaptive to their environments, spreading AI in society.

These forms of tangible advancements helps drive interest into AI, which further supported by large and growing investments from the private sector with the expectations of considerable benefits from implementing AI into their businesses (Deloitte Insigths, 2020). The public sector also believes that AI may have considerable impact, as the European Commission, and many European governments are also making sizable investments into AI, multiple billions of euros over just a few years (Arpteg, 2018). However, the EU does not have uniformly positive view of the potential of AI, as they recently, in April 2021 released a proposal for strict regulation on how AI may be used, and even preventing or limiting the use of AI in some cases, and sets requirements for transparency in other use cases (MacCarthy & Propp, 2021).

2.3.2. AI and The Emergence of New Technologies

Applications of AI have long been promised to have a major impact on our societies and the ways we work, but it is only recently that they started to emerge with functional, practical applications (Brynjolfsson & McAfee, 2017). Meyer and Kuusi (2004) examined development of emerging innovations, with a particular focus on nanotechnology. They argue that development of new technologies comes in two main stages, bootlegging and bandwagon, which can be identified by how widespread the research is, and how the research is funded and how it attains neccesary resources. In the bootlegging stage, there is a relatively small number of researchers, potentially in a few separate locations that are highly dedicated to their work, yet receive criticism from their peers, and they struggle to finance and find neccesary resources their research. When the field becomes more established, there are more actors undertaking research in the specific field, across different sectors, organizations and countries. As this happens, the access to funding becomes easier, and might come from companies that see commercial potential in the technology.

Data is a resource that is crucial to AI innovation, especially in the field of Machine Learning (Kaplan & Haenlein, 2019). This as the concept of machine learning is built on having a machine learn from a large set of high-quality data. In addition, it needs to be combined with sufficient knowledge of AI and technological skill in order to be leveraged for innovation (Yu, Liang & Wu, 2021). Yu, Liang and Wu (2021) note that large incumbent actors are likely to possess large amounts of data, as they have long running operations that may have yielded plenty of information, stored over the years. Despite the fact that data can be infinite and non-competitive, it may be impossible for small and new actors to produce or acquire comparable data on their own, regardless of monetary resources (Yu, Liang & Wu, 2021). As such, start-ups that have technological capabilities may be forced to collaborate with incumbents for access to the complementary resource of data. This dynamic of complementary resources in innovation may lead to the incumbents capturing the bulk of the profits, as the start-ups have little choice but trying to acquire this complementary resource (Teece, 1986). However, in many industries the incumbents may also be incentivised to enter into partnerships with start-ups, as they often do not hold the capabilities to process and leverage the data to its fullest extent in-house (Yu, Liang & Wu, 2021).

Following from these insights, considering the importance of data as neccesary resource for AI innovation, as highlighted by Yu, Liang and Wu (2021), and the role of resources for emerging innovations as noted by Meyer and Kuusi (2004), one can examine how funding and data is attained for AI innovation as an indicator of how well developed the innovation system is. It should be noted that a well-developed innovation system, with sufficient resources does not neccesarily tell anything about how close to market the AI innovations are.

2.3.3 Previous Research on AI innovation

While there is a wide selection of studies on sectoral systems of innovation, as well as studies specifically on innovation systems surrounding new, emerging technologies, there is only a very narrow selection studies of innovation systems that support and develop artificial intelligence innovations. In the Swedish context, there have been no published studies that specifically examine the AI innovation system, but there has been work done to examine the current state of AI, by Statistics Sweden (2020) which examined AI related expenditures and expected prospects in Swedish companies and public sector.

The most in-depth exploration of an Artificial Intelligence innovation system comes from Arenal et al. (2020) and their qualitative investigation of the AI innovation ecosystem in China. They stress the particularly strong role of different levels of government, and alignments between government interests and industry actions characteristics of this innovation ecosystem. Furthermore, they stress that while there has been strong adoption of artificial intelligence among China's large technology and internet companies, while traditional industries have been very slow in adapting artificial intelligence into their operations.

Yu, Liang and Wu (2021) examined how actor relations in China's artificial intelligence innovation system are shaped by data. In the Chinese AI value chain, they identified three categories of corporate actors: infrastructure providers, technology developers, and application users. The infrastructure providers produce equipment like AI chips and networking equipment, whereas the technology developers provide solutions like computer vision, and natural language processing. Finally, the application scenarios bring this together in all types of actual products or use cases. They note that these three categories of actors are all trying to capture more of the value chain, either through expansion of their business internally, or through partnerships in the value chain.

Examining trends in how and where innovation happens in the Chinese AI innovation system, Yu, Liang and Wu (2021) argues that China's large digital platforms are growing in importance, while academia is decreasing. This can be observed AI scientists are increasingly moving from academia to industry, either to established AI companies, or to start their own businesses, they note that the same trend can be seen internationally. However, they argue that universities are becoming increasingly interested in collaborating with the industry, to access the data that the industry holds. Beyond this, the partnerships with universities are important for the industry actors to ensure that long term research is undertaken, for example through joint research labs. Their study highlights the importance of holding and controlling data for partnerships and collaborations in the artificial intelligence ecosystem, that holding or having access to data changes the dynamics in these relationships. Following from this, they stress how this means that relationships between actors in an artificial intelligence innovation system may not directly follow the relationship structures from other innovation systems as data as a resource is fundamentally different from other neccesary resources for innovation.

Pique, Berbegal-Mirabent and Etzkowitz (2018) examined the evolution of the innovation ecosystem in Silicon Valley. Their study was not limited to artificial intelligence and related technologies, but they note that it was one of the hottest areas of investments from the industry actors at the time of the study. They found that with the current technology development, large industry actors are interacting more with early-stage start-ups, including traditional non-tech actors that are starting to interact with tech start-ups. They note that this increased interaction takes place through an increase of accelerator and incubator programmes, which facilitates the relationships and allows the involved companies to receive market feedback from one another.

In addition to these topic specific studies on innovation systems that support AI and related innovations, there is an extensive body of literature examining other innovation systems that support new emerging technologies. Alkemade, Kleinschmidt and Hekkert (2007) outlines a framework to study innovation systems surrounding emerging technologies, and demonstrates its usefulness by examining an innovation system focused on renewable electricity production in California. They suggest that to best study an emerging innovation system, one should focus on mapping the activities or functions of that innovation system. They argue that this helps to fully understand how the innovation system behaves and performs. To analyse entrepreneurial activities, they suggest “mapping the number of new entrants, the number of diversification activities of incumbent actors and the number of experiments with the new technology” (Alkemade, Kleinschmidt & Hekkert, 2007, p.143).

2.4 Salient issues based on the previous literature

The three most crucial aspects of the innovation system for the purpose of this study refers to the roles of firms in innovations, the role of resources, and finally the role played by innovation networks. By highlighting these issues in this study of Sweden’s AI innovation system, it should be possible to gain valuable insight into the state innovation as well as to gain an understanding of how AI innovation happens in Sweden, and how it differs among incumbent firms that work in different sectors.

The work of individual firms identifies what type of work is being undertaken, and the processes they use to further their innovative efforts. By examining the role of resources in AI innovation, the motivations for certain types of activities may become clearer. Furthermore, resources may play a significant part in the relationships incumbent actors have with other companies, and innovation networks. These infrastructures and the roles played by different actors in them can help show how innovation progresses, and what steps different actors take to further innovate.

3. Methods

3.1 Methodological approach

Qualitative methods are often used for studying innovation systems (see Chaminade, Lundvall & Haneef, 2018). They argued that this approach has a variety of strengths, particularly how in-depth and context specific this can be, in comparison with quantitative studies. For example, they note that a qualitative study can examine the linkages between actors, and then understand the exchange of knowledge which takes place through that link. Moreover, they argue that qualitative studies play an important part in indicating what specific statistics are valuable in an innovation system, for further study using quantitative methods. As this study concerns an emerging innovation system, focused on a technology where there has only been a very limited number of previous studies, it may be able to illuminate important, technology specific factors for further study.

Furthermore, Chaminade, Lundvall and Haneef (2018) argue that a qualitative study can break down the complexity of an innovation system, either by focusing on a particular relationship such as university-industry interactions. Alternatively, they argue that the complexity can be broken down by using a functional approach, to focus on the activities and their functions in the system, such as examining the activities of organizations that have different kinds of impact on the innovation process and the innovation system. Following from this understanding, and the recommendation by Alkemade, Kleinschmidt and Hekkert (2007) that studies of emerging innovation systems should focus on mapping activities in the innovation system, this study is conducted in the form of a qualitative mapping of activities. In addition to this, cross-case analyses were done in order to identify similarities and differences. The different incumbent companies were considered as separate cases for this purpose, as there are multiple units of analysis for each studied company. Yin (2003) notes that this approach is particularly valuable in an analysis of multiple cases, as it simplifies analysis and the findings tend to be more robust. This is because the cross-case synthesis allows for similarities and differences between the cases to be identified, which helps to clarify the unique aspects of different cases, as well as general observations across cases.

In this qualitative research, the mapping itself serves as a form of analysis that highlights the functions and activities in the system. To assist the analysis in this process, the empirical materials were collected, structured and presented in a manner which echoes the theoretical framework. This is done in conjunction with a standard approach for qualitative analysis, where the data is first described, then classified, and finally connections are made, within the data and to the literature (Dey, 1993). Following from this analysis it should be possible to further reflect on the state of this innovation system and to understand the significance of its activities and connections.

3.2 Data

3.2.1 Case selection

3.2.1.1 Choice of incumbent actors

An innovation system includes a variety of types of actors, and the triple helix framework does not neccesarily give preference to either one of them. This study of the Swedish AI innovation system is centred on incumbent corporate actors, to examine their role in the innovation system, and how they relate to other actors, both corporate, academic, and the state. This is due to this innovation's nature as an emerging technology, and the dynamic that exists between incumbent actors and others, given their access to resources and particularly data.

To centre this study, ten large companies with a very strong Swedish connection and involvement were chosen as the incumbents to be at the centre of this mapping. These companies have been identified as industrial champions, or strategically supported companies in Sweden's innovation system. Maincent and Navarro (2006) noted that the concept of industrial champions is contested and does not have a clear, succinct definition. However, they claim that it is often related to companies that may be large, successful, and active in a strategic sector. Falck and Heblich (2007) expands on these criteria with the notion that national champions are successful on a global market. In the Swedish context, Erixon (1996) argued that the national champions have been large and successful companies, who mostly lack domestic rivals on their own scale.

The chosen companies are from a variety of sectors, with the industrial companies Scania, Volvo, ABB, Ericsson and Saab making up half the selection. Husqvarna, H&M and Ikea/Ingka Group producing cyclical consumer goods, while AstraZeneca is a pharmaceutical company. The purposes and inclusion of AI into their business and products can in part be understood as a reflection of the type of business they have, whether they are using it for internal decision-making and product development processes, or as part of a service for their customers, or both.

The selection of companies was done based on their identity as a national champion. Several of these were mentioned as national champions by Erixon (1996). However, his study had a specific focus on industrial champions, and as such other non-industrial companies that fit into the loose definition of an national champion were included.

Considering that ownership structures vary among the notable companies that often considered Swedish, from publicly listed, in Sweden and elsewhere, to wholly owned subsidiaries of other internationally listed companies or privately held, the condition for inclusion in this study was a strong historical Swedish connection, or Swedish origins. The companies were all founded in Sweden, between 1689 when Husqvarna was originally founded, and 1947 when H&M was founded. The current corporate entities may have undergone mergers, acquisitions, and splits, but their Swedish identity refers to their origins and strong national connection.

3.2.1.2 AI innovation and the role of incumbent actors

It is of particular interest to examine the role of incumbent actors in relation to emerging technologies and radical technological innovation, as previous situations have shown various roles played by incumbent actors. Hill and Rothaermel (2003) note that while incumbent actors occasionally may hold an advantage in face of a radical technological innovation such as AI, this view is not a universal one, and previous technological breakthroughs have often displayed a very different dynamic between incumbents and challengers. Traditionally, incumbents have been expected to go into a decline, while new actors rise and better manage to exploit the new technology, and rise to dominate the market, however this is not always the case.

In this specific study of AI innovation, new entrants such as start-ups may be at a unique disadvantage if they do not partner with another established actor for access to data which is a neccesary complementary resource for AI innovation (Yu, Liang & Wu, 2021). As such, incumbent actors should play a more significant role in development of this emerging technology, than what would be expected based on the experiences from previous radical technological innovations. This is further supported by Yu, Liang and Wu (2021) who argues that companies who have been working directly with customers in traditional industries may be holding a goldmine of data that has been collected over time, but may not yet be leveraged with the help of AI. The incumbents in this study all come from this kind of traditional industry, which predates digitalization to a large extent.

Additionally, Agrawal, McHale and Oettl (2019) argue that AI has qualities of a general purpose technology. This means, among other things that the technology can be applied in many different ways, by different types of actors in different sectors to achieve a variety of different goals, as the technology is general purpose (Lipsey, Carlaw & Bekar, 2005). Yu, Liang and Wu (2021) argue that this characteristic means that incumbent actors may apply AI to enhance their traditional business by simply adding it on, letting them form an ‘AI plus X’ industry. This possibility further enhances the value of examining the AI innovation system from the view of incumbent actors, as incumbent actors across different sectors and industries may all be involved in AI development, applying it in a way to suit the needs of their business. Following from this understanding, it can be appropriate to centre the study around incumbent actors who do not neccesarily have a main focus on digital services and AI, as AI should have an impact on all sectors.

3.2.1.3 Geographical scope

Innovation systems can be studied at many different spatial scales, ranging from local and regional systems to those that are national or even spanning international borders. The choice to analyse Sweden's national system was driven by both the conditions of this innovation, the system supporting it, and relevant legislation, as well as practical limitations for the scope of the study.

There is no notable regional government to consider for this innovation system, as was neccesary in the studies by studies by Pique, Berbegal-Mirabent and Etzkowitz (2018) and Arenal et al. (2020). Additionally, the companies intended for analysis in this study were not limited to one region, which would have further complicated a region limited analysis. Additionally, in the Swedish public sector, national government actors are responsible for roughly two thirds of the AI related expenditure, where the remaining third is split between regional and municipal governments (Statistics Sweden, 2020). This further supports the notion that the national level is most relevant to study this innovation system at. Additionally, as Lundvall (2007) notes, different geographical levels of analysis are not exchangeable alternatives to studying a national system of innovation, but each level of analysis has important contributions of their own. As this study intends to explore the relevance of national context, as a point of departure we limit the scope of this study to Sweden. However, this does not underestimate the importance of cross-national comparative studies. This study can nevertheless pave the way for further cross-national studies.

3.2.2 Source Material

As this study is a mapping of actors and their functions and activities, the data source needs to reflect this. The chosen main data for this study is official communication from companies, which takes the form of corporate documents from the companies in this study, as well as documents from the other actors they partner with. This is in the form of excerpts from their annual and sustainability reporting, as well as press releases about the AI products and projects they are working on. In addition, corporate blog posts and other website information from the official company websites is included in the main data used for this study. Publicly avaliable interviews with responsible individuals at the included companies and their partner organizations is also used to expand upon and support what is said in the official communication. The dataset containing this information was collected in the period March – May in 2021.

The empirical material was collected through a systematic search of company reporting, their websites and press releases. Key terms such as: AI, ML, Artificial Intelligence and Machine Learning were used to search through recent annual and sustainability reports and the company websites. In addition to this, the key terms were used to search the wide internet in relation to the company name, in order to find mentions of collaborations, in the websites and press releases of other collaborators in those projects, as well as publicly avaliable interviews with relevant representatives. There was no specified time limit to the documents that were included in the sample for this study, instead any activities and collaborations that had been undertaken in the field of AI were included. This as AI is an emerging technology which the companies are not expected to have been working with for a very long time. In addition, any efforts and collaborations, including early ones could be relevant to explain the current state of the innovation system.

This data collection process continued until all companies had been covered to an extent, and a saturation point was reached, both for the entire innovation system, but also for each individual case, and thereby company. Faulkner and Trotter (2017) note that saturation in qualitative research is an ambiguous concept, and that it can be hard to identify exactly when the point has been reached, but that it happens when there are no new themes, nor information observed from the data. Considering this, the data collection for this study continued until all the specified data sources appeared to be exhausted and fully covered.

3.2.3 Reliability and validity

Reliability in research generally refers to the repeatability of a study, the ability to follow the methodology and data sources to arrive at similar conclusions in a repeated study, essentially meaning that there are no accidental circumstances in the study (Kirk & Miller, 1986). Meanwhile, the related concept of validity refers to the accuracy of the findings, how true they are to reality. Yin (2003) notes that these have to be examined and considered in order to ensure the quality of any social research.

Creswell and Creswell (2018) suggest that validity in qualitative research can be approached by using a variety of different strategies to ensure that it is valid. One of the strategies they suggest triangulation between data sources. While this research uses one type of data, corporate documents, there is a wide variety of sources that these documents have been collected from. In addition, the validity should be strengthened by the reliance on published information, directly from the companies that are being studied is that the statements should be highly accurate. This as the type of documents are intended as true communications of the companies' actions and intentions. While one might believe that there is a risk that a company will attempt to portray their technological progress in a particularly positive light, the issue of honesty in managerial reporting has been extensively studied. Generally, it is understood that companies and their representatives have more to gain from reporting honestly, although this can be impacted by a variety of factors and is not confirmed for this particular context (Evans, Hannan, Krishnan, & Moser, 2001; Hannan, Rankin & Towry, 2006). Triangulation could have continued further through the inclusion of other types of data such as interviews. However, conducting interviews directly with stakeholders as part of this study was decided against given the restricted time, assumed limited access to valuable individuals, and limited value it was expected to have to this study. While it may have been possible to gain access to some individuals at the included companies, it was deemed unlikely that access to decision makers at the companies would be possible. As such, it is expected that interviews would only serve to triangulate the data from the examined documents, and while this would be valuable to validate findings, it was decided against given the limited time and resources of this study as they were not expected to add more depth to the data.

Creswell and Creswell (2018) further suggest that presenting contradictory evidence that does not neccesarily match the themes is a strategy to support the validity of the study. Given the structure of the analysis in section four, contradictory themes that have emerged in the research should be clearly identifiable. In particular, the summary table clearly presents actors who lack activities in certain themes. This serves a valuable part in the in the cross-case synthesis.

Regarding reliability, Yin (2003) suggests documenting the procedures of the case study in extensive detail. In addition to this, Creswell and Creswell (2018) suggest that it is examined that the analytical definitions, codes used in the analysis remain constant and equally applied across the dataset. For this thesis, the methodology and steps taken for analysis are described with an appropriate level of detail. In addition, the analytical definitions are kept simple, so which reduces the risk of misinterpretation and improper application.

4 Findings

4.1 Identification of AI Activities

The mapping of activities and functions in the innovation system is presented first with a very brief introduction to the state of the whole innovation system. This is followed by a detailed examination of the ten included incumbents, including their internal work. This is followed by an overview through the form of a summary table of the activities the incumbents have together with other actors. This is followed by a discussion that reflects on the innovation system as a whole, as well as how can it be understood and analysed through relevant literature and the theoretical framework.

4.2 Analysis of the data

All the companies included in this study are utilizing AI in their business, either internally to support their ongoing development and organizational work, or as part of a product they offer to their customers. Moreover, all companies take part in some form of multi-stakeholder projects or collaborations where they play a part in AI development together with another actor. The roles that the different companies take in the collaborations gives some insight into their role in the innovation system. Some serve as a technical partner that is responsible for the intelligence aspects of AI, some provide the data that can be leveraged together with another party, while some simply invest financially, or acquire other actors to expand their AI business. The main activities that the companies undertake are presented in the summary table at the end of section 4.3. This allows for an overview of how the company engages with AI together with other actors but does not include their wholly internal AI projects which are expanded upon before, in the case details.

4.3 Case details

4.3.1 ABB

ABB is a Swiss-Swedish industrial company with roots in the Swedish company ASEA which was founded in 1883 as a producer of electrical system equipment (ABB, n.d.a). As an industrial company, ABB is primarily looking at AI to improve the industrial processes they design and work with, for themselves and their customers. In this pursuit, they have internal projects, they help launch and finance start-ups in the field, as well as enter collaborations with other large corporate actors.

They have three separate programmes to interact with start-ups in their field, both internationally, in Europe and in Sweden specifically. Firstly, a venture capital programme, the ABB Technology Ventures which focuses on several 4th industrial revolution technologies, including AI (ABB, n.d.b). They also have the European ABB Industrial AI Accelerator, where together with a Berlin based start-up accelerator, they select AI start-ups to help speed up the development of their innovations (Lietha, 2019). They also have a Swedish specific start-up accelerator, Synerleap (SynerLeap, 2016). It is created by ABB and partners with the government organization RISE - Research Institutes of Sweden, as well as Vinnova, the governmental agency which administers funding for research and development, a local university, in addition to the local and regional government from where the accelerator is located. In these interactions, ABB is leveraging its financial resources and knowledge to engage with start-ups that work with new innovative technologies that complement ABB's business. In the Swedish accelerator Synerleap they also connect with governmental actors to provide additional strategic support to the start-ups, which is in ABB's best interest as an investor in them.

ABB is also working with other large, international companies such as Microsoft. With them, they integrate data collected by sensors from ABB industrial equipment into a cloud infrastructure driven by Microsoft, so that it can analysed in a broader context, and AI can be used for predictive maintenance. When speaking of this partnership, ABB's VP of Digital R&D said "why build our own when we can rely on the Microsoft cloud" (Microsoft, n.d., para.9). In their relationships with other large tech companies, ABB appear to have a similar relationship, as in their partnerships with both IBM and Hewlett Packard Enterprises, the partner provides AI driven solutions to analyse data from ABB's sensors.

4.3.2 AstraZeneca

AstraZeneca has its roots in the Swedish pharmaceutical company Astra AB which was founded in 1913 and merged with British Zeneca in 1999 to form the global pharmaceutical company it is today (Pettersson, 2002). They primarily leverage AI in order to improve their product development processes, something they are pursuing through internal work, as well as partnering with a variety of different actors, both in Sweden and internationally.

In Sweden, AstraZeneca runs an internal facility called iLab, where they leverage AI and machine learning to improve their internal development processes (AstraZeneca, n.d.). Additionally, they are partnered with AI Sweden, an organization funded by the government agency Vinnova to accelerate AI development in Sweden by running projects that target strategic issues, as well as helping to provide computing power and datasets (Holmén & Bendtsen, 2019). Through this collaboration, AstraZeneca is one of three partners that has made a dataset publicly avaliable to other partners. In addition, this, they rotate their PhD and postdoctoral researchers with AI Sweden to have them interact with research from other backgrounds. In Canada, they work with Mila, a similar initiative where they will leverage Machine learning expertise from The Quebec AI Institute together with AstraZeneca's AI and medicine knowledge to better use AI to understand disease and medicine development (Mila, 2021). In addition, AstraZeneca is part of several international academic partnerships that are also centred around using AI for medicine discovery and development, including MLPDS where they partner with MIT in Massachusetts, as well as the Cambridge Centre for AI in Medicine, where they partner with the University of Cambridge and pharmaceutical company GSK (MLDPS, n.d.; O'Neill, 2020). This is a wide range of partnerships in Sweden and abroad where AstraZeneca can share their expertise together with other actors that have different kinds of area specific knowledge.

Internationally, AstraZeneca also partners with a variety of large technology companies that provide AI driven solutions that help with their endeavours, including Nvidia, Amazon AWS, Schrödinger, Benevolent AI, and Deepmatter. In all these collaborations, AstraZeneca provides data and topic specific expertise, while their technical partners assist with the neccesary technical expertise, computing resources and other aspects of AI infrastructure.

Beyond this, AstraZeneca is part of the large European MELLODDY project, a project for AI drug discovery between 10 pharmaceutical companies, 2 universities, 4 subject matter experts and a large AI computing company, Nvidia, which aims to use data from multiple partners to better train a model, without requiring the partners to give data access to each other (MELLODDY, n.d.). This is a public-private partnership, funded by the European Union.

4.3.3 Electrolux

Electrolux was founded as an vacuum cleaner manufacturer in 1919, and grew into a manufacturer of all types of appliances through mergers and acquisitions (Erixon, 1996). Electrolux's focus in their AI work is to integrate AI into their appliances, to make them smarter and more easily controllable. Electrolux has integrated with Google's existing voice control services to help make their appliances smart (Electrolux Group, n.d.). Additionally, Electrolux has a partnership with IBM, who provides an AI driven weather forecasting service that integrates into Electrolux's appliances. In both relationships with a global technology company, Electrolux is acquiring and integrating into their existing AI driven solutions.

Electrolux is attempting to engage with start-ups that leverage AI to make appliances easier to operate through the Electrolux Innovation Factory, a physical space and start-up accelerator located in Italy. It is targeting smart appliances and is meant to share Electrolux resources to the start-ups and to facilitate collaborative experimentation and innovation (Electrolux Group, n.d.). However, it does not specifically work with AI, or have any AI oriented projects currently.

While their work with AI is somewhat sparse, Electrolux recognizes the value of data that can be collected through the large number of appliances they produce and they have been recruiting data scientists to understand how it can create value for them and their customers (Electrolux Group, 2017).

4.3.4 Ericsson

Ericsson is a telecom equipment company founded in 1876, which has transitioned into working with all the software and hardware that is neccesary in the backend to keep our connected society connected (Ericsson, 2020). As a company with IT services at the core of many of their products, it is unsurprising to see that Ericsson has a wide range of AI initiatives, both internally and with other actors and networks in Sweden and globally. Their in-house activity helps them develop their product portfolio and they claim to be including AI in every part of their portfolio where it makes sense (Ericsson, 2021b).

Ericsson serves as a technical partner in a Swedish collaboration with Telia, a telecom provider, Chalmers University and Sahlgrenska University Hospital to leverage AI to improve COVID-19 pandemic response (Ericsson, 2021a). In this collaboration, Telia provides network data for analysis, Ericsson provides experience in with AI and telecom networks, and the other actors help contextualize the insights that can be found from the analysis to the reality of a pandemic and the impact it may have on society. Additionally, Ericsson is involved in one of Sweden's largest AI projects, WASP (WASP, n.d.b). It is an expansive project which includes academic research and funding and connecting different actors to work on projects together, in labs run directly by WASP. Ericsson's involvement in WASP comes in a variety of ways, from representation in management, to Ericsson running one of the research centres. In addition to this, Ericsson is a part of the AI Sweden Edge Lab, a physical lab where research into Edge AI is conducted, together with Volvo and other partners (AI Sweden, 2021). In these partnerships Ericsson engages with a variety of academic and corporate actors and provides both direct technical knowhow as well as managerial insight which Ericsson can bring, having worked with research and development in high-tech industries for most of its history.

Ericsson recognizes the importance of data, and the impact it can have on actor relations, as was suggested by Yu, Liang and Wu (2021). They recognize that their access to datasets from their clients and collaborators allow them to better train their algorithms, which in turn benefits all their clients, and their end users (Ericsson, n.d.). This, together with the role that Ericsson plays in their partnerships make it clear that they take a commanding role in AI innovation, as they both hold technical and managerial expertise, have access to large amounts of data and have access to other neccesary resources for AI innovation.

4.3.5 H&M

H&M was founded with a single clothing store in Sweden in 1947, and has since grown into a global fashion company with a variety of brands and stores all across the world (H&M Group, n.d.). Today, they work to include AI in much their work, from a tool to decision making, to being able to leverage it for improving their logistics. They accomplish this with an internal team that develops AI, as well as through collaborations, and investments in other companies.

The internal team is called H&MxAi, and they work with all kinds of internal data analytics. They work with the incredibly large set of data that H&M has which they can leverage for decision making across their entire value chain, from quantifying fashion, making sure that it reaches the right places, to making it personalized to every customer (H&M Group, 2019b).

H&M is a part of the European AI Alliance, a multi-stakeholder forum by the European Commission that works with stakeholder driven policy making on the topic of AI. This corresponds well with an emphasis on responsible AI that the head of H&M's AI policy has stressed (H&M Group, 2019a). H&MxAi is also a partner to the Data Innovation Summit, a large AI focused conference.

H&M has engaged with start-ups through venture capital investments, Thread and ZysMe that both leverage AI for fashion, through clothing recommendations or for tailor made measurements (Conlon, 2018; Zha, 2019). Here H&M provides financial resources to the start-ups, as well as an arena for their products to be tested and potentially leveraged for H&M's goals.

4.3.6 Husqvarna

While originally founded in 1689 as a rifle manufacturer, Husqvarna eventually transitioned into sewing machines and bikes before starting to work with the lawn mowers and chainsaws they are currently known for in the early 1900s (Husqvarna Group, n.d.a). Husqvarna organizes a variety of projects where they engage with AI and digitalization, through internal development, start-up accelerating, venture capital, and partnerships with other actors. They run an innovation lab in Sweden, where they attempt to further integrate AI into more of their products.

In partnership with THING Stockholm innovation hub, Husqvarna organizes the Sustainovate Open, which is an innovation competition for start-ups, where they share resources and interact (Husqvarna Group, n.d.b). It is not exclusive to AI technologies, but one of the finalists in 2020, Ekkono uses machine learning to optimize connected products. In addition to this, Husqvarna has invested in several AI driven start-ups, that use data for better gardening through venture capital investments. In these projects, Husqvarna leverages its resources, both financial and others to help accelerate AI development in its field. By partnering with an innovation hub, they can leverage their own network, as well as the network and resources of the innovation hub, such as connections to academia or other firms that also work with the innovation hub.

Through a partnership with Telenor, Husqvarna was able to offer a connected equipment rental service, which used Telenor's IoT Cloud services, which enabled Husqvarna to expand their product offerings (Telenor Connexion, 2018). Here, Husqvarna was able to add on an existing AI powered technology to improve their offerings to customers.

4.3.7 Ikea and Ingka Group

Ikea was first established as a furniture company in 1943, which has since expanded globally through selling, flat-packed, self-assembled furniture (IKEA, n.d.). They are part of the Ingka group which operates most Ikea stores worldwide, controls the Ikea brand and does venture capital investments (Ingka Group, n.d.). Ikea and the whole Ingka Group has a range of different AI related projects, where they apply AI to help their customers, their product development, as well as their sustainability goals. They acquired the start-up Geomagical Labs and are having it continue to work independently within the organization, it works with AI powered 3D technology, that lets customers visualize products in their homes (Ingka Group, 2020). Similarly, Ingka Investments has invested in Winnow, a company using AI to track and reduce food waste in commercial kitchens. Additionally, Ikea has a partnership with the company Optoro, which uses AI to direct product returns in the most efficient manner. In all these projects, Ikea is using its financial resources to acquire and invest in AI solutions that may be strategically important for them.

Ikea runs an independent research and design lab, Space10 which works with human centred design. As a part of this, they have been researching how to design human centred AI, that works in the ways regular people want (Space10, n.d.). This follows from what the Chief Digital Officer of Ingka Group shared in an interview, that they want to ensure that people are comfortable with the ways their products records, stores, and uses data (Gale, 2021). This work is strategic rather than focused on incorporating AI into their core business but may help Ikea with their future AI work.

4.3.8 Saab

SAAB is a Swedish company that was founded in 1937 to develop and manufacture combat aircraft, since then they have been heavily involved in a variety of defence manufacturing, as well as civilian aircraft (SAAB, n.d.). Saab works to include AI in some of their products, in order to keep them future proof and relevant for their clients. Beyond this, they partner with a variety of industry actors, universities and other institutions in order to further ai in their strategic areas.

Saab is involved in several Swedish collaborative projects where they interact with academia and industry actors for AI development. Particularly through long running collaborations with WASP and Linköping University. One of these projects is a physical research arena for autonomous systems where thy also partner with the Swedish technical consultants Combitech in addition to WASP and Linköping University (Combitech, n.d.). They dedicate several of their PhD researchers and other engineers to this project which allows researchers from all organizations to interact and create new knowledge. Together with Linköping University, Saab has had other research projects for a long time and has formally added AI as a topic to that pre-existing collaboration (Nilsen, 2017). They are also part of the Combient industry collaboration network, that is set out to expand AI on an industrial scale (Combient, n.d.). There, Saab’s Chief Strategy Officer is represented on the board of directors, and Combient facilitates collaborations through sharing assets and providing formal links between companies and universities.

Internationally, Saab also has university collaborations, such as with NTU in Singapore, which Saab has established a joint research centre with on topics that are close to Saab's focus (SAAB, 2017).

4.3.9 Scania

Scania started out as a car manufacturer in 1891 but ever since the early 20th century they have been working with buses and heavy trucks, and was doing this as they merged with SAAB between 1969 and 1995 (Erixon, 1996; Scania, 2021). Today, Scania works with a variety of AI projects, both internally and as collaborations with other companies, universities and more to improve their products on issues like autonomous driving as well as their product development processes.

Scania engages with start-ups through their internal venture capital fund, Scania Growth Capital (Scania AB, 2020). Through them they have invested in start-ups that work towards the goals they have in their Smart Engineering Lab and Smart Factory Labs which is where they conduct in-house digital research and development into how AI can improve their production and engineering processes. For example, they have invested venture capital into AKOA, a company working with AI for business process automation which aligns with the work in their internal labs.

Like several other incumbents in this study, they are a partner to AI Sweden, where they collaborate to share their resources and experiences with other partners. It gives Scania access to resources like the AI Sweden Data Factory, where they can conduct testing and explore new solutions, without having to set up their own testing environment (Scania, 2021). Here they are also able to collaborate with other firms who are working on the same issues, using the same resources that AI Sweden can provide.

Scania is a part of a project named FAMOUS financed by VINNOVA, together with University of Linköping and the start-up Crosser, where they investigate scaling AI and Machine learning solutions to a large fleet of vehicles (Vinnova, 2020b). In this collaboration they can leverage VINNOVA funds to have dedicated researchers and engineers between all three organizations to work on the project, sharing their knowledge and expertise on the topic.

To improve their communications, both internally and externally Scania is working with Artificial Solutions, a company that works with conversational AI and makes chat-bots and has licensed one of their products for this (Artificial Solutions, 2019). Here, Artificial Solutions simply provides an off the shelf, AI driven product to Scania.

4.3.10 Volvo

Volvo Group was founded in 1927 and has since produced cars and other vehicles, and continues to develop trucks and buses in Sweden to this day (Volvo, n.d.). They have a range of different partnerships in Sweden and abroad with both universities and other firms. Their work with AI is mainly centred around self-driving vehicles and leveraging AI for that, but also extends to other areas of their business. They appear cognizant of the impact that AI may have on their business in the long run, as courses on AI is included in their employee training programme.

Internally, Volvo is working with leveraging AI in projects ranging from a start-up accelerator that targets financial services including AI driven solutions (Volvo, 2019). In addition, they work with AI driven mobility at their Innovation Lab in Silicon Valley, and through the MobilityXlab partnership, where Ericsson provides connectivity solutions (MobilityXlab, n.d.). These different applications of AI help indicate that they use work to apply AI across different aspects of their business, which emphasizes the role of AI as a general-purpose technology.

Volvo, like AstraZeneca is a partner to AI Sweden. They are one of the three partners that provide a dataset to other partners in AI Sweden. In addition, they are a partner in the AI Sweden Edge Lab, a lab where together with Ericsson and other actors they can research the topic of Edge AI (AI Sweden, 2021). In these partnerships, Volvo provides data and other resources to these collaborative efforts where they engage with universities and other firms. At the same time, they get better access to research that is more tailored to their individual needs.

Internationally, Volvo partners with Nvidia for AI computing. Their relationship is focused on decision making systems for autonomous vehicles, where Nvidia provides a full stack software solution, and Volvo is essentially a client of theirs (Volvo Group, 2019). There is a similar dynamic in North America where Volvo partners with SAS to connect their existing vehicle analytics and diagnostics solution to the cloud, where the AI driven solution can help reduce the time needed for repairs and diagnostics (Volvo Group, 2018).

Table 1 Summary Table of Cases

Incumbent Company	Resources & Data sources	Networks: WASP / AI Sweden / Others	University partnership	International partnership	Internal support to start-ups
ABB	Internal	None: only internal projects for Start-up support	None	Large international Tech partners: IBM, HPE - Hewlett Packard Enterprise & Microsoft	Swedish internal Accelerator Synerleap and European Industrial AI Accelerator and internal tech venture capital ATV
AstraZeneca	Internal resources, Vinnova, EU financing	AI Sweden: Provides data & shares researchers MILA in Quebec: shared resources	Cambridge Centre for AI in Medicine	MELLODDY consortium MLDPS consortium Partners providing tech insight and solutions: Amazon, Nvidia, Deepmatter, Schrödinger, BenevolentAI	None
Electrolux	Internal	None	None	Integrating with Google & IBM for smarter appliance control	Electrolux Innovation Factory: Start-up Accelerator but not specifically AI focused
Ericsson	Internal, data from internal operations and others	Has established a WASP research facility	Chalmers / Sahlgrenska for COVID RISElab UC Berkley	Joint AI lab with China Unicom for the Chinese market	AI Accelerator in Montreal
H&M	Internal	None	None	European Commission Stakeholder forum on responsible AI Partner to the Data Innovation Summit	Made direct investments in two AI driven clothing start-ups

Incumbent Company	Resources & Data sources	Networks: WASP / AI Sweden / Others	University partnership	International partnership	Internal support to start-ups
Husqvarna	Internal	None	None	Partner with Telenor IoT cloud for a connected service	Sustainovate Open: Innovation competition together with innovation hub in Stockholm Venture capital into two AI startups
IKEA/Ingka	Internal, data from Geomagical Labs	None	None	Not strictly AI related partnership with Google to scale ecommerce during the pandemic	Acquired Geomagical Labs for AI imaging technology VC Investments into two AI driven Sustainability startups
SAAB	Internal, Wasp	WASP core member: board representation, joint research projects, shared researchers Combient: Wasp related collaboration network	Linköping university: Long partnership, AI one of several themes NTU Singapore	NTU Singapore: Joint research centre – unclear AI focus	None
Scania	Internal, Vinnova	AI Sweden: leveraging resources such as the AI Sweden Data Factory	Linköping University: Partnership regarding a project with another firm	Licencing AI Chatbot solution from Artificial Solutions	None
Volvo	Internal	AI Sweden: providing data, partner for Edge AI Lab MobilityXlab: mobility research with Ericsson & others	NTU Singapore: AI driven Autonomous vehicle research	SAS North America: AI driven remote vehicle diagnostics	Volvo Financial Services supports AI driven startups through programme iLabX

4.5 Cross case analysis and comparison

4.5.1 Incumbent actors and their innovative activities

All the incumbent actors in this study have to some extent engaged with AI innovation to improve their business or their products. Most, but not all actors seem to be undertaking considerable amounts of internal research and development in their work with AI. H&M and Ikea who both produce non-technical consumer goods, works almost exclusively through their internal teams in order to develop AI and data science capabilities, they only engage with other firms or start-ups through capital investments. While they are taking risks and engage in research and development, they appear do so largely in a vacuum and not in interactive or collaborative efforts with other firms or universities. This becomes even more apparent as Geomagical Labs, which after being acquired by Ikea was kept as a separate, autonomous unit in the organization. Similarly, the investments by H&M are venture capital investments into two start-ups.

As an alternate model, Electrolux which also produces consumer goods appears to have little to no internal development work that is specifically centred around AI, but they have integrated into pre-existing AI driven solutions that were developed by the global technology firms Google and IBM. They have a start-up accelerator, but it does not specifically work with AI. Here it becomes clear that by simply licencing external, pre-existing products they take very little risk thereby do very little to innovate. Other actors may also licence pre-existing solutions from a provider, such as Volvo who has a full stack AI software solution from Nvidia. The difference here is that Volvo also engages in other internal AI development work, on their own and in collaboration with other actors, and thereby actively innovate and take risk, unlike Electrolux.

4.5.2 The role of resources in innovation

While most of the incumbent companies are mainly reliant on internal financial resources, it becomes apparent that this is not neccesarily the case for the majority of AI projects. This as the technology-oriented actors with a wide selection of different AI projects such as Scania, AstraZeneca and ABB all receive external funding for some of their projects. This follows from what Lindgaard Christensen (1992) suggested regarding funding of technology intensive research, that even while large actors may be able to finance it internally, they may also be looking for external funding given the high demands of keeping up with high-tech research. Meanwhile, the organizations who appear to be less involved with AI for most of their business, such as H&M and Ikea rely entirely on internal funding for the AI endeavours they have and research they undertake.

Regarding data as a resource, it can be very clear who provides data and how the relationship looks when these incumbent actors partner with a large technology provider as many of the included incumbents have done. In those cases, such as both Volvo and AstraZeneca's partnerships with Nvidia, the incumbent actor in this study provides the data and acquires assistance for analysing and managing it. As such Nvidia serves as the infrastructure provider according to the AI value chain classification by Yu, Liang and Wu (2021), with both AstraZeneca, Volvo and their potential clients serving as the application users.

Several actors in this mapping make it very clear that they hold data that is valuable for others to use and utilize. Both AstraZeneca and Volvo provide open datasets for others to use as part of their collaborations with AI Sweden. This is not a strict hierarchical, monetary exchange, but instead it is closer to an organized market, as suggested by Lundvall (1999). Volvo and AstraZeneca benefit from this as AI Sweden attracts new partners and resources which they may be able to leverage going forward, and other partners may see immense value in access to these datasets in order to develop their AI driven innovations.

In collaborative research efforts it may be more unclear what actor provides what resources unless it is explicitly stated. For example, the project that involved Scania, Crosser and Linköping University. They all provide expertise and knowledge, and we can assume that the neccesary data will come from Scania as they should hold plenty of valuable data resources, but it is not abundantly clear. However, in Ericsson's partnership regarding COVID-19 pandemic response, they are clearly identified as the technology partner, where other actors provide the data and social context. Telia which provides the data in that collaboration is also a large corporate actor, and there would not be the same risk of imbalance from a complementary resource to an innovation as Teece (1986) suggested. In fact, when these companies are working with small start-ups it appears to happen largely though innovation networks and innovation facilitators. As such, the risk of imbalance that Teece (1986) stressed may not apply in these cases, as there is a moderating factor in form of the accelerator or network that is meant to support the start-ups.

The MELLODDY project that AstraZeneca is part of further suggests that the issue of complementary resources to an innovation does not always have to be a problem in AI innovation, if there is external infrastructure to facilitate a different kind of relationship and data sharing. This as it is possible for many corporate actors to allow their data to be used to train the same model, without giving out valuable access to the specifics of their dataset. Here, the European Union as a governmental actor provides the funding and enables the trust and helps organize the relationship between the actors, to allow them to collaborate in their mutual best interest, which given the secrecy of data may not have been possible otherwise.

4.5.3 Role of innovation networks and infrastructures

A more common facilitator of relationships in this innovation system comes in the forms of innovation networks and other innovation infrastructure. Half of the incumbents are partners in either WASP or AI Sweden which both work to help the incumbents share their knowledge and expertise. Both networks help facilitate collaborations where the incumbent actors can receive direct inputs from academia. Saab receives direct inputs as they rotate their PhD researchers with WASP, just how AstraZeneca contributes their PhDs to AI Sweden. This allows the researchers to both use physical labs that they may not have the internal resources to set up, in addition to giving them opportunities to collaborate with researchers from other organizations to further their research and the innovation process. These partnerships through intermediary actors could help explain why there are no direct relationships between an incumbent and a university apart from the one between Saab and Linköping University. Because while the connections are important are important to the incumbents for access new research and important for the universities to access data, the two parties are able to satisfy their needs through the innovation networks.

While these two networks may appear to play a similar role, but they differ in the aspect of resources. WASP is primarily privately funded by a foundation from the Wallenberg family which has strong ownership links to Swedish industry, and they set up WASP in order to support strategic goals (WASP, n.d.c). Meanwhile, AI Sweden is primarily funded by the governmental agency Vinnova (AI Sweden, 2020a). This difference becomes more apparent when examining the projects that are facilitated through these networks, where it is unclear who provides what resources in the projects that are facilitated by WASP. Meanwhile, many collaborations that include AI Sweden have a clear financial backing from Vinnova, and thereby the Swedish government.

The final variety of innovation infrastructure that appears relevant in this system is the company organized start-up accelerators. They serve to connect the incumbent actors who hold resources such as knowledge and funding with start-ups who may have novel ideas and skills and need the organizational and financial resources of bigger firms. Husqvarna partnered with THING Stockholm to organize their incubator, which helps them leverage the other knowledge and resources that THING Stockholm has that can specifically help start-ups. ABB on the other hand organizes two separate incubators internally, and their Swedish accelerator Synerleap is partnered with several other actors including Vinnova. This indicates that despite being internal projects to engage with start-ups, the incumbents take these opportunities to also connect with other innovation support structures in the innovation system.

By examining all the collaborative efforts and interactions that the incumbent actors have it becomes clear that their connections to start-ups are relegated only to innovation infrastructures. For the direct firm-to-firm relationships that the incumbents have on the topic of AI are with other large, global companies. Meanwhile, all incumbent relationships to start-ups are facilitated by this type of innovation infrastructure such as AI Sweden, WASP or through an accelerator programme.

These activities indicate that the innovation system is well developed. Following from the insight by Meyer and Kuusi (2004) that an emerging innovation goes through a bootlegging and bandwagon stage. We see here that funding and resources comes from a variety of actors, both firms and others. In addition, there is a wide range of different types of actors involved in this innovation system, which further supports the notion that the innovation system should be relatively mature.

4.5.4 Role of government in AI innovation

The incumbent actors in this study appear to have few direct connections to governmental actors in their own work. However, governmental actors appear more relevant in projects that involve multiple parties including start-ups. Both ABB and Scania have projects and partnerships where start-ups are involved that are supported by Vinnova. As such, it appears as if governmental impact on this innovation system appears to be more relevant for start-ups than it is for the incumbent actors that can largely self-finance their research and it is hard to gauge to what extent the government sets the pace of innovation or potentially restrains it in this study of incumbents, which Gregersen (1992) suggested would be happening. However, considering the proposed legislation by the European Union that restricts what types of AI work is permissible or not is enacted which may have requirements for transparency, the government may play a more impactful role that steers development in the future (MacCarthy & Propp, 2021).

5 Conclusion

5.1 Research aims and objectives

This thesis set out to provide insight into the current state of AI innovation in Sweden, the types of projects and endeavours which characterize it, and what types of relationships between actors are the most prominent in this innovation system.

The Swedish AI innovation system appears to be well developed as it is characterized by a wide variety of actors that are strongly involved in its development in a variety of different ways. The incumbent actors that are at the centre of this study all engage with AI to improve their work or their products, and most of them engage directly in development, internally as well in relation to other actors. All incumbent actors all work with AI together with other firms, large and/or small ones. These relationships range from direct customer relationships and venture capital investments to long running AI development partnerships with other firms. It has become quite clear that innovation infrastructures such as start-up accelerators and innovation networks play a crucial part in facilitating connections between incumbent actors and any actor that is not of a comparable size. Similarly, these infrastructures play an important part in connecting incumbent actors with academia, as direct links between the two are rare, but still exist. This study has shown that the innovation system is active in a diverse range of ways, with a range of actors innovating on their own and in collaboration with many others which indicates that the innovation system is strong and well developed.

5.2 Limitations

There is a variety of methodological limitations to this study which may have had an impact on the findings, and the ability of this study to yield an insight into the Swedish AI innovation system. Firstly, the choice to restrict the data sources to published company communications, while being reliable limits the ability to attain further details on the activities and relationships between actors. Interviews with key individuals would have allowed targeted questions that not only provide additional information on the state of the innovation system but can focus specifically on the case topic and causal inference, which would help explain with more detail why the innovation system is in its current state.

Secondly, this selected case involves incumbent actors from a variety of sectors, while this approach enables insight into different areas of the Swedish AI innovation system, it may have been possible to yield additional insights by focusing on actors where AI is part of their core business. This approach was used in the previously mentioned studies on the Chinese AI innovation system and can provide a more specific understanding into how AI focused businesses are innovating and being impacted by factors of the innovation system.

5.3 Future research

The particularities of AI innovation systems around the world remain understudied. The mentioned studies of China's AI innovation system uncovered several particularities in innovations in this sector that deserves further examination, in Sweden and globally. While this mapping indicates that much of what was observed by Yu, Liang and Wu (2021) in regards to how relationships are shaped by data holds in Sweden, it would be of interest to study this in more detail, as Sweden has a different legislative landscape which may impact who holds and has access to data.

As mentioned in the limitations of this study it is recommended that there is additional research of Sweden's AI innovation system which looks specifically from the starting point companies where AI is part of their main business. This would serve as a good compliment to this study to provide a fuller picture of the state of Swedish AI innovation, how it is funded and what types of relationships exist between actors. In addition, a study on this topic should examine companies of various sizes, ranging from large to small in order to better gauge how AI innovation takes place.

5.4 Practical implications

This research has helped shine a light on how innovation happens in Sweden's innovation system that supports the emerging technology AI. As such, this research can be of assistance to stakeholders in the innovation system who may wish to support it. This includes innovation networks such as AI Sweden and WASP, as well as the financiers behind these networks. Furthermore, this study has helped further signify the importance of collaborative efforts in AI innovation specifically. As such, it can provide guidance to those who wish to further study the state of innovation in a quantitative manner, as this study has highlighted some particularities of AI innovation.

References

ABB. (n.d.a). History of ABB, *ABB Group*, Available Online: https://global.abb/group/en/about/history [Accessed 24 May 2021].

ABB. (n.d.b). ABB Technology Ventures (ATV), *ABB Group*, Available Online: https://global.abb/group/en/technology/ventures [Accessed 27 May 2021].

Adner, R. & Levinthal, D. A. (2002). The Emergence of Emerging Technologies, *California Management Review*, vol. 45, no. 1, pp.50–66.

Agrawal, A., McHale, J. & Oettl, A. (2019). 5. Finding Needles in Haystacks: Artificial Intelligence and Recombinant Growth, in A. Agrawal, J. Gans, & A. Goldfarb (eds), , [e-book] University of Chicago Press, pp.149–174, Available Online: https://doi.org/10.7208/9780226613475-007.

AI Sweden. (2020a). About AI Sweden, *AI Sweden*, Available Online: https://www.ai.se/en/about-0 [Accessed 24 May 2021].

AI Sweden. (2020b). Partners, *AI Sweden*, Available Online: https://www.ai.se/en/partners-9 [Accessed 27 May 2021].

AI Sweden. (2021). Edge Lab, *AI Sweden*, Available Online: https://www.ai.se/en/data-factory/edge-lab [Accessed 27 May 2021].

Alkemade, F., Kleinschmidt, C. & Hekkert, M. (2007). Analysing Emerging Innovation Systems: A Functions Approach to Foresight, *International Journal of Foresight and Innovation Policy*, vol. 3, no. 2, pp.139–168.

Andersson, M., Anokhin, S., Autio, E., Ejermo, O., Lavesson, N., Lööf, H., Savin, M., Wincent, J. & Ylinenpää, H. (2013). Det Innovativa Sverige: Sverige Som Kunskapsnation i En Internationell Kontext, [e-book] Stockholm, Sweden: ESBRI - Entrepreneurship and Small Business Research Institut, Available Online: https://harisportal.hanken.fi/en/publications/det-innovativa-sverige-sverige-som-kunskapsnation-i-en-internatio [Accessed 10 May 2021].

Antonelli, C. (2009). The Economics of Innovation: From the Classical Legacies to the Economics of Complexity, *Economics of Innovation and New Technology*, vol. 18, no. 7, pp.611–646.

Arenal, A., Armuña, C., Feijoo, C., Ramos, S., Xu, Z. & Moreno, A. (2020). Innovation Ecosystems Theory Revisited: The Case of Artificial Intelligence in China, *Telecommunications Policy*, vol. 44, no. 6, p.101960.

Arpteg, A. (2018). Can Sweden Keep up with AI Investments around the World?, *Peltarion*, Available Online: https://peltarion.com/blog/data-science/can-sweden-keep-up-with-ai-investments-around-the-world [Accessed 9 May 2021].

Artificial Solutions. (2019). Artificial Solutions to Steer Conversational AI Applications for Scania, *Conversational AI Platform for Enterprise - Teneo | Artificial Solutions*, Available Online: https://www.artificial-solutions.com/blog/artificial-solutions-to-steer-conversational-ai-applications-for-scania [Accessed 25 May 2021].

Ashford, N. A. & Hall, R. P. (2011). The Importance of Regulation-Induced Innovation for Sustainable Development, 1, *Sustainability*, vol. 3, no. 1, pp.270–292.

AstraZeneca. (n.d.). The AstraZeneca ILab, Available Online: https://www.astrazeneca.com/r-d/our-technologies/ilab.html [Accessed 27 May 2021].

Billing, M. (2019). One of Sweden's Richest Families Is Investing Its Billions into AI, *Sifted*, Available Online: https://sifted.eu/articles/marcus-wallenberg-ai/ [Accessed 27 May 2021].

Brock, J. K.-U. & von Wangenheim, F. (2019). Demystifying AI: What Digital Transformation Leaders Can Teach You about Realistic Artificial Intelligence, *California Management Review*, vol. 61, no. 4, pp.110–134.

Brynjolfsson, E. & McAfee, A. (2017). The Business of Artificial Intelligence, *Harvard Business Review*, Available Online: https://hbr.org/2017/07/the-business-of-artificial-intelligence [Accessed 2 January 2021].

Buchanan, B. G. (2005). A (Very) Brief History of Artificial Intelligence, 4, *AI Magazine*, vol. 26, no. 4, pp.53–53.

Chaminade, C., Lundvall, B.-Å. & Haneef, S. (2018). Advanced Introduction to National Innovation Systems, Cheltenham, UK: Edward Elgar Publishing.

Combient. (n.d.). About Us | Combient, Available Online: https://www.combient.comabout-us [Accessed 27 May 2021].

Combitech. (n.d.). Research Arena for Collaborative Autonomous Rescue Systems, Available Online: https://www.combitech.com/news-inspiration/stories/research-arena-for-collaborative-autonomous-rescue-systems/ [Accessed 27 May 2021].

Conlon, S. (2018). All Sewn up: Online Fashion Platform Thread Scoops H&M Funding, *The Guardian*, Available Online: http://www.theguardian.com/fashion/2018/oct/16/all-sewn-up-online-fashion-platform-threadcom-scoops-hm-funding [Accessed 25 May 2021].

Connell, J., Kriz, A. & Thorpe, M. (2014). Industry Clusters: An Antidote for Knowledge Sharing and Collaborative Innovation?, *Journal of Knowledge Management*, vol. 18, no. 1, pp.137–151.

Connell, J. & Voola, R. (2008). Strategic Alliances - A Marriage of Convenience or a Matter of Trust?, 22nd ANZAM Conference, Auckland, New Zealand, January 2008, Auckland, New Zealand, pp.1–16, Available Online: https://opus.lib.uts.edu.au/handle/10453/11460 [Accessed 12 May 2021].

Corral de Zubielqui, G., Jones, J., Seet, P.-S. & Lindsay, N. (2015). Knowledge Transfer between Actors in the Innovation System: A Study of Higher Education Institutions (HEIS) and SMES, *Journal of Business & Industrial Marketing*, vol. 30, no. 3/4, pp.436–458.

Creswell, J. W. & Creswell, J. D. (2018). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, 5th edition., Los Angeles, CA: SAGE Publications, Inc.

Deloitte Insigths. (2020). Thriving in the Era of Pervasive AI Deloitte's State of AI in the Enterprise 3rd Edition, Deloitte Development LLC.

Dey, I. (1993). Qualitative Data Analysis : A User Friendly Guide for Social Scientists, London, UK: Routledge.

Díez-Vial, I. & Montoro-Sánchez, Á. (2016). How Knowledge Links with Universities May Foster Innovation: The Case of a Science Park, *Technovation*, vol. 50–51, pp.41–52.

Edquist, C. (1997). Systems of Innovation Approaches - Their Emergence and Characteristics, in C. Edquist (ed.), *Systems of Innovation Technologies, Institutions and Organizations*, Abingdon, UK: Routledge, pp.1–35.

Electrolux Group. (2017). Data Science – the next Big Thing in Home Appliances, *Data Science – the next Big Thing in Home Appliances*, Available Online: https://www.electroluxgroup.com/en/data-science-the-next-big-thing-in-home-appliances-24012 [Accessed 4 May 2021].

Electrolux Group. (n.d.). FAQ – Electrolux Innovation Factory, *Electrolux Innovation Factory*, Available Online: https://www.innovationfactory.digital/faq/ [Accessed 25 May 2021].

Ericsson. (2020). Our History, *Shaping History*, Available Online: https://www.ericsson.com/en/about-us/history/shaping-history [Accessed 24 May 2021].

Ericsson. (2021a). Ericsson Tests AI for COVID-19 Response, Available Online: https://www.ericsson.com/en/news/2021/3/ai-for-good [Accessed 2 May 2021].

Ericsson. (2021b). AI in Telecom Networks, Available Online: https://www.ericsson.com/en/ai [Accessed 27 May 2021].

Ericsson. (n.d.). AI by Design - Our Differentiators, Available Online: https://www.ericsson.com/en/ai/ai-differentiators [Accessed 2 May 2021].

Erixon, L. (1996). The Golden Age of the Swedish Model: The Coherence Between Capital Accumulation; Economic Policy in Sweden in the Early Postwar Period, Stockholm, Sweden: Department of Economics, University of Stockholm.

Etzkowitz, H. (2002). Networks of Innovation: Science, Technology and Development in the Triple Helix Era, *International Journal of Technology Management & Sustainable Development*, vol. 1, no. 1, pp.7–20.

Etzkowitz, H. & Leydesdorff, L. (2000). The Dynamics of Innovation: From National Systems and "Mode 2" to a Triple Helix of University–Industry–Government Relations, *Research Policy*, vol. 29, no. 2, pp.109–123.

European Commission. (2020). European Innovation Scoreboard 2020, Luxembourg: Publications Office of the European Union.

Evans, J. H., Hannan, R. L., Krishnan, R. & Moser, D. V. (2001). Honesty in Managerial Reporting, *The Accounting Review*, vol. 76, no. 4, pp.537–559.

Fagerberg, J. (2005). Innovation: A Guide to the Literature, in *The Oxford Handbook of Innovation*, Oxford, NY: Oxford University Press.

Fagerberg, J. & Sapprasert, K. (2011). National Innovation Systems: The Emergence of a New Approach, *Science and Public Policy*, vol. 38, no. 9, pp.669–679.

Falck, O. & Heblich, S. (2007). Do We Need National Champions?: If so, Do We Need a Champions-Related Industrial Policy? ; An Evolutionary Perspective, Working Paper, 2007,088, Jena Economic Research Papers, Available Online: https://www.econstor.eu/handle/10419/25655 [Accessed 23 May 2021].

Faulkner, S. L. & Trotter, S. P. (2017). Data Saturation, in J. Matthes, C. S. Davis, & R. F. Potter (eds), *The International Encyclopedia of Communication Research Methods*, [e-book] John Wiley & Sons, Inc, pp.1–2, Available Online: https://onlinelibrary.wiley.com/doi/abs/10.1002/9781118901731.iecrm0060 [Accessed 12 May 2021].

Fisher, W. (2001). Intellectual Property and Innovation: Theoretical, Empirical, and Historical Perspectives, *Industrial Property, Innovation, and the Knowledge-based Economy, Beleidsstudies Technologie Economie*, vol. 37.

Furman, J. & Seamans, R. (2019). AI and the Economy, *Innovation Policy and the Economy*, vol. 19, pp.161–191.

Gale, M. (2021). The Power Of People Centricity, How Ikea Uses Ai To Enhance The Consumer Experience, *Forbes*, Available Online:

https://www.forbes.com/sites/forbesinsights/2020/04/21/how-ikea-has-embraced-ai-and-digital-to-create-a-deep-human-experience-part-1/ [Accessed 14 May 2021].

Granstrand, O. & Holgersson, M. (2020). Innovation Ecosystems: A Conceptual Review and a New Definition, *Technovation*, vol. 90–91, p.102098.

Gregersen, B. (1992). The Public Sector as a Pacer in National Systems of Innovation, in B.-Å. Lundvall (ed.), *National Systems of Innovation: Toward a Theory of Innovation and Interactive Learning*, London, UK: Pinter Publishers, pp.129–145.

Gürdür, D., El-khoury, J. & Törngren, M. (2019). Digitalizing Swedish Industry: What Is next?: Data Analytics Readiness Assessment of Swedish Industry, According to Survey Results, *Computers in Industry*, vol. 105, pp.153–163.

Haenlein, M. & Kaplan, A. (2019). A Brief History of Artificial Intelligence: On the Past, Present, and Future of Artificial Intelligence, *California Management Review*, vol. 61, no. 4, pp.5–14.

Hannan, R. L., Rankin, F. W. & Towry, K. L. (2006). The Effect of Information Systems on Honesty in Managerial Reporting: A Behavioral Perspective*, *Contemporary Accounting Research*, vol. 23, no. 4, pp.885–918.

Hill, C. W. L. & Rothaermel, F. T. (2003). The Performance of Incumbent Firms in the Face of Radical Technological Innovation, *Academy of Management Review*, [e-journal], Available Online: https://journals.aom.org/doi/abs/10.5465/amr.2003.9416161 [Accessed 7 March 2021].

H&M Group. (2019a). Meet Linda Leopold, Head of AI Policy, *H&M Group*, Available Online: /news/meet-linda-leopold-head-of-ai-policy/ [Accessed 6 May 2021].

H&M Group. (2019b). Flying High with AI: Dealing with Data the Best Possible Way, *H&M Group*, Available Online: /our-stories/flying-high-with-ai-dealing-with-data-the-best-possible-way/ [Accessed 5 May 2021].

H&M Group. (n.d.). History, *H&M Group*, Available Online: https://hmgroup.com/about-us/history/ [Accessed 24 May 2021].

Holmén, A. & Bendtsen, C. (2019). AI Sweden: Joining Forces to Help Answer Big Questions in AI, Available Online: https://www.astrazeneca.com/what-science-can-do/topics/data-science-ai/ai-sweden-joining-forces-to-help-answer-big-questions-in-ai.html [Accessed 27 May 2021].

Howard, J. (2019). Artificial Intelligence: Implications for the Future of Work, *American Journal of Industrial Medicine*, vol. 62, no. 11, pp.917–926.

Husqvarna Group. (n.d.a). Our History, *Husqvarna Group*, Available Online: https://www.husqvarnagroup.com/en/our-history [Accessed 24 May 2021].

Husqvarna Group. (n.d.b). Sustainovate Open, *Husqvarna Group*, Available Online: https://www.husqvarnagroup.com/en/sustainovate-open [Accessed 25 May 2021].

IKEA. (n.d.). The History of the IKEA Brand at a Glance, *Inter IKEA Systems*, Available Online: https://about.ikea.com//en/About-us/History-of-IKEA/Milestones-of-IKEA [Accessed 24 May 2021].

Ingka Group. (2020). Ingka Group Acquires Geomagical Labs, *Ingka Group*, Available Online: https://ingka-com-prodv2.azurewebsites.net/news/ingka-group-acquires-geomagical-labs/ [Accessed 25 May 2021].

Ingka Group. (n.d.). Ingka Group Governance, *Ingka Group*, Available Online: https://www.ingka.com/this-is-ingka-group/how-we-are-organised/ [Accessed 24 May 2021].

Johnson, B. (1992). Institutional Learning, in B.-Å. Lundvall (ed.), *National Systems of Innovation: Toward a Theory of Innovation and Interactive Learning*, London, UK: Pinter Publishers, pp.23–44.

Kanbach, D. K. & Stubner, S. (2016). Corporate Accelerators As Recent Form Of Startup Engagement: The What, The Why, And The How, 6, *Journal of Applied Business Research (JABR)*, vol. 32, no. 6, pp.1761–1776.

Kaplan, A. & Haenlein, M. (2019). Siri, Siri, in My Hand: Who's the Fairest in the Land? On the Interpretations, Illustrations, and Implications of Artificial Intelligence, *Business Horizons*, vol. 62, no. 1, pp.15–25.

Kerr, W. R. & Nanda, R. (2015). Financing Innovation, *Annual Review of Financial Economics*, vol. 7, no. 1, pp.445–462.

Kirk, J. & Miller, M. (1986). Reliability and Validity in Qualitative Research, [e-book] Newbury Park, California: SAGE, Available Online: https://methods.sagepub.com/book/reliability-and-validity-in-qualitative-research.

Kline, S. J. & Rosenberg, N. (1986). An Overview of Innovation, in R. Landau & N. Rosenberg (eds), *The Positive Sum Strategy: Harnessing Technology for Economic Growth*, Washington, DC: National Academic Press, pp.275–304.

Knowledge@Wharton. (2015). How Stockholm Became a 'Unicorn Factory', *Knowledge@Wharton*, Available Online: https://knowledge.wharton.upenn.edu/article/how-stockholm-became-a-unicorn-factory/ [Accessed 10 May 2021].

Laursen, K. (2012). Keep Searching and You'll Find: What Do We Know about Variety Creation through Firms' Search Activities for Innovation?, *Industrial and Corporate Change*, vol. 21, no. 5, pp.1181–1220.

Lazonick, W. (2005). The Innovative Firm, in J. Fagerberg & D. C. Mowery (eds), *The Oxford Handbook of Innovation*, Oxford, NY: Oxford University Press.

Leydesdorff, L. & Meyer, M. (2003). The Triple Helix of University-Industry-Government Relations, *Scientometrics*, vol. 58, no. 2, pp.191–203.

Lietha, V. (2019). ABB Conversations > Behind the Scenes of the ABB Industrial AI Accelerator, Available Online: https://www.abb-conversations.com/2019/08/behind-the-scene-of-the-abb-industrial-ai-accelerator/ [Accessed 27 May 2021].

Lindgaard Christensen, J. (1992). The Role of Finance in National Systems of Innovation, in *National Systems of Innovation: Toward a Theory of Innovation and Interactive Learning*, London, UK: Pinter Publishers, pp.146–168.

Lipsey, R. G., Carlaw, K. I. & Bekar, C. T. (2005). Economic Transformations: General Purpose Technologies and Long-Term Economic Growth, Oxford, NY: Oxford University Press.

Lundvall, B.-Å. (1992). Introduction, in B.-Å. Lundvall (ed.), *National Systems of Innovation: Toward a Theory of Innovation and Interactive Learning*, London, UK: Pinter Publishers, pp.1–19.

Lundvall, B.-Å. (1999). National Business Systems and National Systems of Innovation, *International Studies of Management & Organization*, vol. 29, no. 2, pp.60–77.

Lundvall, B.-Å. (2007). National Innovation Systems—Analytical Concept and Development Tool, *Industry and Innovation*, vol. 14, no. 1, pp.95–119.

MacCarthy, M. & Propp, K. (2021). Machines Learn That Brussels Writes the Rules: The EU's New AI Regulation, *Brookings*, Available Online: https://www.brookings.edu/blog/techtank/2021/05/04/machines-learn-that-brussels-writes-the-rules-the-eus-new-ai-regulation/ [Accessed 13 May 2021].

Maincent, E. & Navarro, L. (2006). A Policy for Industrial Champions: From Picking Winners to Fostering Excellence and the Growth of Firms, 2, Brussels, Belgium: European Commission, Available Online: https://ec.europa.eu/docsroom/documents/1923/attachments/1/translations/en/renditions/native.

Malerba, F. & Nelson, R. (2011). Learning and Catching up in Different Sectoral Systems: Evidence from Six Industries, *Industrial and Corporate Change*, vol. 20, no. 6, pp.1645–1675.

MELLODDY. (n.d.). FAQs, *MELLODDY*, Available Online: https://www.melloddy.eu/faqs [Accessed 11 May 2021].

Meyer, M. & Kuusi, O. (2004). Nanotechnology: Generalizations in an Interdisciplinary Field of Science and Technology, *International Journal for Philosophy of Chemistry*, vol. 10, no. 2, pp.155–170.

Microsoft. (n.d.). ABB Case Study, *How the cloud can elevate Artificial Intelligence (AI) solutions*, Available Online: https://partner.microsoft.com/ru-kz/case-studies/abb [Accessed 5 May 2021].

Mila. (2021). Mila Announces Collaboration with AstraZeneca to Maximize the Potential of AI for Drug Discovery and Development, *Mila*, Available Online: https://mila.quebec/en/mila-announces-collaboration-with-astrazeneca-to-maximize-the-potential-of-ai-for-drug-discovery-and-development/ [Accessed 27 May 2021].

MLDPS. (n.d.). MLPDS – Machine Learning for Pharmaceutical Discovery and Synthesis Consortium, Available Online: https://mlpds.mit.edu/ [Accessed 27 May 2021].

MobilityXlab. (n.d.). MobilityXlab, *MobilityXlab*, Available Online: https://www.mobilityxlab.com/en [Accessed 27 May 2021].

Moultrie, J., Nilsson, M., Dissel, M., Haner, U.-E., Janssen, S. & Lugt, R. V. der. (2007). Innovation Spaces: Towards a Framework for Understanding the Role of the Physical Environment in Innovation, *Creativity and Innovation Management*, vol. 16, no. 1, pp.53–65.

Nelson, R. R. (1993). National Innovation Systems :, Oxford, NY: Oxford University Press,.

Nelson, R. R. & Rosenberg, N. (1993). Technical Innovation and National Systems, in *National Innovation Systems*, Oxford, NY: Oxford University Press, pp.3–22.

Nilsen, A. (2017). New Agreement between LiU and Saab, Available Online: https://liu.se/liu-nytt/arkiv/nyhetsarkiv/1.549567/1.551731?l=en [Accessed 27 May 2021].

OECD. (2018). OECD Reviews of Digital Transformation: Going Digital in Sweden, [e-book] Paris, France: OECD Publishing, Available Online: https://www.oecd-ilibrary.org/content/publication/9789264302259-en.

O'Neill, S. (2020). Cambridge Centre for AI in Medicine Announces Its Official Launch, *CCAIM*, Available Online: https://ccaim.cam.ac.uk/cambridge-centre-for-ai-in-medicine-announces-its-official-launch/ [Accessed 27 May 2021].

Pauwels, C., Clarysse, B., Wright, M. & Van Hove, J. (2016). Understanding a New Generation Incubation Model: The Accelerator, *Technovation*, vol. 50–51, pp.13–24.

Pettersson, J.-E. (2002). Intraprenörer, Innovationer Och Tillväxt i Svenska Storföretag, Östersund, Sweden: Institutet för tillväxtpolitiska studier (ITPS).

Pique, J. M., Berbegal-Mirabent, J. & Etzkowitz, H. (2018). Triple Helix and the Evolution of Ecosystems of Innovation: The Case of Silicon Valley, *Triple Helix*, vol. 5, no. 1, p.11.

Quintas, P., Wield, D. & Massey, D. (1992). Academic-Industry Links and Innovation: Questioning the Science Park Model, *Technovation*, vol. 12, no. 3, pp.161–175.

Ranerup, A. & Henriksen, H. Z. (2020). Digital Discretion: Unpacking Human and Technological Agency in Automated Decision Making in Sweden's Social Services, *Social Science Computer Review*, p.0894439320980434.

Romer, P. M. (1992). Two Strategies for Economic Development: Using Ideas and Producing Ideas, *The World Bank Economic Review*, vol. 6, no. suppl_1, pp.63–91.

SAAB. (2017). NTU and Saab Partnership to Develop Innovative High-End Digital Technology, *Start*, Available Online: https://www.saab.com/newsroom/press-releases/2017/ntu-and-saab-partnership-to-develop-innovative-high-end-digital-technology [Accessed 27 May 2021].

SAAB. (n.d.). Over 400 Years of History, *SAAB*, Available Online: https://www.saab.com/about/history [Accessed 20 May 2021].

Sandström, C. G. (2014). Var Skapades Sveriges 100 Främsta Innovationer?, Stockholm, Sweden: Reforminstitutet, Available Online: http://www.reforminstitutet.se/wp/wp-content/uploads/2014/08/Sveriges-100-fr%C3%A4msta-innovationer.pdf [Accessed 5 May 2021].

Scania. (2021). Scania Signs Partnership with Artificial Intelligence Center AI Sweden, *Scania Group*, Available Online: /group/en/home/newsroom/news/2021/scania-signs-partnership-with--AI-Sweden.html [Accessed 6 May 2021].

Scania AB. (2020). The Scania Report 2019 Annual and Sustainability Report, Södertälje, Sweden: Scania AB, Available Online: https://www.scania.com/content/dam/group/investor-relations/financial-reports/annual-reports/Scania_AnnualReport_2019-English.pdf.

Space10. (n.d.). About, *SPACE10*, Available Online: https://space10.com/about/ [Accessed 25 May 2021].

Statistics Sweden. (2020). Artificial Intelligence in Sweden, Solna, Sweden: Statistics Sweden, p.70, Available Online: https://www.scb.se/contentassets/048c2c293c404f3e899e91b844b6b9c2/artificiell-intelligens-i-sverige-2019_slutrapport.pdf [Accessed 10 May 2021].

SynerLeap. (2016). About SynerLeap, *SynerLeap*, Available Online: https://synerleap.com/about-synerleap/ [Accessed 26 May 2021].

Teece, D. J. (1986). Profiting from Technological Innovation: Implications for Integration, Collaboration, Licensing and Public Policy, *Research Policy*, vol. 15, no. 6, pp.285–305.

Telenor Connexion. (2018). How Husqvarna Is Reaching More Customers with IoT, *Telenor Connexion*, Available Online: https://www.telenorconnexion.com/iot-case/how-husqvarna-is-reaching-more-customers-with-iot/ [Accessed 27 May 2021].

Toll, D., Lindgren, I., Melin, U. & Madsen, C. Ø. (2019). Artificial Intelligence in Swedish Policies: Values, Benefits, Considerations and Risks, in I. Lindgren, M. Janssen, H. Lee, A. Polini, M. P. Rodríguez Bolívar, H. J. Scholl, & E. Tambouris (eds), *Electronic Government*, Cham, 2019, Cham: Springer International Publishing, pp.301–310.

Verspagen, B. (2005). Innovation and Economic Growth, in J. Fagerberg & D. C. Mowery (eds), *The Oxford Handbook of Innovation*, Oxford, NY: Oxford University Press.

Vinnova. (2020a). Fler företagsinkubatorer får stöd från Vinnova, *Vinnova*, Available Online: https://www.vinnova.se/nyheter/2020/06/fler-foretagsinkubatorer-far-stod-fran-vinnova/ [Accessed 2 May 2021].

Vinnova. (2020b). FAMOUS - Federated Anomaly Modelling and Orchestration for ModUlar Systems | Vinnova, *Vinnova*, Available Online: https://www.vinnova.se/en/p/famous---federated-anomaly-modelling-and-orchestration-for-modular-systems/ [Accessed 25 May 2021].

Vinuesa, R., Azizpour, H., Leite, I., Balaam, M., Dignum, V., Domisch, S., Felländer, A., Langhans, S. D., Tegmark, M. & Fuso Nerini, F. (2020). The Role of Artificial Intelligence in Achieving the Sustainable Development Goals, 1, *Nature Communications*, vol. 11, no. 1, p.233.

Volvo. (2019). Volvo Financial Services Launches 10-Week ILabX Program with 7 Start-Ups, Available Online: https://www.volvogroup.com/en/news-and-media/news/2019/feb/news-3209840.html [Accessed 27 May 2021].

Volvo. (n.d.). History and R&D Milestones, *Volvo Group*, Available Online: https://www.volvogroup.com/en/about-us/history-and-r-d-milestones.html [Accessed 24 May 2021].

Volvo Group. (2018). Volvo Trucks' Collaboration with SAS Enhances Remote Diagnostics through Advanced Analytics and AI, *Volvo Group*, Available Online: https://www.volvogroup.com/en/news-and-media/news/2018/oct/volvo-trucks-collaboration-with-sas.html [Accessed 27 May 2021].

Volvo Group. (2019). Volvo Group Partners with NVIDIA to Develop Advanced AI Platform for Autonomous Trucks, *Volvo Group*, Available Online: https://www.volvogroup.com/en/news-and-media/news/2019/jun/news-3340185.html [Accessed 27 May 2021].

Wagner, M. (2010). Acquisitions as a Means of Innovation Sourcing by Incumbents and Growth of Technology-Oriented Ventures, *International Journal of Technology Management*, vol. 52, no. 1/2, pp.118–134.

Wang, W. & Siau, K. (2019). Artificial Intelligence, Machine Learning, Automation, Robotics, Future of Work and Future of Humanity: A Review and Research Agenda, *Journal of Database Management (JDM)*, vol. 30, no. 1, pp.61–79.

WASP. (n.d.a). The Research In Wasp, Available Online: http://wasp.acc.linkin.se/research/ [Accessed 27 May 2021].

WASP. (n.d.b). WASP Research Arenas – WASP, Available Online: https://wasp-sweden.org/research/research-arenas/ [Accessed 27 May 2021].

WASP. (n.d.c). Wallenberg AI, Autonomous Systems and Software Program – WASP, Available Online: https://wasp-sweden.org/about-us/ [Accessed 22 May 2021].

Yin, Robert. K. (2003). Case Study Research Design and Methods, 3rd edn, Thousand Oaks, California: Sage Publications.

Yu, Z., Liang, Z. & Wu, P. (2021). How Data Shape Actor Relations in Artificial Intelligence Innovation Systems: An Empirical Observation from China, *Industrial and Corporate Change*, [e-journal] no. dtaa063, Available Online: https://doi.org/10.1093/icc/dtaa063 [Accessed 31 March 2021].

Zha, W. (2019). H&M Harnesses AI to Test Online Tailoring Feature, *FashionUnited*, Available Online: https://fashionunited.uk/news/fashion/h-m-harnesses-ai-to-test-online-tailoring-offer/2019041542692 [Accessed 25 May 2021].