Artificial intelligence, Social Innovation and Sustainability

A qualitative case study of Telenor´s research department

Oda Hennissen Wilhelmsen

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Oda Hennissen Wilhelmsen

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"Nothing in life is to be feared, it is only to be understood. Now is the time to understand more so that we may fear less."

-Marie Curie

Abstract

Private companies are important profit-motivated actors whose innovative activities significantly contribute to economic performance. However, firms' R&D activities also have the potential to foster substantial changes in society through so-called social innovations. Social innovation has, among other things, the immense potential to contribute to addressing environmental challenges.

Though, research on relationships between industrial R&D-departments activities and social innovation toward sustainability is quite limited. With this research gap in mind, the present thesis investigates the following question: Can R&D of AI carried out by large companies' R&D departments lead to social innovation that can contribute to sustainability?

The thesis will investigate the question by focusing on one of the most consequential new technological paradigms of our times: artificial intelligence (AI). It is rapidly developing as one of the most important technologies in the digitally transformed world with various applications in several industrial sectors and service activities. One such area of application is that it can contribute to addressing complex environmental challenges. The leading Norwegian telecommunication company Telenor is one of the actors who have seen artificial intelligence's potential to address environmental challenges. Their internal research department has a separate team dedicated to exploring and experimenting with the technology. Two of their projects illustrate their efforts to orient the technology toward sustainability: the Green Radio project and the Air Quality project. This thesis focuses on Telenor's R&D Department as an empirical case and these two AI projects as relevant illustrations. Furthermore, it will examine the questions: "How is Telenor Research's AI-work described by the actors involved in their projects?" and "o Do these descriptions represent relevant cases of social innovation oriented towards sustainability?"

In-depth interviews with various actors involved in the work constitute the study's methodological approach and empirical data material. A narrative analysis strategy was applied when analyzing the data. The goal was to understand how the perspectives the informants presented and what components of the story they emphasized.

The findings indicate that Telenor Research's AI team actively seeks to align their business interest with their responsibilities towards society when picking projects. They utilized

different approaches to the work of creating AI solutions, as well as knowledge and competence in sustainable AI. Through engaging in various collaborations, they not only produced these things but also shared them with their surrounding actors. The work showed several impacts ranging from proving how AI can be used to address environmental challenges, improve operations and routines, cut the waste of resources, strengthen the company's social profile, and inspire others. By producing new AI solutions that meet the societal need to fight environmental issues, which showed beneficial impacts on society and the environment, one might assess this as a case of social innovation oriented towards sustainability.

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Abbreviations

AI – Artificial Intelligence

ML – Machine Learning

R&D – Research and development

CSR – Corporate Social Responsibility

IoT – Internet of Things

BU – Business Unit

NTNU – Norges teknisk-naturvitenskapelige universitet

UiO – Universitetet i Oslo

List of Tables

Table 2.1 …………………………………………………………………………..26

Table 5.1 …………………………………………………………………………..50

Table of Contents

1.0 Introduction ……12
2.0 Research, Social Innovation and Sustainability ……..15
2.1 Addressing sustainability challenges ……...15
2.2 The impact of research ……15
2.2.1 What is impact? ……..15
2.2.2 Different ways of exploring impact ……16
2.3 The role of firms ……....17
2.3.1 Firms´ R&D activity ……...17
2.3.2 Responsible R&D ……....19
2.4 Social innovation ……..21
2.4.1 Defining social innovation ……..21
2.4.2 Where social innovation meets environmental sustainability ……..…..23
2.5 Implications of the literature review ……..…..25
2.5.1 A gap in the literature……..25
2.5.2 Some analytical factors……25
3.0 Contextual background: The world of AI ……....27
3.1 AI´s history……27
3.2 Defining AI ……....29
3.3 Types of AI ……30
3.3.1 Characteristics of AI levels ……30
3.3.2 Different AI technologies……31
3.4 AI in different parts of society ……...35
3.5 Why AI is important in society and the business world ……....38
3.6 Controversies about AI……...40
4.0 Telenor Research and Artificial Intelligence ……41
4.1 The case of Telenor and Telenor Research ……..41
4.2 The AI & Analytics team and their work on AI ……....42
4.2.1 The Green Radio project ……43
4.2.2 The Air Quality project ……44
5.0 Methodology and data ……45
5.1 Research design……45
5.1.1 Research question and methods ……..……45
5.1.2 A case study approach ……46
5.1.3 Qualitative interviewing ……47
5.1.4 Data sources ……...49
5.2 Data collection ……...49
5.2.1 Sampling strategy ……....49
5.2.2 Informants ……...50
5.2.3 Preparing for and conducting the interviews……...53
5.3 Strategy of analysis ……55
5.3.1 Reducing and organizing the data ……..55
5.3.2 A narrative analysis strategy ……..56
5.4 The rigor of the study ……57
5.4.1 Reflexivity ……...58
5.4.2 Ethical considerations ……59

6.0 Empirical results: The descriptions from the actors involved in Telenor Research´s work on AI. …….. 62
6.1 The AI-team in Telenor Research …… 62
6.1.1 Motivations ……..62
6.1.2 Approaches to the work …….. 65
6.1.3 Impacts ……67
6.2 The Green Radio project ……...……70
6.2.1 Motivations ……70
6.2.2 Approaches to the work ……72
6.2.3 Impacts ……74
6.3 The Air Quality project ……77
6.3.1 Motivations ……77
6.3.2 Approaches to the work …… 80
6.3.3 Impacts ……82
7.0 Discussion ……86
7.1 Motivations ……86
7.1.1 Motivations driven by business interests ……86
7.1.2 An alignment of business interest and societal interests ……87
7.2 Approaches to the work ……89
7.2.1 Building sustainable knowledge and competence ……..89
7.2.2 Acting as a sustainable intrapreneur and entrepreneur ……91
7.3 Impacts ……..93
8.0 Conclusion: Artificial intelligence for sustainability……97
References……...101

1.0 Introduction

Private companies are important profit-motivated actors whose innovative activities significantly contribute to society´s economic performance. The R&D (research and development) activities of firms also have the potential to foster substantial change in society through so-called social innovations. (Ambec & Lanoie, 2008; Scherrer & Astrachan, 2018; Rothwell, 1992; SAGE Publications, 2012). The concept refers to the introduction of new elements that meet a societal need and have beneficial impacts on society. Social innovation has, among other things, the immense potential to contribute to addressing environmental challenges. (Eichler & Schwarz, 2019; Domanski, Howaldt & Kaletka, 2019).

Regardless, research on the relationships between industrial R&D-departments activities and social innovation towards sustainability is quite limited. With this research gap in mind, the present thesis investigates the following question:

> *Can R&D of AI carried out by large companies' R&D departments lead to social innovation that can contribute to sustainability?*

This establishes the main focus of this thesis: the examination of the relationship between the research and development (R&D) work of industrial R&D departments on artificial intelligence (AI) and social innovation oriented towards sustainability.

With this in mind, the thesis focuses on one of the most consequential new technological paradigms in the present time: AI. This is rapidly becoming one of the most important technologies in the digitally transformed world with various applications across industrial sectors and service activities. (Noroff, 2018; Brynjolfsson & McAfee, 2014).

Given the emerging importance of this technology, more and more companies have been engaging in its development. Both entrants and incumbents in various industries participate in such activities in different ways to sustain their positions and maintain their competitiveness in the market. The most influential industrial actors in today's society, such as Google, Amazon, Apple, Facebook, and Microsoft, have taken the lead in investigating and producing this technology. (Botha, 2019; BI India bureau, 2019; CBSInsights Research Portal, 2019).

The profit-motivated nature of companies and the potential risks of AI surround the topic with many controversies. (Teknologirådet, 2018, s.7-13; Ambec & Lanoie, 2008; Bero,

2019; Buranyi, 2017; Fabbri, Lai, Grundy & Bero, 2018; Besley, McCright, Martin, Elliot & Zahry, 2017). However, a variety of opportunities also exist; for example, AI technologies such as prediction algorithms have the potential to contribute to addressing complex environmental challenges. In light of the pressing environmental challenges facing society, comprehensive innovations across the whole system are needed to secure society's long-term sustainable change and development. (Teknologirådet, 2018, s.7-13; Aagaard, 2018, Ambec & Lanoie, 2008; Markard Geels, & Raven, 2020; Ekin, 2019; Snow, 2019; Minevich, 2021). The Norwegian telecommunications company Telenor is one of the actors that have seen the potential of AI to address environmental challenges. Their internal research department has a team devoted to conducting R&D on AI. Two of their projects illustrate their efforts to orient the technology toward sustainability: "the Green Radio project" and "the Air Quality project".

Telenor's R&D department serves as this thesis's empirical case with these two AI projects as relevant illustrations. Two additional questions are asked to delimit and concretize the scope of the study:

How is Telenor Research's AI work described by the actors involved?

Do these descriptions represent relevant cases of social innovation oriented towards sustainability?

Furthermore, this thesis explores the R&D work of Telenor Research on green AI and how it relates to social innovation aimed at sustainability. This thesis will thus take on the case of Telenor Research's AI-team's R&D work on green AI. The case was selected because of its inclusion in an overarching research project at the OSIRIS center at the University of Oslo (UiO). The OSIRIS project aims to investigate the research, development, and innovative work of Telenor Research and assess the impact it has made.

The overarching research project facilitated the data collection. Qualitative in-depth interviews with the various actors involved in the work were conducted. A narrative analysis strategy was applied when analyzing the data.

The findings indicate that Telenor Research's AI team actively seeks to align their business interests with their responsibilities towards society when choosing projects. They utilize various approaches in the process of creating AI solutions and build knowledge and competence on green AI. Through engaging in collaborations, they not only produced these but also shared them with their surrounding actors. The work showed several impacts, such as

proving how AI can be used to address environmental challenges, improve operations and routines, cut resource use, strengthen the company's social profile, and inspire others. As the work produced new AI solutions that showed beneficial impacts on society and the environment, thus meeting the societal need to fight issues such as pollution and climate change, the case of Telenor Research and their work on AI can be assessed as a case of social innovation oriented towards sustainability.

This thesis is structured as follows: First, Chapter 2 will present a review of the literature on R&D, its impacts, and social innovation. Chapter 3 explores the contextual background of the AI concept. Chapter 4 briefly describes the empirical case of Telenor Research and their AI work, while chapter 5 provides an overview of the methodological approach undertaken in this present study. Chapter 6 conveys the empirical findings, which are then discussed in Chapter 7. Finally, Chapter 8 summarizes the findings and draws some conclusions.

2.0 Research, Social Innovation, and Sustainability

2.1 ADDRESSING SUSTAINABILITY CHALLENGES

Worldwide interest in environmental challenges such as pollution, overconsumption, and climate change, has accelerated since the 1980s. Accordingly, sustainability and sustainable development have risen higher on the agenda with several societal actors. (Aagaard, 2018, Ambec & Lanoie, 2008). To enable society to better meet these environmental challenges, many argue that a transformation of society is required. Due to several factors, this is, however, a difficult task. Markard, Geels, and Raven (2020) identify private companies as one of the key actors in such processes. Additionally, they claim that that in order to realize long-term transformative change of society and secure sustainable development, there is a need for comprehensive innovation and transformation of the whole system, including various actors, institutions, and practices. According to Weber and Rohracher (2012) there has been increasing consensus around the fact that activities such as R&D and innovation play a crucial role in addressing societal and environmental challenges, a claim supported by Markard, Geels, and Raven´s (2020) argument that emerging innovation accelerates and contributes to more overarching system transformation.

2.2 THE IMPACT OF RESEARCH

2.2.1 What is impact?

Impact, in the context of R&D and innovation, has been defined and addressed in various ways. Penfield, Scoble, and Wykes (2014) discuss and present different definitions of the term “research impact”. Some distinguishes between “academic impact” (intellectual contribution to one´s field of study within academia) and “external socioeconomic impact” (which entails the intellectual contribution to one´s field of study beyond academia). Others describe it as the effect on, change of, or benefit to the economy, society, culture, public policy or services, health, the environment, or quality of life beyond academia. Another

suggestion is that impact is essentially a question of what sort of difference has been made and to what extent.

Similarly, Donovan (2011) states that some distinguish between "research quality" (the excellence of academic outputs intended for academic consumption, such as journal articles and books) and "research impact" (which includes the benefits to society). Others, however, include more general societal returns in their definitions of "impact". Traditionally, research impact was associated with the generation of money and the international competitiveness of a country, but Donovan claims that a redefinition of impact has occurred: It now entails more general social, cultural, environmental, and economic returns.

Bornmann (2012) considers the "societal impact of research" and claims that despite the various concepts that have been introduced, it is essentially the measurement of social, cultural, environmental, and economic returns. Research is decreasingly evaluated solely on its scientific impact, and so there is a need to quantify the contributions science makes to society. To this end, Bornmann sketches out the different components inherent in "societal impact." "Societal benefit*"* refers to the contribution research makes to the social capital of a nation by producing new approaches to social issues or informing public debate. Research may also have "cultural benefits" in adding to the cultural capital of a nation. It can, for example, provide insight into how one´s culture relate to other societies and cultures, help people to better understand their history, and contribute to cultural preservation and enrichment. "Economic benefits" center around the improvements to a nation´s economic capital by enhancing its skills and improving its productivity. Lastly, "environmental benefits" involve the natural capital of a nation, which is enhanced by reducing waste and pollution, as well as improving nature preserves and biodiversity. This thesis is concerned with such societal impacts with a particular focus on environmental benefits.

2.2.2 Different ways of exploring impact

Penfield et al. (2014) argue that there are different motivations behind the assessment of research impact, such as to monitor and manage the performance of research organizations; to disseminate the contributions, and to demonstrate the socioeconomic value of research. According to Grant (2006), there is a need to justify research investments through the demonstration of their value to the community. However, Spaapen and van Drooge (2011) argue that research impact is difficult to detect. One challenging aspect is, for example, the time gap between the research and its impact.

As such, impact has been explored in various ways in order to achieve a better understanding of it. For example, Grant (2006) claims that case studies represent valuable in-depth examinations of research that provide "narratives" of the research process and outcome. On the other hand, Spaapen and van Drooge (2011), seek to understand social impact in a more general context by proposing a "productive interactions" approach. They present three components of the term: direct/personal interactions, indirect interactions (through text or artefacts), and financial interactions (e.g., through money).

Penfield et al. (2014) explore ways to better understanding how research activity leads to social impact. The "Research Excellence Framework*"* (REF), for example, is a framework that divides the concept of research into three aspects: outputs, impact & environment. Donovan (2011), on the other hand, argues that research impact has traditionally been examined on the through the lenses of economic, scientific, technological, and innovative indicator factors. However, Penfield et al. observe a shift which implies that general social, cultural, environmental, and economic returns have increasingly come in to play when regarding research impact and that indicator factors are often combined with narratives.

2.3 THE ROLE OF FIRMS

2.3.1 Firms´ R&D activity

R&D activity and knowledge creation have accelerated during the past centuries, giving researchers and academia a more central societal role. Traditionally, research has been performed at universities, but it is now spread across other parts of society through the development of stronger network relationships between academia, industry, and government. The link between industry and universities is arranged in a variety of ways, ranging from industry-university collaborations, commercialization of university research, and academic researchers relocating and becoming an increasingly natural part of the staff of industrial firms. (Etzkowitz & Leydesdorff, 2000; Hsu, 2005; Guan, Yam & Mok, 2007).

As such, it is becoming more important for industrial firms to engage in research, development, and innovation activity. Their role in conducting R&D may be connected to the intensification of the industrialization of society and the specialization of societal and industrial sectors – for example, as illustrated through Murmann´s (2000) analysis of the

synthetic dye industry in the late 1800s and early 1900s. R&D activity and the building of solid knowledge and competence are important for staying competitive in the market. Kaiser, Kongsted, Laursen & Ejsing (2018) claim that science and scientists make central and important contributions to the innovation outputs of private companies in a variety of industries. They argue that hiring researchers with experience in both academia and industry is particularly valuable for the innovative output of firms as it builds science-based, problem-solving capabilities that may lead to more quality innovation output. Keesing (1967) claims that competitive advantage in the market is partly connected to R&D activity, finding a connection between the intensity of R&D activity in American industry and their export performance. R&D is thus claimed to "explain" competitive trade success in manufacturing industries considerably better than other variables.

As such, industry carrying out R&D is highly significant. Furthermore, the execution of R&D activity is connected with the anticipation of having an impact: One of the fundamental reasons for conducting R&D is that generation and transformation of knowledge will produce benefits. (Penfield et al, 2014). Industrial companies carrying out R&D have different types of impact, which, in light of environmental issues and sustainable development, has become even more important. Ambec and Lanoie (2008) stress that the prospect of firms carrying on with a business-as-usual approach is highly worrying. Accordingly, firms are put under a great deal of pressure by stakeholders (e.g., customers, investors, bankers, NGOs) to reduce their negative impact on the environment and partake in the "green shift." Firms are now divided between seeking to meet to meet profit targets by cutting costs, outsourcing, and merging on one side and taking a more central role in addressing social, economic, and environmental issues on the other. (Ambec & Lanoie, 2008; Mirvis, Herrera, Googins & Albareda, 2016).

Similarly, Anser, Zhang and Kanwal (2017) claim that companies are fundamentally driven by the desire to discover ways to make a profit. As such, firms merge, enter global markets, focus on R&D, and seek to discover new ways to improve value. They argue, however, that achieving this has involved the minimization of social values. Moreover, recent years have seen a shift in which companies are under increasing pressure to meet societal expectations and fulfill their corporate social responsibility (CSR). Anser, Zhang and Kanwal claim that firms are facing more and more difficulties in making a profit, and they seek, discover, and adopts various innovation types and strategies in order to meet these challenges.

2.3.2 Responsible R&D

Cillo, Petruzzelli, Ardito, and Del Guidice (2019) also assert that firms are increasingly expected to develop innovations that align with such, social, economic, and environmental goals. This is connected to CSR which refers to the responsibilities firms have to act in a way that benefits society. According to this notion, firms should not only benefit owners, stakeholders, or investors by making more money, but should also benefit other stakeholders such as consumers, employees, the community in general, the government, and the natural environment. CSR applies to all organizations because of their visibility and power in society. On other words, with power comes with responsibility. (SAGE Publications, 2012). As assessed by Aagaard (2018), it is no longer sufficient for firms to create radically new innovations, if leading customer groups perceive these innovations as unsustainable.

Generally, CSR is associated with a reduction in competitiveness. (Ambec & Lanoie, 2008). Innovations are essentially surrounded by a great deal of uncertainty, and there is a lack of a prescribed and fixed procedure for the successful innovative activity of firms. Additionally, firms have complex and interactive strategy-making processes that involves a long list of main targets (e.g., distribution, market position, technology, skills, production, evaluation of corporate structure, acquisition/disinvestment, diversification/concentration, finance, integration) that complicates the process even further. (Rothwell, 1992).

Öberg (2012) claims that recent years have seen growing interests in CSR and more firms focusing on financial, environmental, and social sustainability. She acknowledges that CSR may have a potentially restrictive effect on the business activities of firms, in that society prohibits or constrains activities that are harmful to the environment. However, she also reflects that CSR may create new business opportunities for firms viathe competitive advantage created through the ethical focus of firms and to marketing advantages resulting from the exposure of societal contributions in the media. Additionally, her study found that while CSR may lead to innovation, it is mostly connected to the firms´ regular business and to incremental development of present products and services. Similarly, Aagaard (2018) claims that developments in innovation management imply that solving persistent environmental and social problems provides new inspiration for businesses in pursuing innovative opportunities. A shift is apparent in the firms´ behavior: They are becoming increasingly interested in meeting societal and environmental goals, the solving of which could benefit both society and the firms. As claimed by Ketata, Sofka and Grimpe (2014), sustainable innovation has claimed a high place the agenda of many firms the past decades. They suggest that that

although sustainable innovation provides firms with new opportunities, it is also a complex matter and requiring certain organizational routines and capabilities. Investments in internal absorptive capabilities and the drawing from external sources for innovation are driving forces in improving the degree of sustainable innovation within a firm's innovation activities. In this sense, investments in employee training are more important than technological R&D-expenditures.

According to Scherrer and Astrachan (2018), future-oriented companies have long recognized the pressure for sustainability to be an important strategic success factor to consider, rather than a short-term trend. This is because younger customers demand more and more intelligent and sustainable product and service offerings, as well as the fact that employees much rather prefer working for companies with a proven sustainability track record. Research shows that a sustainability orientation – especially when combined with entrepreneurial thinking and action and a strong innovation orientation – can benefit a business economically. Scherrer and Astrachan describe "sustainable entrepreneurship*"* as being characterized by a strong market-based and innovation-oriented approach to sustainability. Even though sustainable entrepreneurship may seem to be an intuitively appealing and easily comprehensible concept, its implementation is challenging and often leads to fundamental changes in organizational structure and culture. The process of discovering, developing, and utilizing new opportunities that generate an economic, social, and environmental value is also complex, uncertain, and risky.

Ambec and Lanoie (2008), argue that due to their power and place in the market, firms are particularly powerful with regard to their opportunity to change the world and contribute to the green transformation of society. Additionally, they claim that firms can try to amplify their environmental impacts without hurting their economic performance by implementing ambitious innovation strategies that may result in more revenues or reduced costs. For example, better environmental performance may lead to better access to markets, differentiating products, or selling pollution-control-technologies, as well as to improve risk management and relations with external stakeholders; cost of material, energy, and services; and cost of capital and labor.

Hockerts and Wüstehagen (2010) suggest that incumbent firms and new entrant firms' approach R&D activities differently. Incumbents are often less ambitious in their environmental and social goals, and new entrants are often considered more radical. However, incumbents are regarded as having more general outreach due to their established market positions. In order to sustain competitiveness in markets, Mirvis, Herrera, Googins and

Albareda´s (2016) argue that firms are exploring new innovation sources (e.g., open-innovation, crowd sourcing, employee engagement, co-innovation) and methods (e.g., incubators, design thinking, and contests).

2.4 SOCIAL INNOVATION

2.4.1 Defining social innovation

With the environmental challenges facing society, the impact of research on them, and the role of firms in mind, one might ask: What can be done about it? As seen in the previous section, R&D activities have long been regarded as central in the development and production of new innovations. Examples like fertilizers, the Post-it note, and electricity have had important and transformative effects on society. (Wolf, 2008. s. 203-207; Post-it, 2013; The Editors of Ecyclopaedia Britannica, 2013, 08.10; Institute for energy research, 2021; Kjøllesdal, 2011). There is, however, a growing consensus that technological innovations are not adequate for overcoming the societal challenges modern societies are facing. As such, the importance of "social innovation" successfully addressing social, economic, political, and environmental challenges is stressed.

The concept of "social innovation" is far from new but has only recently gotten interest from the social sciences. Defining social innovation is, however, a difficult task. (Domanski, Howaldt & Kaletka, 2019; Cajaiba-Santana, 2014). According to Cajaiba-Santana (2014), the concept of social innovation is underdeveloped. Innovation is traditionally regarded as having technological and economic aspects and is seen as the profitable exploitation of new ideas, the key drivers of which are the prospects of commercial success and economic profit. However, Cajaiba-Santana argues that innovation is a social phenomenon requiring its own paradigms and theoretical perspectives. In contrast to technological innovations, social innovations do not take the shape of a technical artefact, but rather as a new social practice that will ultimately become institutionalized in social structures. The "social" part of social innovation also refers to the creation of a greater common good. Social innovations are here associated with intended, planned, coordinated, goal-oriented, and legitimated actions undertaken by social agents aiming at a social change emerging from the establishment of new social

practices. Thus, social innovations are a type of social change with an impact of future social development and present stability beyond temporary fads.

Mirvis, Herrera, Googins and Albareda (2016) connect social innovations doing the greater good. On the other hand, Phillips, Lee, Ghobadian, O´Regan and James (2015) describe social innovation as the innovative activities and services oriented towards meeting a social need. Domanski, Howaldt and Kaletka (2019) also point out that social innovation appears and influence our lives in various ways, such as changing the way people live, travel, work, and handle crises. Different societal sectors and cross-sectoral networks often drive social innovation.

Following Josef Schumpeter, innovations are inventions that successfully takes hold on the market. These innovations involve, among other things, new combinations, new ways of producing, and ways of organizing. In the literature contributions following him, the concept of innovation was mainly reduced to technological innovations. (Fagerberg, 2003). However, Domanski et al. (2019) point to the emergence of a fundamental shift in the innovation paradigm in which the innovation process opens to society and is oriented towards societal challenges, as well as more strongly recognizing non-technological innovations directed towards changing social practices. With this background, they propose to describe social innovation as new combinations of social practices in certain social contexts prompted by certain actors or group of actors with the motivation to improve how needs and problems is currently addressed by established practices. An innovation is social to the extent that it, conveyed by the market or "non-profit," it is socially accepted and diffused throughout society or in certain societal sub-areas, transformed depending on circumstances, and ultimately institutionalized as new social practice or made routine. Social innovations as new practices contribute to social change. The establishment of new social practices, for example, plays a prominent role in making mobility more environmentally friendly, diseases less frightening, or improving energy use.

Similarly, Howaldt and Schwarz (2007) describe social innovations as new practices that contributes to social change and that plays a prominent role in addressing societal issues. They posit that the "social" part lies in the collectivity of behaviors held together by "practical skills." Social practices are always present, reproduced, and changed by acting subjects by re-creating what already exists in the continuity of practice again and again. Social practices are formed, changed, or replaced by new ones through the making, sustaining, or breaking of the connection between their components. Purtik and Arenas (2017) regards social innovation as the complex processes of introducing new products, processes, or programs that profoundly

change the basic routines, resources, and flow of authority, or beliefs in the social systems in which the innovations occur. Social innovation requires an institutional change in societal problems such as climate change, poverty, alleviation, and income inequality. While Eichler and Schwarz (2019) sketch out five aspects that should be included in any definition of social innovation: (1) social need, (2) innovative element, (3) implementation and execution, (4) improvement, (5) relationships and collaboration. Additionally, they present a definition that covers all five identified aspects in the definition of social innovation. "*Social innovations are new solutions (products, services, models, markets, processes etc.) that simultaneously meet a social need (more effectively than existing solutions) and lead to new or improved capabilities and relationships and better use of assets and resources. In other words, social innovations are both good for society and enhance society´s capacity to act*". (Eichler & Schwarz, 2019, s.12). Additionally, Eichler and Schwarz identify some types of social innovators: social entrepreneurs (and individual citizens); NGOs and non-profits; public institutions; firms; civil society (group of citizens). They found that social innovations are not exclusively related to social entrepreneurs but are developed and implemented by all innovator groups.

2.4.2 Where social innovation meets environmental sustainability

Howaldt and Schwarz (2017) also claim that social innovations are becoming exceedingly important in addressing societal challenges. They argue that the concept of social innovation must be approached analytically. The "news" (such as new solutions, products, and services) introduced to society takes place at the level of social practices that are relevant for social innovation. Domanski, Howaldt and Kaletka (2019), however, suggest a systemic concept of social innovation. This implies that since social innovation stands against the societal challenges of modern societies, it requires ecosystems, as well as the examination of how social innovation diffuses and is adopted, imitated, and translated into other contexts. They emphasize the importance of considering how institutional and social networks and interactions between different sectors work to enable or constrain innovation. For successful social innovations to take place, all societal sectors need to innovate and collaborate on similar grounds. Finally, their systemic concept of social innovation also refers to how communities are an important arena for social innovations that can join the development of intermediary infrastructures to create solutions to complex social problems. Such infrastructures can be created in the form of social innovation parks, centers, labs, or incubators.

Mirvis, Herrera, Googins, and Albareda (2016) explores how companies learn to engage in successful social innovation through acquiring tacit knowledge from external parties. They show that much of the knowledge exchanged in corporate social innovation is tacit knowledge that companies develop during their experiences and interactions with other firms. They also state that multinational corporations are focused on making a profit as well as facing the expectancy to take a more central role in addressing societal challenges and are seeking to explore new innovation sources and methods. Some of the leading firms are focusing on using social innovation tools to enhance their supply chains and to reach socially conscious and green consumers, as well as supporting and partnering with social innovation and enterprises to bring business solutions to societal needs. To innovate in this context, companies must learn together since there is no established playbook with fixed rules and there are considerable differences between the firms.

Phillips, Lee, Ghobadian, O´Regan, and James (2015) claim that CSR-literature suggests that these initiatives go beyond meeting the immediate interests of profit-driven enterprise stakeholders, offering the potential to enhance performance. Phillips et al. accordingly draw attention how social innovation can be used in the face of social issues and societal challenges and propose examining social innovation and social entrepreneurship through a "systems of innovation" approach. According to this view, social entrepreneurs exist within a social system (a community/network of practitioners that together seeks to address social issues). Social innovation systems can thus be regarded as sets of interrelated sub-systems that may act independently but, through interactive and collective learning, contribute towards addressing social needs and concerns.

According to Cillo, Petruzzelli, Ardito and Del Guidice (2019), the expectancy for firms to develop innovations that align economic, environmental, and social goals promotes the emergence of the concept "sustainable innovation". Achieving this is not easy; the sustainable innovation path is expected to be longer than the conventional innovation equivalent. Sustainable innovations require niche transitions. Cillo et al. provide an overview of previous research on sustainable innovation. A systematic approach is adopted in which they sketch out three perspectives on the concept: "internal managerial" (revolves around the relationship between sustainability and innovation), "external relational" (refers to the relationship between firms' ability to innovate and relational capital and the intangible value of relations), and "performance evaluation" (centers around how innovation can be profitable to a company and have a positive effect on society). Accordingly, the literature emphasises a causal connection between innovating for the benefit of society and addressing societal challenges.

Based on the growing importance of this, the present thesis will focus on social innovation for sustainability.

2.5 IMPLICATIONS OF THE LITERATURE REVIEW

2.5.1 A gap in the literature

The literature has devoted much attention to the topics of research impact, the role of firms, and social innovation. R&D activity impacts both the institution in which it is conducted, and its external surroundings. Private companies with their powerful market positions play a central role in carrying out R&D, producing innovations, and impacting the world. Various societal stakeholders are increasingly expecting firms to conduct such activities responsibly – in other words, to innovate in line with societal and environmental needs, wants, and goal.

However, to the extent of my knowledge, investigations into the role of industrial R&D departments and their R&D work in producing social innovations oriented towards sustainability has been limited. This research gap poses an interesting entry point and raises the question: *Can R&D of AI carried out by large companies´ R&D departments lead to social innovation that can contribute to sustainability*?

2.5.2 Some analytical factors

Several implications may derive from the literature review that may guide the examination of the research question. For example, the R&D activity of companies apparently consists of some core components: (1) first, the "motivations" behind the work refer to the drivers behind the R&D activity. Based on assessments of the complex and conflicting nature of firms´ R&D-activity (apparent in, for example, Ambec & Lanoie, 2008; Mirvis, Herrera, Googins & Albareda, 2016; Anser, Zhang & Kanwal, 2017) two main categories of motivations are apparent: "business interest" (e.g., making a profit, creating new capabilities, and staying competitive in the market) and "societal interest" (related to CSR, amplifying the green shift, reducing waste of resources, and creating knowledge).

(2) The second component involves the "approaches to the work." Given the intersection and relationship between academia and industry, as well as scientist´s combined experience from these, (Etzkowitz & Leydesdorff, 2000; Hsu, 2005; Guan, Yam & Mok, 2007; Kaiser, Kongsted, Laursen & Ejsing, 2018), this component ca be further broken down into can be further broken down into "academic work approaches" (such as collaborating with academia, experimentation, and the production of academic papers), and "applied work approaches" (such as making solutions/services/products, and testing them out in practice).

(3) Third is the "impact" of the work. Evident from the literature are the various ways of regarding research impacts (e.g., Donovan, 2011; Penfield et al, 2014; Bornmann, 2012). Derived from this one might distinguish between "institutional impact" concerns how the research might affect and give back to the institution (such as research centers, universities, firms) conducting the work. These impacts are often economically oriented (such as returns on investments; the development of sellable products and services) but might also involve the building of immaterial assets (such as network, reputation, and knowledge). On the other hand, is the "external impact," which may be described as how research affects and influences its surrounding society and the environment. That includes, for instance, how research might affect the culture and politics, how it shapes or reshapes societal structures, and how it addresses societal challenges such as climate change.

Table 2.1: *Analytical factors to guide the assessment the work*

MOTIVATIONS		APPROACHES TO THE WORK		IMPACT	
Business interests	*Societal interests*	*Applied work approach*	*Academic work approach*	*Institutional impact*	*External impact*

3.0 Contextual background: The world of AI

The research issue and question noted at the end of Chapter 2 are investigated through focusing on the emerging new technology of the present time: AI and it´s potentials to address environmental challenges. This chapter provides a short introduction of the relevant concepts and recent literature on AI. The first section presents a historical overview of the concept, followed by examining various ways of defining the concept. The third section explores the various AI technologies. While section four presents various application areas of AI. Before the fifth section looks at the importance of the technology and the last section regards some controversies surrounding the technology.

3.1 AI´S HISTORY

The digitalization of the world has led to discussions about the rise of a new economy in which people work with their brains rather than their hands. Innovation has become more important than mass production, new concepts are prioritized over new machines in the competition for investment, and things change rapidly. in light of this digital transformation of society, AI is a groundbreaking and pervasive digital technology. It is predicted to be the next "General Purpose Technology" and holds the promise of revolutionizing many areas of society and the environment. (Bekar, Carlaw, & Lipsey; Hempell; 2006; Trajtenberg, 2018, s. 2-5).

Some of the first traces of AI appeared in Isaac Asimov's science fiction (sci-fi) stories in the early 1940s about robots and the laws of robotics. These stories were to inspire generations of scientists in the field of robotics in the years to come. British mathematician Alan Turing developed the Turing Test during the 1950s, the purpose of which was to identify the intelligence of an artificial system. The term "artificial intelligence" itself was coined in 1956 by researchers at Dartmouth College during a summer research project on the technology. Subsequently, the 1950s saw the establishment of AI as an academic discipline, and several academic experiments and progress in the development of premature AI technologies followed. However, it remained an area of relative scientific obscurity throughout the 1950s and 1960s, and the 1970s saw the wane of academic enthusiasm. Scarce

practical interest was shown in the field until the rise of big data and improved computer technology paved the entry of AI into the business environment and public conversations. (Haenlein & Kaplan, 2019; Taulli, 2019, s. 1-18; Girasa, 2020, s. 54).

The late 1980s and 1990s saw the beginning and slow emergence of a newfound AI enthusiasm. The private sector began to invest more than the government and public sectors into the field and significant improvements on several AI areas took place in this period. (Haenlein & Kaplan, 2019; Taulli, 2019, s. 1-18; Girasa, 2020, s. 54).

Haenlein and Kaplan have argued that AI in the future will become as central in everyday life as the internet and social media are today. As such, AI will not only impact our personal lives but also fundamentally transform how firms make decisions and interact with external stakeholders such as employees and customers (Haenlein & Kaplan, 2019; Taulli, 2019, s. 1-18; Girasa, 2020, s. 54).

Makridakis (2017) similarly claimed that AI will bring about extensive changes and affect all aspects of society. Its impact on firms and employment will be substantial, and the technology will enable people to buy goods and obtain services from anywhere in the world. It has been pointed out that those who utilize the internet and take risks to innovate products or services will possess significant advantages and experience success. However, Makridakis argued that there are also challenges in the development of this technology. Such as exploiting the benefits of AI. It is difficult to benefit from the opportunities for new products, services, and improvements in productivity while at the same time avoiding the dangers and disadvantages such as unemployment and increasing wealth inequality.

Artificial intelligence is an important phenomenon in this era of the history of technological development, which Brynjulfsson and MacAfee (2014) called "the second machine age." The machines previously developed during the industrial revolution imitated and improved upon human muscle power. By contrast, the computers of this new technological age are given the mental capacity and ability to understand and shape surrounding environments. As such, this technology has the potential to revolutionize many aspects of society as we know it.

Technologies that have great transformative effects on the economy, institutions, and social structures are referred to as *general purpose technologies* (GPTs). In terms of GPT theory, AI shows qualities that substantiates its central role in society and its vast effects on society. Among other things, AI is pervasive and spreads to many related and complementary sectors. It is a complex technology with various possible areas of application and is already found in all aspects of today's digital world. It also has the potential to be improved over

time. Finally, AI makes it easier for new innovations, like new business models, to be developed (Mazzucato, 2018, s. 141-145; Bekar, Carlaw & Lipsey, 2018, s. 1007-1010; Kommunal- og moderniseringsdepartementet, 2020, s.5-8; SINTEF, 2021; Noroff, 2018).

3.1 DEFINING AI

Defining AI is a difficult task and partly depends on which profession or activity is of interest for the definition. Given that AI is constantly evolving, numerous possible definitions of the concept exist. Some scholars describe AI as a digital computer´s or computer-controlled robot´s ability to perform tasks commonly related to intelligent beings. Another definition is that AI, sometimes referred to as machine intelligence (ML), revolves around the intelligence machines demonstrate, which contrasts with the natural intelligence displayed by humans or other animals. Another description emphasizes how computer systems can perform tasks that usually require human intelligence. Such as visual perception, speech recognition, decision-making, and translation between languages. (Girasa, 2020, s. 8-9).

Given these variations, AI can essentially be described as a system that performs acts, whether physical or digital, based on the interpretation and processing of structured or unstructured data to reach a certain goal. Such data is the "lifeblood" of AI. Computer systems are trained to learn from their experience and solve complex problems in different situations or environments, under the guidance of precise instructions (Kommunal- og moderniseringsdepartementet, 2020, s.9; Teknologirådet, 2018, s. 7-13). AI is the creation of "intelligent machines," and their intelligence lies in the fact that they are taught to work, react, and understand language like humans do. The key advantages of AI over human intelligence are its scalability, longevity, and continuous improvement capabilities (Akerkar, 2019, s. 3-6).

Making machines follow instructions is not new; computers have been programmed to perform various acts for a long time. Goodwin (2020) examined the difference between programmed algorithms and AI-based algorithms. Algorithms that are programmed are given precise descriptions of the actions they should perform. For example, a programmed algorithm with the aim of translating from Norwegian to English would require precise definitions about every possible nuance in the languages of Norwegian and English as well as every word. That is an unrealistic task, because both languages are so complex that it is impossible for a programmer to define everything. By contrast, other algorithms are based on

AI, and they thus possess the ability to learn. Much like the way children learn, AI algorithms are trained by the provision of exhaustingly many examples, which enables them to further their understanding of the information they are provided. An AI algorithm trained on example sentences in Norwegian and English will, with enough examples, become able to better understand how to translate between the two languages. Instead of programming all the linguistic nuances (Goodwin, 2020, s. 11-24).

3.3 TYPES OF AI

Güngör (2020) suggested AI as an umbrella term for various methodologies designed to provide computers with human-like mental abilities (such as hearing, seeing, reasoning, and learning). We can describe AI capabilities and characteristics in various ways, but two are focused on here: (1) characterization of different levels of AI and (2) different types of AI technologies.

3.3.1 Characterization of AI levels

Güngör (2020) outlined three main types of AI. The first is "*narrow AI*," which covers current techniques, applications, and algorithms that explain "what" is happening. Second, "*general AI*" is about a system that can learn and act intelligently across a range of environments and problems in a similar way to the methods used by a person. Third, "*super AI*" refers to AI that can be applied to any area and will outperform humans in all areas in the future.

Somewhat similarly, Girasa (2020, s. 10-11) characterized AI as consisting of several elements. The first is a*rtificial narrow intelligence (ANI),* which is considered "weak" intelligence because it concerns the performance of a singular task, which it generally accomplishes very well. Examples are playing chess against human experts, making sales, calculating predictions, autonomously driving automobiles, and performing speech and image recognition. Its weakness lies in its limitation to one task rather than having a range of uses. The second element is a*rtificial general intelligence (AGI),* constituting the next higher level of AI, known as "strong AI" or "human-level AI." It seeks to imitate the human brain, even though its development continues to lack the reasoning and other attributes of the brain. The question of how to classify a particular technology as ANI or AGI depends on whether it meets the *Turing Test* standard of whether its behavior resembles that of a human (and other measures). The more it resembles a human being, the more it can be characterized as AGI.

The last of Girasa's elements is *artificial superintelligence (ASI), which indicates* a futuristic characterization of AI as having surpassed the capacity of the human brain in creativity, social skills, and wisdom. ASI is the theme of sci-fi stories, which focus on the idea that robots become so intelligent that they make humans subject to their control.

A third way to characterize AI stems from the former Head of Google China and the CEO of Sinovation Ventures, Kai-Fu Lee. Lee thinks of AI as possessing four waves, which are occurring simultaneously and characterize AI's ascendance. *The first stage: Internet A.I.* while they are examining the vast amount of internet data, users label the worthiness of the data based on their individual preferences, demands, habits. *The second stage is Business A.I.* Here, managers can improve their decision-making through using algorithms trained on proprietary data sets to analyze customer purchases, machine maintenance, and complex business processes. *The third stage is Perception A.I.* This stage is illustrated by the collection and analysis of data not previously accomplished, such as the forms that occur in smart devices and interfaces, as well as face recognition and computer-vision applications. *The fourth stage, Autonomous A.I.,* integrates the three other stages to enable the machines to perceive and react to the world from which the data flows. These machines move instinctively, manipulate objects as a human person would, "see" surrounding environments, recognize patterns, determine how to correlate the data, make decisions (such as in automated assembly lines and warehouses), implement commercial tasks, and perform consumer chores (Girasa, 2020, 10-11).

3.3.2 Different AI technologies

Considering AI as an umbrella term implies the existence of subgroups or subfields. Hence, AI includes a variety of different sub-technologies, and various contributions to the literature indicate diverse concepts. This thesis focuses on seven main types of AI.

(1) *Machine learning*

This is the science of training devices or software to perform a task. These tasks include improving the machine's own capabilities by being given data and information for processing and by learning over time, without being explicitly programmed to do so. The programs or algorithms enable machines to improve themselves with added data and to make accurate predictions (Girasa, 2020, s.13-33; Taulli, 2019, s 39-68).

A subset of machine learning (ML) is *deep learning*, which is concerned with algorithms analogous to the human brain cells, called "neurons." The difference is exemplified in the fact that an ML algorithm can be trained to recognize horses through the process of supervised learning and will provide good results, but with some limitations. Deep learning, however, will solve accuracy problems through its analysis of all the data, pixel by pixel, in order to find relationships, using a neural network which mimics the human brain. (Girasa, 2020, s.13-33; Taulli, 2019, s. 69-90).

Deep learning is thus a type of system that allows for processing vast data to find relationships and patterns that even humans are unable to detect. It is an artificial neural network modeled that use layers of artificial neurons, or computational units, to receive input and to apply an activation function. As each layer is added, the machine is trained further (Girasa, 2020, s.13-33; Taulli, 2019, s. 69-90). Deep learning utilizes networks capable of unsupervised learning based on unstructured or unlabeled data. The neural networks underpinning deep learning capabilities are becoming ever more efficient and accurate due to unprecedented access to "big data" and improvements in computing power (Akerkar, 2019, s. 3-6).

(2) Robotics

This field refers to the study of technology associated with the design, fabrication, theory and application of robots. It is an interdisciplinary science field which comprises several types of engineering disciplines – such as mechanics, electronics, and information engineering and computer systems. AI robotics has evolved from a singular task machine (which lacked AI) to a machine that operates within an environment and is able to perceive, plan, and execute in accordance with the massive data incorporated within it and continuously added to.

Robots are exploited in a many ways, including industrial robots for safety in the workplace, cognitive robots performing complex tasks, and human–robot interfaces that analyze the information flow between user and robot (Girasa, 2020, s.13-33).

Taulli (2019) divides the topic of robotics into two aspects: *robotic process automation (RPA)* and *physical robots*. First, RPA refers to software-based robots or "bots" that allow the usage of low-code visual drag-and-drop systems to automate the workflow of a process. Examples are the inputting, changing, and tracing of HR documents, contacts, and employee information; processing an

insurance claim; sending invoices; and detecting issues with customer service and acting to resolve the problems. This is done when robots replicate the workflow for an application. Hence, RPA can be thought of as a "digital employee." It can either be "unattended RPA," consisting of a completely autonomous process where the bot runs in the background, or "robotic desktop automation," wherein RPA helps employees with their jobs and tasks. (Taulli, 2019, s. 91-142).

Second, *physical robots* focus on physical machines. Such as tiny machines that explore the human body, or flying machines and underwater vessels. They must be able to take certain actions (such as moving an item, and talking) and understand the environment in order to act. This is made possible by sensors and feedback systems. Additionally, it needs to contain some form of intelligence, either AI capabilities or programmed instructions, to enable it to take action. These robots can either be operated by the remote control of humans or through autonomous actions (Taulli, 2019, s. 91-142).

(3) *Speech processing*

This is described as the study of speech signals and processing methods. The field is located at the intersection of speech signals and natural language processing. These signals are in digital format and include the acquisition, manipulation, storage, transfer, and output of speech signals, without use of hands or eyes. Many problems are associated with speech processing, such as accents, loudness, particular modes of speaking, and the use of language. For example, translations on TV often contain numerous inaccuracies. AI has often been instrumental in improving reliability by accurately representing what has been stated by human speakers. The individual preferences of humans determine the accuracy of the speech processing software. (Girasa, 2020, s.13-33). Speech processing has generated valuable tools, such as the conversion of spoken text into machine processable text in Word documents (Akerkar, 2019, s. 3-6).

(4) Natural Language Processing (NLP)

This field is concerned with the interactions between computers and human language. It concerns the intersections of computer science, AI, and computational linguistics, and focuses on how computers process and analyze natural language data. "Natural language" refers to the way humans communicate with each other through speech and text. Natural language is the process of building computational

tools that respect language by the use of machine translation, summarization, questions, and answers (Girasa, 2020, s.13-33).

Language is what sets humans apart from animals and may be considered key to the Turing Test. Although computers have understood computer languages for years, human languages are different. Where computer languages are literal, with limited sets of commands and strict logic, human language is complex and dynamic. It is used in many variations and poses many challenges for NLP technologies. Words are constantly changing; people make grammar mistakes; sarcasm, accents, and dialects are complicated; and conversations can be non-linear and have interruptions.

NLP involves two key steps: 1) cleaning and preprocessing the text and 2) language understanding and generation. The technology has – for example – been used to improve sales for businesses, to manage depression, and to create content. It is used in virtual assistants, chatbots, and smart speakers (Taulli, 2019, s. 103-124).

(5) Computer Vision

This field is defined as the technology that enables AI system to extract information, build models, and apply multi-dimensional data in a range of computer-generated activities. Subgroups include computational vision, which is the process of recording, analyzing, and comprehending visual images that are then utilized in machine vision for various social and scientific purposes. These purposes include the use of feature engineering to make machine learning algorithms operate efficiently, and machine vision, which comprises several technologies such as systems engineering. Machine vision is generally the application of computational vision in an industrial or practical application or process. With computer vision, facial recognition technology machines are able to extract data that can assist in identifying or verifying a particular individual from a digital image or video frame (Girasa, 2020, s.13-33).

(6) Artificial neural networks

This term refers to computational models based on the structure and function of biological neural networks. Information flowing through the network affects the structure of the network, because a neural network changes – or learns, in a sense –

based on the input and output. It is a computing system made up of a number of simple interconnected processing elements, which process information through their dynamic state responses to external inputs. The networks seek to imitate the process by learning from examples given from complex data inputs. It is a framework for algorithms to work together. The technology has been used to perform various tasks like medical diagnosis, social network, and video games (Girasa, 2020, s.13-33).

(7) Evolutionary computation

This is a subfield composed of algorithms that relate to the use of evolutionary systems as computational processes for solving complex problems. Scientists and engineers use it as a tool while commencing a set of candidate solutions, which are updated periodically through a process of trial and error. The generations are randomly detrended, removing less desirable solutions, coupled with random changes. The optimal solutions are periodically presented and altered to achieve maximum optimization (Girasa, 2020, s.13-33).

(8) Knowledge-based systems

These systems are also known as "expert systems" *and* refer to the concept of rule-based knowledge representation, with emphasis on reasoning with uncertainty. Akerkar, 2019, s. 3-6).

3.4 AI IN DIFFERENT PARTS OF SOCIETY

In its role as a new GPT, AI will have substantial societal effects and will change numerous sectors, areas, and industries. Telle (2017) explored how ML, neural networks, and AI are threatening the existence of humanity. However, he also outlined some opportunities that follow the introduction of AI technologies, such as improving efficiency in various processes, the translation of text, and the analysis and classification of images. Furthermore, Telle argued that more knowledge on the workings of AI makes it easier to have fruitful discussions about its possible consequences. The importance of using machines sensibly by ensuring that

open and free academic research continues to steer the technology's development – rather than an oligopoly of powerful companies – is stressed. Finally, in many fields where machines are taking over, this is often because of increased bureaucratization, which infiltrates more parts of life.

Krokan and Aarli (2020) concentrated on platforms and AI in their exploration of the status quo and the possibilities and challenges associated with the digital transformation of work processes in courts. They argued that digitalization is first and foremost about finding solutions for the interplay between humans and technology. They stated that technology may be utilized in four ways: 1) *support existing work processes*; 2) *contribute to new work processes; 3) take over the judge's work tasks* and 4) ensure *the quality of judges' decisions.*

Girasa (2020) sketches a rather detailed and comprehensive list consisting of different societal areas and how AI is likely to change them. Similarly, the Norwegian Board of Technology presented some sectors and how AI may affect them (Teknologirådet, 2018). Among other things, they listed sectors such as:

1) *Health care* (see also Hainc, Federau, Stieltes, Blatow, Bink, & Stippich, 2017; Alhasan & Hasaneen, 2021; Shung & Sung, 2020)
2) *Banking, finance, and accounting* (see also Tratjenberg, 2018; Huse, 2020)
3) *Work life, worker safety, employment, workplace environment, and human resources* (see also Elliott, 2018; Lind, 2021; Østerlund, Jarrahi, Willis, Boyd & Wolf, 2020; Allal-Chérif, Aránega & Sánchez, 2021)
4) *Marketing* (see also Davenport, Guha, Grewal & Bressgott, 2020; Gentsch, 2019)
5) *Retail* (see also Anica-Popa, Anica-Popa, Radulescu & Vrîncianu, 2021))
6) *Government* (see also Jiménez-Gómez, Cano-Carrillo & Lanas, 2020)
7) *Businesses and prediction by businesses* (see also Güngör, 2020; Milkau, 2019)
8) *Education* (see also Jaiswal & Arun, 2021)
9) *Robots and robotics*
10) *Autonomous vehicles*
11) *Law firms*
12) *Military and national security*
13) *Sports and training*
14) *Energy and energy management.*

This thesis focuses on applying AI in areas related to the environment. Such "green AI" has been studied from various perspectives. Van Wynsberghe (2021) presented the concept of "sustainable AI" and related it to AI applications. Examples are how to foster change in the

idea generation, training, implementation, and governance of AI products to improve ecological integrity and social justice. Van Wynsberghe emphasized developing AI that supports societal values that are fundamental to society. The paper was meant to inspire stakeholders to connect AI with the environment.

Girasa (2020, s. 23-59) listed – among other things – the potential use of AI in combination with data-gathering sensors to manage systems, make power grids smart, and provide a basis for the construction of "smart buildings." Similarly, Aguilar et al. (2021) examined the case of smart buildings based on the fact that buildings are major energy consumers in cities and the need for improvement of energy management systems. AI techniques bear a potentially fundamental role in these improvements. They present a systematic review of the literature on research oriented towards improving energy management systems for smart buildings using AI. The paper aims to merge various approaches, strategies, and procedures for how and when to use AI techniques for energy management in smart buildings. To establish the positioning of researchers and visualize the current challenges and opportunities in each domain, they grouped the literature contributions according to the concept of "autonomous cycles of data analysis tasks." This refers to a set of data analysis tasks that interact with each other and have different roles: observation of the process; analysis and interpretations; and decision-making. The aims is to improve the process under study. An autonomous management system requires specialized tasks, such as like monitoring, analysis, and decision-making, to reach objectives in the environment – such as improving energy efficiency. The integration of tasks in a cycle allows the autonomous resolution of system problems. The models stipulated for these tasks are based on AI techniques.

Tushar, Wijerathne, Li, Yuen, Poor, Saha and Wood (2018) stated that buildings consume 60% of global electricity. They proposed the Internet of Things (IoT) and AI technology-based ML as providing opportunities to integrate intelligence into building management systems for monitoring and managing a building's energy consumption to reduce costs. They demonstrated how to extract high-level building occupancy information through simple low-cost IoT sensors so as to study how human activities impact a building's energy use.

Furthermore, Ygitcanlar, Mehmood, and Corchado (2021) highlighted the need for a consolidated AI approach, namely green AI, to further support the smart city transformation. They stated that smart cities and AI are becoming frequent topics of discussion. They claimed that a green AI approach and even the "green AI" concept is an enabler of the smart city

transformation. It offers the opportunity to move away from purely technocentric efficiency solutions toward efficient sustainable solutions that can realize the desired urban future.

3.5 WHY AI IS IMPORTANT IN SOCIETY AND BUSINESS

AI touches on almost every aspect of our lives and has become a prominent business buzzword. It brings promises of significantly transforming existing business models and at the same time creating new ones. AI is found almost everywhere in society – in cars, on Facebook, Netflix, Google, YouTube, and online newspapers. Since it is used in so many different areas, it may be easy to think that the term has lost all meaning. However, it is important to understand what AI is and how and where it can be applied. It will become relevant for every industry and as such is proving to be a critical priority for both startups and traditional companies. More and more jobs and areas of society will require AI-related knowledge and competencies. The leading firms in the world are trying to gain a head-start in the field. AI solutions differ from what people are used to and will have a much greater impact and bring new opportunities and challenges. AI will change how we engage with the world around us. It will advance not only how business is done but also the kind of work people do. As such, it will foster new creativity and inventiveness. For businesses, this implies that the implementation of AI means less time spent on routine administrative tasks internally and gaining more satisfied customers externally. However, many organizations still fail to effectively apply AI to solve their specific business needs (Taulli, 2019, s. ix-xii; Akerkar, 2019, s. v-vii, 3-6; Bjørkeng, 2018, s. 9-11).

Several contributions to the literature assess how AI will have a significant impact and why society and the business world should care. Haenlein and Kaplan (2021) argued that although nobody can tell for sure what tomorrow will bring, it is certain that AI has made an entry and will transform the business world and society; it is likely to create the *fourth industrial revolution.* This implies significant adaptations, such as equipping employees with new skills, the discussion and analysis of ethical questions, and developing and implementing new regulation. Furthermore, they stated that quality academic research is required to guide the decision-making for consumers, managers, and public policy-makers. Additionally,

regulation and legislation are needed on a global level to ensure that humans can flourish and coexist with AI to achieve a fulfilling future.

Trajtenberg (2018) similarly suggested that AI will disrupt society, working life, and the business world. He departed from the point that historically, dismal prophecies regarding the impact of great technological advances rarely come to pass. However, he argued that many occupations will vanish with the advent of AI as a new GPT. Therefore, society should search for ways to improve the detrimental effects of AI and enhance the positive effects in education, skills development, and the professionalization of personal care occupations. Furthermore, to also address the effects of the direction of technical advances (the "human-enhancing innovations" versus the "human-replacing innovations").

To meet the challenges of the AI revolution – such as unemployment, displaced workers, and vast demographic transitions – governments will have to design innovative strategies in key areas (Trajtenberg 2018). First, the revolutionization of education means that AI requires new skills. Second, many future jobs will be in personal services, which calls for an upgrade of the sector's schooling, academic standards, advanced curriculums, use of technology and so on. Finally, AI-based "human-enhancing innovations" have the potential to unleash a new wave of human creativity and productivity, particularly in services. By contrast, "human-replacing innovations" either decrease employment or create unworthy jobs. Here some direction is needed in the technological development.

Trajtenberg also argued that although AI may lead to a future where humans may be rendered obsolete and their jobs will vanish, with mass unemployment becoming the "new normal," many occupations will simply undergo significant changes. There is a need to anticipate the required institutional changes and to experiment in the design of new policies, particularly in education and skills development. Further needs to identify are the professionalization of service occupations and in areas affecting the direction of technical advance. In light of these reflections, it is evident that the world of business must not only acknowledge the rise of this new pervasive technology but must also take action and adapt to its accompanying changes.

Güngör (2020) argued that although AI is increasingly applied in many areas of commercial business, as well as in government organizations, it is still not clear how the technology has the potential to create value and how it will impact various stakeholders. However, organizations should explore AI value creation opportunities in the value chain – that is, which parts of the value chain AI can be applied in. Additionally, to use the multi-stakeholder perspective to assess the potential benefits (e.g., revenue increase, cost savings,

risk mitigation) from the different perspectives of shareholders, customers, employees, suppliers, and society. Furthermore, Güngör sketched the value creation potential of AI from the perspectives of different stakeholders and developed guidelines for exploring a high-level AI business strategy by considering a multi-stakeholder perspective.

In their discussion about the use and impact of intelligent machines on industries, Østerlund, Jarrahi, Willis, Boyd and Wolf (2020) assessed how the integration of AI and work remains a challenge. There is a need for better empirical understanding and guidance of the information community in this area, in a coherent way. They argued that research needs to focus on how AI is becoming a part of the world of work, how the world of work is becoming part of AI, and how the information community can help to address the topic of work in the age of intelligent machines. There are numerous possible AI futures. Interdisciplinarity as well as embedding AI within people's practices, infrastructures, and organizational life are vital tasks in the face of AI development. To create more inclusive and diversified AI for the future. The authors' aim was to provide an impetus for disciplinary convergence around the interplay between AI and the world of work.

3.6 CONTROVERSIES ABOUT AI

AI is considered to possess immense potential to make machines perform better than humans. This situation prompts both ideas and concerns. Some attribute the technology with substantial risks to society; when coupled with the profit-based view on private companies' motivations, this may be regarded as a case of harm to – and exploitation of – society (Ambec & Lanoie, 2008; Bero, 2019; Buranyi, 2017; Fabbri, Lai, Grundy & Bero, 2018; Besley, McCright, Martin, Elliot & Zahry, 2017). Such assessments have been given by actors outside of the process, such as the media. Therefore, one might ask how the actors involved in industrial R&D with AI might describe the field, and whether those reflections represent relevant cases of social innovation oriented to sustainability.

The following chapter presents the empirical context and case of this thesis, which is the work by Telenor's research department on AI for social innovation oriented towards sustainability. The subsequent analysis shows that AI technologies can indeed be an important new trajectory fostering sustainability and the green transition.

4.0 Telenor Research and Artificial Intelligence

4.1 THE CASE OF TELENOR AND TELENOR RESEARCH

Telenor, one of the leading industrial firms in Norway, is a telecommunications company that operates in the Nordic European countries and various parts of Asia. The operations in these countries are the various subsidiary companies. These are referred to as “business units” (BUs) and are responsible for the daily management of the operations and work Telenor offers in the form of mobile telephony and other products and services. The company is led by Telenor Group, which has the overall responsibility for the entire company. The company places great emphasis on research development, and innovation, and within Telenor Group lies the research department. Telenor Research have existed for a long time and has several different roles and responsibilities. Including supporting the business sections of Telenor in matters such as choice of technologies and new ways of operating; as well as conducting research and building competence and knowledge in various areas of strategic importance to Telenor. Telenor Research is expected to look beyond the daily running of the company and consider possible future market opportunities. Telenor is a future-oriented company on a digital journey with the wish to empower societies. It aim to be at the forefront of technological development, constantly innovating and exploring for the benefit of its customers, businesses, and society in general. The company has also set ambitious sustainability goals towards which they are working. These include use of renewable energy and have a focus on environmental efforts. Telenor is one of the industrial actors that has sensed the opportunities and potential of AI technology possess. It has actively sought to understand more about AI and to investigate areas of application and has attempted to implement it within the various parts of the company. For example, network AI is an area in which the company seek to optimize their network operations. Artificial intelligence is also relevant for improving the company´s interactions with and the service it provides to customers. A third area is exploring AI´s connection with IoT and look at the potential that possibly lie here. (Telenor, 2022B; Telenor, 2022C; Telenor, 2022D; Telenor Group, 2019A; Telenor Group, 2019B; Telenor Group, 2019C, Telenor Group, 2018A; Telenor Group, 2018B; Telenor Group, 2017).

4.2 THE AI & ANALYTICS TEAM AND THEIR WORK ON AI

As discussed previously, the last decades have seen the emergence and increased relevance of AI. Based on this trend, its opportunities of competitive advantage, and Telenor´s promoted wish to become a data driven company (Telenor Group, 2022), the leaders in the research department saw the need to build competence in this area. Accordingly, the *Analytics & AI Team* (hereafter referred to as the AI team) was established within the research department at the beginning of the 2010s.

The work of the AI team is structured around certain areas of strategic importance. One of the team´s goals is to advance research and in areas it believes will be important for Telenor in the future. For example, the team considers it important to contribute to building AI competence both in Norway and in Europe. Thus, in addition to collaborating with different internal and external actors on their various research projects, they also form other kinds of collaborations. For example, the team has participated in EU-financed projects such as "AI4EU" which involves several European partner organizations. One of the aims of this project is to strengthen AI knowledge and competence in Europe. In addition, together with NTNU, the team established what is now known as "the Norwegian Open AI Lab". Telenor contributes to the lab in terms of both financial investments and scientists. The goal of the lab is to create and build a national knowledge base on AI. (Telenor Group, 2020; Telenor Group, 2017).

Another area of strategic importance is to building Telenor´s brand and contributing to the establishment of a data science culture within the company. One way in which the team achieves this is by being strategic in the criteria it applies when choosing projects. For instance, selecting cases that contribute to empowering societies helps to build Telenor´s brand, and picking projects that may be scaled, such as internal business problems that are similar to several of the BUs. This enables the team to maximize the return on the work conducted for the project. The team also searches for new opportunities and potential market positions for Telenor to take in the future and advices the BUs on decisions regarding such matters as the acquirement of new technology and selection of vendors. (Telenor, 2022B; Telenor, 2022C; Telenor, 2022D; Telenor Group, 2019A; Telenor Group, 2019B; Telenor Group, 2019C, Telenor Group, 2018A; Telenor Group, 2018B; Telenor Group, 2017).

The AI team´s R&D work on AI based tools, solutions, products, and technologies takes place in various ways. The team´s R&D activity is organized into projects that ranges from speech-to-text translations to power-saving algorithms. The strategies and approaches to the work differs from project to project. For some projects, the team conducts internal research, publishes academic papers, works with partners in academia, and supervises students. These projects tend to be theoretically oriented and centered on building knowledge which is then used to provide Telenor with the best possible advice and support in matters of operations and business. Other projects involve more practical applications. These often involves collaborations with internal partners, such as one of the BUs. Thus, the AI team is motivated both by doing research and, at the same time, supporting the practical application of the insights and products created. As explained earlier in section 2.5.2, a distinction is made between "academic" and "applied" work approaches.

The AI team´s project portfolio is thus varied and differ not only in approaches to the work but also the themes of the projects. For example, they have projects that revolve around optimizing speech to text transcriptions in Norwegian, and others are algorithms implemented into small sensors to detect various objects. Further projects centers around environmental challenges and two of these will be investigated in this thesis.

4.2.1 The Green Radio project

One of the AI team´s projects examined in this thesis is "the Green Radio-project". After having worked together with the Telenor Research´s AI team on other projects, data scientists and engineers in Telenor Denmark proposed an idea for a new project. Since networks operations and power use were connected with a lot of costs, they wanted to look into ways of optimizing these aspects of their daily operations. Accordingly, the AI team and Telenor Denmark began exploring whether they could use and analyze historical data to save more power and improve how the company´s mobile network operations. The AI team developed an AI algorithm to achieve this and tested it in practice on the base stations. The aim of the project was to reduce of energy use on Telenor´s various base stations, and they began to look into ways of using data on their radio networks to determining whether there were any periods

during the day when the power could be turned off without affecting the customers´ experience. The team was able to save around 700 tons of CO_2 per year. After testing the solution in Telenor Denmark, it was tested in the company´s other BUs in Bangladesh, Pakistan, and Myanmar. (Telenor Group, 2020B)

4.2.2 The Air Quality project

The other example project that is be assessed in this thesis is "the Air Quality project", which began with Trondheim commune wishing to explore new technologies and find ways of monitoring of the air quality in their city. Although the city already had a few expensive, high-quality sensors in different parts of their city, they were too few, stationary, and too expensive to scale. Telenor wanted to see if cheaper, lower-quality sensors could be placed all around the city to achieve better coverage. The AI team developed an AI model to analyze the air quality in the city and make predictions about the future. The team collaborated with several external actors in this project. In addition to Trondheim commune, it also partnered with NTNU and the Norwegian Open AI lab. The project was also linked to the "AI4EU-project" funded by Horizon Europe. (Telenor, 2022A)

5.0 Methodology and data

This chapter briefly presents the data collection process, and the methods adopted to address the research question on the case of Telenor Research and AI. taken. Explanations and arguments are provided to underline why the methods chosen were considered the most appropriate in the context of this study. In addition, various challenges and ethical considerations are assessed and reflected upon. The first section explains the choice of research design, the research question, and the methods. The second section describes the data collection, and the third section focuses on the data analysis. While the last section reflects on the rigor of the research.

5.1 RESEARCH DESIGN

5.1.1 *Research questions and methods*

Research projects may be designed in several ways. I begin by explaining the choice of research question and method. The project at hand saw the construction of three research questions. One overarching main question: *Can R&D of AI carried out by large companies´ R&D departments lead to social innovation that can contribute to sustainability*? Followed by the sub-questions of (1) *How is Telenor Research´s AI work described by the actors involved in their projects?* And (2) *Do these descriptions represent relevant cases of social innovation oriented towards sustainability?*

Research questions are classified differently, and Dillon (1984) has identified some main categories to understand the properties of questions. These may help to better understand the goals of this research project and what dimensions of the phenomenon – Telenor Research´s AI work and social innovation directed at sustainability – that is to be studied. My main research question can be categorized as what Dillon refers to as a third-order research question dealing with "contingencies." Such questions produce knowledge about the relations associated with the phenomenon under study. My ambition in addressing this question was to gather information about, examine, and understand how the phenomenon of "industrial actors carrying out R&D of AI*"* could be related and connected to the phenomenon of "social innovators oriented towards sustainability". The first sub-question

arguably falls into the first-order research questions, namely those that address "properties." These questions seek to produce descriptive knowledge of a particular phenomenon, including what the phenomena is and what its attributes are. The goal of my question was to reveal information about how the informants described and characterized Telenor Research´s AI work. The second sub-question can be categorized into a second-order research question that addresses "comparisons". These types of questions concern comparisons of phenomena to identify similarities and differences. The intention behind this question was to compare the descriptions of the work by the actors involved and to understand whether they coincide with or differ from social innovation oriented towards sustainability. The research questions were constructed in this way to delimit the research and to specify precisely what dimensions of the phenomenon were to be studied in this project.

In addition, the research questions have implications for the overall research design. Identifying what parts of a phenomenon to examine is related to choosing what approach should be used to collect appropriate data and information to answer the questions. A distinction can be drawn between quantitative and qualitative research methods. The first is characterized by the identification of regularities, patterns, and distinguishing features of a population to establish statistical relations of similarity and difference among the population´s members. The latter addresses "why" and "how" questions and questions regarding what actors do in a particular a case, why they act in this way, and what produces change in the actors. (Stratford & Bradshaw, 2016, s. 118-120). Given these criteria, this research project may be characterized as a qualitative study as it aims to understand what actors do, why they operate as such, and what implications this has. The choice of qualitative research was based on the fact that it was the most appropriate method to explore why and how this particular research department engages in R&D in AI technology, and what implications and effects this work has.

5.1.2 A case study approach

A case study approach is one of the most used approaches and involves an in-depth examination of a specific case to understand a more general phenomenon. It is a useful tool for producing deep, concrete explanations of a phenomenon. (Yin, 2003, s.5-17; Baxter, 2016, s. 130-144). This approach was selected based on the aim of understandig the overarching phenomena of "Telenor Research´s and their work on AI" and its relatedness to "social

innovation oriented toward sustainability". To understand this phenomenon, two of the projects in the AI team´s project portfolio was selected: "the Green Radio project" and "the Air Quality project". These projects were selected due to their orientation toward sustainability and the green shift. This study may also be regarded as a case of a general phenomenon, namely "how industrial actors engaging in R&D of AI may be regarded as cases of social innovation directed at sustainability". Thus, the case of Telenor might apply to other industrial actors engaging in R&D of AI. The selection of cases for this research project was based on the fact that I got the opportunity to participate in a research project examining Telenor Research´s R&D-work at the OSIRIS-center at TIK (Center for Technology, Innovation, and Culture at the University of Oslo). As a result of this, I chose to focus on the AI work conducted by the company´s research department for my research and to examine it in light of social innovation for sustainability.

Case study research may focus either on single or multiple cases (Yin, 2003, s. 18-19). For this study, I chose a cross-case approach, which enabled me to compare examples of the AI work conducted in the research department. Multiple case studies arguably broaden the scope of the exploration of phenomenon and are valuable because it allows for a better understanding of the phenomena in different contexts. (Baxter, 2016, s. 135-142).

I identified the case study approach as the most appropriate approach to apply in this project because it allowed for me to dive deeper into some specific examples to better understand the overall phenomenon. Case studies are also regarded as particularly advantageous when faced with "how" and "why" research questions (Yin, 2003, s. 14). The findings of this study may be regarded as generalizable because they represent examples more overarching phenomenon Generalizability, or transferability, refers to the degree to which the findings apply to other cases of the phenomenon in question. Proving a study´s generalizability makes the study findings more valuable and useful. In this study (Baxter, 2016, s. 142-144).

5.1.3 Qualitative interviewing

Once the research questions and the methodological approach were determined, the question of how to approach the data collection had to be addressed. Since this research project was driven by the wish to obtain more knowledge about the AI work conducted by Telenor Research, qualitative in-depth interviews were identified as the most appropriate approach. This data collection strategy enabled me to gather information directly from the actors

involved in the work and to ask the informants targeted questions to collect information directly oriented, and thus most relevant to the study

The aim of qualitative in-depth interviews is to discover aspects of a phenomenon that one cannot directly observe such as thoughts, intentions, and opinions. (Patton, 2002, s.340-341). They can be described as verbal interchanges in which an interviewer tries to elicit some form of information from an informant. According to Dunn, the strategy is particularly appropriate for research projects driven by a wish to examine complex behaviors and motivations and to collect a diversity of opinions, meanings, and experience. (Dunn, 2016, s.149-151). The choice of qualitative interviews as the data collection strategy for this project was thus based on the compatibility between these strengths and the goals of the project. Qualitative interviewing enabled me to gather of in-depth information about events, experiences, and opinions related to Telenor Research´s AI work from several of the people involved in the work. This allowed a diversity in perspectives which enabled a deeper understanding of the work done by the research department on AI.

Interviews are traditionally conducted physically, face-to-face. However, in recent years they have been increasingly conducted via seen mediated communication of various kinds (e.g., telephone interviews, video conferencing interviews). (Dunn, 2016, s. 149). Since this research project was conducted during the COVID-19 pandemic, it was important to ensure that the research design was flexible and adhered to national restrictions and recommendations. This was one of the main reasons for conducting interviews via online video conferencing platforms rather than physical interviews. Challenges in this regard has been seeked met through keeping the research design flexible and finding ways to utilize the possibilities of the situation rather than focusing on the restrictions. In addressing the challenges posed by the pandemic restrictions, I was able to use the possibilities presented by the situation to my advantage. for example, I was able to take advantage of the fact that the informants could share additional information with me (e.g., presentations to explain different project and articles they referred to in conversations) over digital platforms during the interviews. This allowed me to understand their perspectives and information in new and insightful ways that would not have been possible during physical interviews.

5.1.4 Data sources

The information produced in this project thus stems mainly from primary data sources gathered through these qualitative in-depth interviews – that is, original material in the form of raw data about the case. This type of data provides information that is directly relevant to the specific case. (Booth, Colomb, Williams, Bizup, & Fitzgerald, 2016, s. 65-83). In this project, I was able to ask the informants targeted questions to obtain information that was directly relevant to this study. To better understand the raw data and place them in context, secondary data sources were also used. Secondary sources refer to books, articles, and official reports based on primary sources and written for an academic or professional audience, namely the literary body of an academic discipline. (Booth, Colomb, Williams, Bizup, & Fitzgerald, 2016, s. 65-83). These were mainly collected through search engines such as the (online and offline) university library at UiO and search engines, such as Google Scholar.

5.2 DATA COLLECTION

5.2.1 Sampling strategy

The sample – that is, the participants selected in the study from the larger population – consisted of various employees of Telenor and its partners who were in some way involved in the AI work conducted by Telenor Research. The informants were selected and included into the study through "snowball sampling", which refers to the identification of new study subjects based on the recommendation of initial or existing participants. A possible risk associated with this strategy is that it can produce an "echo chamber effect" with very similar descriptions and opinions. To secure more diversity of opinion, I drew inspiration from another purposive sampling technique, criterion sampling, and established certain criteria to guide to guide the informants in recommending new interview subjects. I, for example, requested new interview subjects in different positions and roles. This ensured that the sample did not consist only of scientists in the AI team but also included leading figures in Telenor Research, and employees of external and internal partner organizations to achieve greater variation in perspectives. (Stratford & Bradshaw, 2016, s. 118-128).

5.2.3 Informants

To ensure that the informants were relevant to this research project, while also keeping variety within the sample, four categories were constructed. These were intended to identify the types of informants most appropriate to include in the study. With the help and advice from my supervisor, I found it most useful to gather information from people involved in the work process, people more on the receiving end of the results derived from the work; and those in leading positions within Telenor Research. Thus, the first category consisted of the (1) "leading figures in Telenor Research." Three of the informants were in this category (interviews 1 and 2 (same informant), interview 12 and interview 18; see Table 5.1). These interviews were mainly centered around general and strategical aspects of Telenor Research´s AI work. (2) The second category was "scientists on the AI team in Telenor Research". Most of the informants of the study were in this category as the main goal of this research was to examine Telenor Research and their AI work, about which the scientists of the team were able to provide useful information. It should be noted that the interviews 1, 5 and 7 focused on AI projects that were not selected for closer examination in this thesis. The reason for this was that I had not at the time decided on which projects to examine in detail. However, these interviews still provided valuable insights into Telenor Research´s AI work. (3) The third category was labeled "internal actors from the BUs" which consisted of the informants in interviews 13, 14 and 16. While the first of these interviews were focused more on the department´s general AI work, the latter two interviews were mostly centered on the Green Radio-project. (4) The last category was "external actors," which included the informants in interviews 8, 9 and 11. The information provided in these interviews was mostly related to work on the Air Quality project, as various employees of some of the external partners of Telenor Research´s external partners worked on this project.

Table 5.1. Overview of the interviews

INTERVIEW NUMBER	***INFORMANT CATEGORY***	***MAIN TOPIC***	***DATE***	***DURATION***	***LOCATION***
INTERVIEW 1	2 (Note: two of the scientists	TinyML-project.	14.10.2021	1 hour. 16 minutes	Telenor´s offices at Fornebu

	was interviewed here)	Overview of Telenor Research´s AI work			
INTERVIEW 2	1 (Note: same informant as in interview 3)	Overview of Telenor Research´s AI work	03.11.2021	58 minutes	Microsoft Teams
INTERVIEW 3	1 (Note: same informant as in interview 2)	Overview of Telenor Research´s AI work	26.11.2021	1 hour. 2 minutes	Microsoft Teams
INTERVIEW 4	2	Overview of Telenor Research´s AI work	02.12.2021	55 minutes	Microsoft Teams
INTERVIEW 5	2	Speech-to-text-project	09.12.2021	1 hour. 14 minutes	Zoom
INTERVIEW 6	2	Air Quality-project	17.01.2022	1 hour. 2 minutes	Microsoft Teams
INTERVIEW 7	2	Battery-project	31.01.2022	52 minutes	Zoom
INTERVIEW 8	4	Air Quality-project	02.02.2022	1 hour. 7 minutes	Google Meet
INTERVIEW 9	4	Air Quality-project	03.02.2022	28 minutes	Google Meet
INTERVIEW 10	2	Air Quality-project	07.02.2022	37 minutes	Microsoft Teams

INTERVIEW 11	4	Air Quality-project	08.02.2022	26 minutes	Google Meet
INTERVIEW 12	1	Overview of Telenor Research´s AI-work	11.02.2022	55 minutes	Microsoft Teams
INTERVIEW 13	3	Overview of Telenor Research´s AI work	15.02.2022	56 minutes	Zoom
INTERVIEW 14	3	Green Radio-project	16.02.2022	43 minutes	Zoom
INTERVIEW 15	2	Green Radio-project	23.02.2022A	34 minutes	Zoom
INTERVIEW 16	3	Green Radio-project	23.02.2022B	32 minutes	Zoom
INTERVIEW 17	2	Green Radio-project	02.03.2022A	1 hour	Microsoft Teams
INTERVIEW 18	1	Overview of Telenor Research´s AI work	02.03.2022B	57 minutes	Microsoft Teams

5.2.2 Preparing for and conducting the interviews

The interviews conducted for this research project were semi-structured interviews, so they were structured around a set of ordered but flexible questions. I used an interview guide and identified certain general, overarching themes that I wanted to cover in the various interviews. (Dunn, 2016, s.150-188). For each theme, I prepared example questions. This facilitated the questioning of the informants and allowed me to sustain a flexible approach to the interviews. The informants were mainly asked to talk more or less freely about some of these pre-determined themes, which gave them the freedom to deicide themselves what was most important. This was an attempt to avoid steering the interviewees, which may have affected the answers and the information they provided. Constructing the interviews in such a way allowed the informants significant freedom to identify the interesting information, while providing some structure to ensure the information they offered was relevant.

I constructed four different interview guides, one for each of the four categories of informants. In general, the themes in the guides were mostly similar (e.g., motivations, work procedures, results). However, there were some variations, as not all types of questions were deemed relevant for each type of informant. For example, an informant from informant from category 4 (*external partners*) was not asked how Telenor Research´s AI work was organized and structured.

A funnel structure was used to order the themes, which allowed the informants to "warm up" by discussing some general themes before working towards more specific ones. (Dunn, 2016, s.150-188). The questions asked in the interview was guided by Patton´s (2002) categorization of interview questions. This allowed me to be clear about what was being asked and made it easier for the informants to respond appropriately. It was also a way of ensuring that relevant information was obtained. The questions asked during the interviews were mainly about what Patton refers to as *experience and behavior*, *opinions and values*, and *background/demography*. These were asked to gather information about what the informants experienced, how they acted and worked, what they thought about collaborations, Telenor Research´s AI work; and some background information about them to establish their roles and responsibilities in relation to the work. To avoid influencing the informants' responses, I asked open-ended questions. For example, instead of presupposing the informant´s opinions or experiences, I asked them to describe their views and actions themselves. Questions included the following: "What is your opinion on …?" "Can you tell me a bit about this project?" (Patton, 2002, s. 353-354).

Access to the informants was facilitated by my participation in the OSIRIS-project. The researchers at the OSIRIS center helped with putting me in contact with some initial informants who, in turn, pointed me in the direction of other relevant informants. The potential informants received emails requesting their participation in the study. Those who agreed an information document. This document provided a description of the project and its overall purpose, goals, ad motivations. Attached to this document was a declaration of consent that the informants were asked to sign and send over to secure their willingness to participate in the project. In order to secure a good and professional relation to the informant and to make them feel more comfortable sharing their information with me, I thanked them for their willingness to participate; started the meetings of with some initial chat before the questions started; keeping to the pre-determined themes, and at the end of each interview ensured that the information they provided was most useful. (Dunn, 2016, s.150-188). The interviews varied in length based on what was agreed upon with the informants themselves. Most of the interviews was, however, lasted between half an hour and one hour.

All interviews (except the first) were conducted through video conferencing programs such as Microsoft Teams, Zoom, and Google Meet. The program used depended on the informants' preferences. Digitally mediated interviews brig both challenges and benefits. Usually, they introduce a certain distance into the interview relationship and may feel somewhat awkward and unnatural. However, they also allow the informants to share other types of information. Since they were enabled to share their computer screens, send additional information to me in the chat. For example, documents with overviews of their work, presentations about the, and links to internet pages they referred to in the conversations. This made me understand and experience their work, stories, and contexts in a more diversified way. Because although the only interview I conducted in person consisted of the informants showing me how one of their solutions worked and the like, this would not necessarily have been the case with the other interviews. Since digitally mediated interviews may arguably be regarded as more natural settings for sharing diversified information like this. However, the computer mediation restricted the sharing of other types of information to what one could share digitally. The choice to use video conferencing programs and to encourage the sharing of other types of information were attempts to meet these challenges.

To make the interview setting feel more natural and to make it easier to document the information derived from the participants, audio recordings was done. All respondents were informed about audio recording in the information document and asked about it before the interview started. Additionally, it liberated me from intensive notetaking of all the responses

and additional clues in the interview. By this I was allowed to focus on keeping a natural conversational flow with the informants. Some notetaking was, however, done during the interview. Such as bullet points of what information conveyed in order keep track of what topics was covered. As well as new questions that appeared during the interview. Afterwards the interviews were transcribed, and I was left with written documents for the data analysis. (Dunn, 2016, s.168-188).

5.3 STRATEGY OF ANALYSIS

5.3.1 Reducing and organizing the data

When the data was collected, the process of "making sense" of the data started. This was approached by utilizing various strategies. Throughout the data gathering and analysis, I used memos to document and make short notes to myself about quick insights, associations, and draw connections. This allowed me to get a sense and overview of the data material, its main elements and patterns. (Cope, 2016, s.373-375).

Once all the data was gathered a more formal analysis – consisting of concept mapping and coding – started. Concept mapping, which involves visualizing the data and their relationships, was used to get further overview and sense of the main elements and insights the data. (Cope, 2016, s.375-377). For example, constructed a table (similar to Table 5.1) and the transcribed documents were sorted and piled into four categories based on the main topic of the interviews: "overview of Telenor Research´s AI work", "the Green Radio project", "the Air Quality project", and "Other".

Subsequently, a coding of the data followed. This is a valuable strategy to organize and reduce data, since the distillation of key terms makes it easier to handle and search through a lot of information. Additionally, coding is also aimed at analysis because organizing much information into different types of codes allows the researcher to make connections, discover patterns, and reflect over what is the meaning behind the data they are faced with. There are also different types of codes that may be used, and Cope distinguishes between *descriptive* and *analytical codes*. The first consists of themes and patterns that are apparent on the surface and may be regarded as labels for "what, who, where, when, and how" type of information.

The latter refers themes the researcher is interested in, and that allows the deeper examination of the process´ and contexts, to make associations, and discover patterns. (Cope, 2016, s.377-87). For example, I used the descriptive codes to identify types of projects was talked about in the various sections of the transcribed interviews. On the other hand, analytical codes was used to interpret the text more, to identify the meaning behind the surface, and saw codes such as “work strategies”, “motivations behind the work”, and “effects of the work”.

The coding conducted in this research project was done solely by me and “by hand”. Although, I examined the documents on my computer, no analytical software program was used in the coding. The reason for this was that I felt more comfortable approaching the coding “by hand”, since it allowed me the freedom to visualize and interact with the data in ways, I saw fit. (Cope, 2016, s.377-391).

5.3.2 A narrative analysis strategy

During this initial interaction with the information and data gathered I got familiar with the stories of the people involved in industrial R&D of AI technologies themselves. What I discovered was that they differed a great deal from what is usually associated with industrial firms and AI technology. As argued by Loseke (2007), humans are storytelling animals. Stories is a way for people to understand one´s own and others´ lives. In the case of Telenor Research and their AI work, there was seemingly a distinction between the stories conveyed by the people involved in the work itself, and the way industrial R&D and AI technologies are usually being presented in society. Therefore, a narrative analysis seemed like an exciting way to approach the examination of the information.

Loseke (2007) claims that narratives create identity at all levels of human social life. Within the macro-level there are stories producing *cultural identities* (also called formula stories), characterized by people trying to simplify and make sense of a complex world and thus construct symbolic boundaries around types of social actors. While *institutional identities* are established on the meso-level and can be regarded as the targets of policy or law that justify policy decisions and legitimize institutional arrangements promoting freedom or constraint. *Organizational identities* – which is produced by increasingly common organizations and groups to inform service provisions for the unique people who use these

services – is also to be found at this level. Lastly, at the micro-level, one finds the *personal identities*, the stories constructed by individuals in order to better understand oneself. Identity narratives are therefore produced at cultural, institutional, organizational, and individual levels of social life. These narratives, however, does not operate and exists separately from each other, but rather interact and affect one another in various ways. For example, Loseke argues that there it's clear that narratives of personal identity inform narratives of organizational, institutional, and cultural identity. While individual social actors can use their understandings of cultural narratives as resources to forge their own stories about themselves, personal identity narratives are critical when it comes to the shaping of cultural narratives. Loseke draws an example of before there were socially circulating formula stories of wife abuse, there were the individual women telling their unique tales of hardship and pain. Some of these unique tales coalesced into well-known formula stories and cultural narratives. (Loseke, 2007, 661-677). This strategy has been utilized to trace the components that has been emphasized in the informant´s descriptions; the (antagonist versus protagonist) role the characters play. (Barthes, 1994)

5.4 THE RIGOR OF THE STUDY

Qualitative research is often based on doubts regarding its reliability (whether the data collection method yields consistent and reproducible results when used in similar circumstance by different researchers or at other points in time) and validity (ability to repeat or test to see how general the particular findings of a study is to the more overall population). (Winchester & Rofe, 2017, s. 24; Hay, 2016, 453-457; Bailey, White & Pain, 1999, s.169-173). To ensure the study´s rigor and credibility, several steps have been taken. These are important measures to show that the research was conducted in a trustworthy manner; to secure the validity, reliability, and credibility of the data; and the value of the findings. To guide these reflections, I used Bailey, White and Pain´s (1999, s. 174-176) list of principles to evaluate research processes. The principle of documenting the procedures and actions of the process was followed by describing how I proceeded and made choices during the conduct of the research in the earlier parts of this chapter. As well as by including precise and concise summaries of the information collected in the empirical chapter of this thesis, which we´ll come back to later. The principle of familiarizing with, reflecting upon and evaluating the

data were conducted through for example making memos, coding the data and keeping a research diary (as mentioned in Section 5.3; Bailey, White and Pain, 1999, s. 174-176).

In section 5.4, I reflect upon principles such as the reflexive management of the research process and the recognition of my own influence on the research process and findings. Before finishing of the chapter with some ethical considerations.

5.4.1 Reflexivity

Conducting research inevitably involves various types of social influence. Although objectivity (the separation of the researcher and the research subjects and analysis) is both valued and strived for, studies that involve any human being will inevitably also include some form of social influence. To be aware of and reflect upon this is important to secure the trustworthiness of the research and its findings. (Dowling, 2016, s.29-44). Research projects are first and foremost influenced by researchers themselves in various ways. Our own values, interests, and beliefs can be seen in the choices we make during the process and how we interpret our findings. (Stratford & Bradshaw, 2016, s. 119). This relates to *subjectivity* which is about the influence of personal opinions and characteristics into the research process. Since all are members of interpretive communities (with its own interests, values, standards, theory, research methods, and techniques) another form of social influence is in sight. may be highlighted by the term "intersubjectivity" which revolves around the meanings and interpretations of the world which is created through social interactions between people. A strategy to deal with such issues and to ensure the study´s rigor and credibility *is critical reflexive management.* This refers to the constant, critical examination of one´s own position in and the social influence over the research. (Dowling, 2016, s.29-44).

This project was subject to such various forms of social influence. When it came to, for example, the choice of empirical angle –social innovation oriented towards sustainability – it was based on my own interests and those found in my interpretive community. However, to improve the study´s relevance and credibility I discussed the process regarding the choice of empirical angle discussions with my supervisor and fellow researchers in the overarching project. This was a step of critical reflexivity in which I acknowledged the subjectivity and intersubjectivity that influenced the research process and took measures to secure the credibility and utility of the project. Such discussions with people around me about the

process, the practice and choices made were conducted throughout the research project. Another critical reflexive tool I utilized both in the exemplified situation (in order to reflect upon the choice and discussions about it) and in other parts of the research process was to keep a research diary. This practice made me constantly reflect on the research process itself (such as whether an approach worked, and how questions affected the informants) and the choices I made (such as why they were made, and how they affected the research).

The social aspect of qualitative research is also evident when it comes to questions of power. When it comes to the conduct of qualitative interviewing, this is particularly relevant to reflect upon because power relations may be found between the researcher and the informant. In this project the interview relations may be characterized as *asymmetrical.* Which refers to the significant difference in the social position of the researcher versus the research subjects who holds an elite position. (Dowling, 2016, s.29-44). The informants I interviewed in this project was in positions of greater power than me as a university master student. All had prominent positions in Telenor and in the partners, such as IT-bosses, group leaders, and senior scientists. To ensure that the informants did not have too much control over the interview situation and orientation of the project, I employed critical reflexive management in order to be more aware of the possibility of tis. This practice enabled me to become aware of it so I could recognize whether such power imbalance had occurred in practice and thereby make modifications to deal with it. I approached the interviews with the notion and awareness of this asymmetry in the relation in mind and chose to take a leading position in the interview. Not as an attempt to overpower the informant, but rather as a strategy to take control over the interview setting and its direction. This was an attempt to avoid potentially being overpowered by the informants. Which luckily was not the case.

5.4.2 Ethical considerations

Furthermore, it´s important to include considerations of ethical concerns. That is, reflections of my activities, responsibilities, and commitments to the actors involved in the research (such as the research institution, the public, the audience, and the project´s participants). (Dowling, 2016, s.29-44).

The Norwegian national research committees have sketched out some ethical guidelines for research in the social science and humanities. Section B of these guidelines refer to the

people that´s to be included in the study. Here the researcher has a responsibility to respect and consider their personal integrity, safety, and welfare. (NESH, 2021). In an effort to secure the trustworthy handling, NSD (the Norwegian center for research data) was informed about the research project and how I planned on conducting it. The project was thus examined and approved by them, after which I was started the data collection.

Part B-15 of the ethical guidelines refers to the responsibility to collect an informed consent from the people that are to be incorporated and participate in the research project. In order to secure the proper incorporation of participants in this study, it was important to secure and collect an informed consent from the participants. This was done in this project through giving the informants an information document with an attached declaration of consent before the interviews. Here they were given information about study; its purposes; how it was to be conducted; what was expected of the participants; their rights; how the data would be handled, protected, and used. This secured and documented that the informants knew what they consented and agreed to participating in. (Dowling, 2016, s. 30-33; NESH, 2021).

In part B-20 of the guidelines one finds the responsibility to secure the anonymity of the informants. (NESH, 2021). In this project the participants were promised anonymity. This was sought done through removing their identifying characteristics (like name, age, gender) and replaced it with giving the interviews numbers and categorizing the informant´s into various groups (se section 5.2.3 & Table 5.1).

Part B-24 talks about storage and sharing of the research material. Based on the fear of having personal data like this leak, it is often suggested that the researchers ensure that one cannot identify the informants and that the data is stored at secure places. The data material in this project was anonymized and stored in secure places to ensure this. (Dowling, 2016, s.29-44; NESH, 2021)

Section D of the guidelines refer to considerations in research projects with task givers, financiers and partners. It is stated that the researcher has a commitment to balance norms of openness, freedom and independence with the requirements of use and relevance to society. And section E refers to the responsibility of the researcher to convey the scientific results, work approaches, and opinions to society. While section A refers to the research community and the researcher's responsibility towards other researchers in the community. This part amongst other things includes the securing of free and independent research, and openness. (NESH, 2021). Section 5.4.1 saw the reflection on the social influence on the research process and how I tried to address this. In the following section, I also attempted to communicate the

results from this research process in a responsible and truthful way. Another consideration is that this project is part of an overarching research project at the OSIRIS center at TIK. However, other than serving as a facilitating factor regarding accessing of informants and helping to deicide the empirical case of the master thesis, it did not affect the freedom of the research. No attempt was made to influence the orientation of the research project, the analysis and reports of the results, or the conclusions drawn. The process was – in this sense – completely free.

6.0 The empirical results: The descriptions from the actors involved in Telenor Research´s work on AI

Actors on the outside of industrial R&D activity of AI might describe and emphasize the controversies surrounding the profit-based motivations of private companies and the potentially risky nature of AI technologies. (Bero, 2019; Buranyi, 2017; Fabbri, Lai, Grundy & Bero, 2018; Besley, McCright, Martin, Elliot & Zahry, 2017). This chapter explores the first sub-question of this thesis: *How is Telenor Research´s AI work described by the actors involved in their projects?* The findings of the empirical investigations are presented. The informants´ descriptions of the AI team´s R&D work of AI are structured as follows: the *motivations* behind the work, the *approaches to the work,* and the *impacts* of the work. Two of the team´s AI projects were selected as illustrative examples.

The first section explores the general motivations, work, and impacts of the AI team´s work. While the following section takes this structure and examine the depictions of the Green Radio project. The final section presents the motivations, work, and impact of the Air Quality project.

6.1 THE AI-TEAM IN TELENOR RESEARCH

6.1.1 Motivations

The informants mentioned several motivations behind Telenor Research´s R&D work on AI and why the establishment of the AI team. Two of the leading figures in Telenor Research presented the department´s AI work from a historical viewpoint. The first figure mentioned that at the beginning of the 2010s, AI was once again becoming a hot topic in the tech world. Therefore, the leaders of the research department decided to invest in and focus on AI technology.

> *"It is a technology that´s now on its way up and forward again that is going to be important for Telenor and society. And we should know more about*

it." (Interview 18, 02.03.2022A; Note: it is the researcher´s translation from Norwegian to English).

Then, the research department started to improve and further develop their competence and knowledge in the AI field. A new team was created within the department – the "AI & Analytics Team" – and new people with new competences were brought in.

> *"It is sort of a path-dependency in this. Telenor´s research department has ever since the early 2000s worked a lot with big data-analysis. (…) So, we have through 20 years build up a rather heavy competence on analyzing these data. And when artificial intelligence really started to take off again then (…) it was easy for us to shift our competences over and recruit people that had these algorithm-competences then". (Interview 12, 11.02.2022; Note: it is the researcher´s translation from Norwegian to English)*

The first informant also offered a strategic takes a strategic look at motivations behind the department´s AI work, by listing some of the various motivations behind the A-team. (1) First, to help Telenor improve in areas such as competitiveness, efficiency, customer aid, product developments and operational routines. Seeing that AI is becoming a more and more pervasive technology in society with the potential to optimize how things are run, and services are provided. (2) Secondly, the AI work illustrate how Telenor deliver on their societal responsibilities. The company has a mission to have a good impact on and contribute to drive societies forward. (3) Third, the department is motivated to conduct R&D on AI because it helps to fulfill its task of looking to the future and use its time, energy, and work hours exploring what will become important in the next few years. (Interview 18, 02.03.2022A).

Another Telenor Research-informant follows this strategic point of view and reflects on how the team tries to communicate some things which may serve as indicators for motivations behind their AI work. First, there´s a motivation to support the business on solving business problems with AI solutions. Telenor Research and the AI team are knowledgeable, capable, and available for assisting in the address of these types of problems. This shows that scientists actually are motivated to do research that will prove useful and have an effect. Second, the AI team wants to see that their work not only has an effect on the company´s business parts, but also has an impact on society. Because this is also valuable for the business, since being perceived as social innovators might be used towards building Telenor´s brand and is

beneficial when facing customers. Third, the AI team, with their extensive knowledge and competence, may function as a training and capability building unit that can be used to upskill the company. Amongst other things, by that sharing their knowledge and experience with other parts of the company. (Interview 3, 26.11.2021). The informant also argued that the department has a wish to advance their research and be a part of research communities in areas they believe will become important for Telenor in the future. Additionally, they want to prove the value of AI technologies and solutions by showing how it can be useful. Lastly, they are also driven by providing value for Telenor through improving their brand and contributing to building a internal data science culture. This is, amongst other things, done through picking projects which benefits the company; helping Telenor to select vendors; and and offering advice on technology acquirement, use, and development. (Interview 2, 03.11.2021). An informant in Telenor Norway underlines Telenor Research´s role in technology development. According to the informant, the department´s valuable role is rooted in their experiments, efforts to build knowledge and experience, and sharing the insights with the rest of the company (Interview 13, 15.02.2022).

A third viewpoint on the motivations behind the departments AI work is presented as the individual stakeholder´s various motivations. One informant from the research department reflects that the scientists working in the department generally are motivated by the prospect of having actual impact on business and society. Working in an idustrial research department provides these scientists with the opportunity to explore their fields of interests and expertise, and to witness that their work – the knowledge and products they produce – having an effect. (Interview 18, 02.03.2022A). Another informant from Telenor Research state that the leaders of Telenor are motivated by wanting to make Telenor a future-oriented company. This is shown in the actions the company is taking to go from analogue services over to making almost everything digital. And AI presents opportunities the company wish to exploit. For example, automating a lot of work earlier conducted by many people; reduce energy use and operational costs. Building in-house competence on these cutting-edge new technologies are also driven by the motivation to maintain their competitiveness. Additionally, this informant argued that because Telenor is mainly owned by the Norwegian state also comes with expectation of the company being a driver of innovation in society which also serves as a motivator behind their AI work. (Interview 12, 11.02.2022).

"And there lies also a driver behind this. That when artificial intelligence is one of these core technologies for the future, then it is natural that Telenor´s research department are doing on it. And it is also natural that the research department takes sort of a leading role in the Norwegian society around this." (Interview 12, 11.02.2022; Note: it is the researcher´s translation from Norwegian to English)

Various informant also argue that the AI team is motivated by and focused on contributing to improving the societies Telenor is a part of. (Interview 12, 11.02.2022). For example, in Norway the team has contributed to the establishment of the *Norwegian Open AI Lab* – center Telenor founded and funds together with NTNU. The goal of the lab is to disseminate knowledge about AI, as well as provide a space where academia, the public sector and various business´ may come together and partner up on AI related projects. (Norwegian Open AI Lab, 2022). A lot of narratives in society today frames AI as a frightening technology. Several of the Telenor-informants claims, however, that AI has a lot of interesting potential it's just that various actors don´t know how to use it. Through AI´s capabilities of predicting the future and to sort through a lot of data one potential lie, for example, in addressing environmental challenges. Such as better weather forecasts; predicting temperature; analyzing and getting an overview over pollution in certain areas. Another opportunity is the possibility of changing service activities from being based on scheduled and fixed standards to more individual needs. Such as a commune moving from picking up every citizen´s trash once every week to picking up some peoples trash every third day and others´ trash every third week. (Interview 1, 14.10.2021; Interview 13, 15.02.2022).

6.1.2 Approaches to the work

The AI team works in different ways and with various strategies in order to research, develop and innovate AI. The variety of different narratives all underpins the fact that Telenor Research wants to have an impact and to give something back to society through their work on AI. That is, it´s a wish that the AI work has value both for Telenor and society.

The informant´s tales indicate that their AI work is structured around some main approaches. When it comes to collaboration, they often chose one of two paths. First revolves around collaboration with internal partners (i.e., business units). This strategy relates to one of the purposes of the department: to experiment and build knowledge together with the BUs or share the insights they acquire on their own with the rest of the company. Herein lies a focus on getting AI out in the business. (Interview 18, 02.03.2022A; Interview 13, 15.02.2022; Interview 4, 02.12.2021). The second centers around collaborations with external actors of various kinds. Within this context the team focus on doing research, experiment with different solutions, publish papers, and supervise university students together with universities, public sector organizations, and industry partners. (Interview 18, 02.03.2022A). Two of the scientists additionally identified another set of work approaches used in the team: between projects that are of a more applied nature and those that are more of a research-oriented nature. This "applied approach" often relates to projects that are more oriented towards hands-on operations and products. For example, where the team make a solution and test it out in practice. While other projects following the "academic approach" are aimed more at doing research and acquiring knowledge, and often result in papers and such. For example, building and testing out AI models before writing papers on the knowledge created and insights obtained. (Interview 1, 14.10.2021).

Along the way, the team faces several challenging and facilitating factors. Amongst their challenges lies various problems with data. For example, issues regarding accessing data, privacy concerns, and the quality of data. Another challenge revolves around cost and decisions related to cost. Although, building and piloting a AI model isn't very expensive, the cost comes with having it fully integrated in a more practical sense in the BUs. Additionally, the fact that Telenor Research is somewhat separated from the business parts of the company, since they are not a part of any of the BUs but a part of Telenor Group. The ties between the team/department and the rest of the company (especially the business parts) are, as such, perceived as a bit weak. (Interview 12, 11.02.2022; Interview 18, 02.03.2022A; Interview 1, 14.10.2022; Interview 10, 07.02.2022).

"Ideally, we should probably have had a tighter interaction with the BUs"
(Interview 1, 14.10.2022; Note: it is the researcher´s translation from Norwegian to English).

"Then you can probably say that the business areas in Telenor (…) could be better at using also Telenor Research" (Interview 13, 15.02.2022; Note: it is the researcher´s translation from Norwegian to English)

For several years the team has had a lot of difficulty finding business cases to work on and to get a grip with the business parts of the company on the AI field. However, this has changed seeing that more and more stakeholders understand the value of AI. (Interview 18, 02.03.2022A; Interview 10, 07.02.2022). Several other facilitating factors may also be highlighted. The fact that there´s a higher degree of understanding for the potential that lies within AI and data has presented the team with opportunities to explore the possibilities of using AI, amongst other things, on the network side, in order to improve the running of the networks. For example, the development of algorithms to save power and energy in the base stations or to optimize the managing of backup generators. This helped to open up a lot of new opportunities to the AI team which improved their workflow. (Interview 13, 15.02.2022; Interview 18, 02.03.2022A). Another facilitating factor is the fact that the team enjoys great freedom compared to other research institutions. Because although they have to acquire some external funding, they still receive a lot of money from the company. This enables them to use less time trying to get funding and a lot more time doing actual research. Also, they have great freedom to choose which cases and projects they want to take on. And through being lead and run by the company´s group leaders, the AI team is able to more easily choose cases that are important and relevant to the company. (Interview 18, 02.03.2022A)

6.1.3 Impacts

The AI team produce a variety of different results through their work and operations. One informant argued that it´s important for the team to both improve the company and have a beneficial impact on society. As such the results of the team´s AI work can mainly be divided into the categories of (1) *Business value*, the results that are of value to Telenor; and (2) *Societal value*, the results that are of value to society. (Interview 3, 26.11.2021).

When it comes to *business value*, one informant argued that the team´s AI work, amongst other things, contributes to building the company´s in-house knowledge and competence on this technology area.

"[O]ur role [is] first to explain these benefits and risks that this technology potentially can bring to society". (Interview 3, 26.11.2021).

The team has been working with the European Commission and other experts to define the trustworthy and ethical principles for AI that Europe wants to promote, standardize, develop, and fund research on. This example serves to illustrates that the AI team actively research this technology and its field in order to multiply its benefits and minimize its risk. (Interview 3, 26.11.2021). Which in turn strengthen both the trustworthiness and brand of Telenor. From this, the company appear as a more responsible actor engaging in ethically oriented development of a cutting-edge new, controversial technology. Through creating awareness in Norway and the European Union on risks and opportunities with developing technical tools and starting to do research on this area themselves they are building in-house knowledge and competence.

Another informant exemplifies the business value of the team´s work by drawing on their projects regarding predictions of important customers in the networks and using this knowledge in marketing efforts. Projects that analyze people´s mobility and make predict about when and where people would be at certain hours. The results and insights of which has been used by Telenor to help the government to reduce the damaging effects of COVID-19. (Interview 12, 11.02.2022). The latter is an example on how the team contribute to improve Telenor´s brand. A brand where the company is presented as responsible, ethical, and innovative.

"That has an impact on Telenor´s brand. It has an impact on how we are perceived by customers and other important stakeholders, like our owners, politicians etc. (…) they know there is a connection (…) between if a company is perceived as to take their societal responsibility seriously and actually deliver (…) and the locality of customers to that company. That is, the social profile of companies is important and we think that it´s going to become even more important." (Interview 18, 02.03.2022A; Note: it is the researcher´s translation from Norwegian to English)

Through these experimental effort around different AI technologies – finding various areas of application for the technologies and figuring out how it may be implemented in the daily doings of the business areas of the company –AI team´s work creates value for the business by strengthening and improving the company with regard to improving their brand;

knowledge- and competence base; as well as exploring new opportunities in the market. This has commercial value since it proves the trustworthiness, competence, and quality of Telenor and their products/services to its clients and customers which may improve sales.

On the other hand, there is the societal value of the team´s work. Upon the reflection of the social impact the AI team has with their work, one of the leading figures in Telenor agreed by stating:

"that´s an important part that we do" (Interview 3, 26.11.2021).

One of the ways the team is helping to drive society forward through their work is exemplified by the informant as the fact that they, together with the European Commission and other actors, developed some principles surrounding AI work. The team then bring these back with them to Norway and applies it in work with industry partners, the government and through Norwegian Open AI Lab. They work on how to translate these principles into actual research within their Norwegian AI community. Additionally, the team has begun to try and explore the problem of explaining AI seeing that the technologies consist of complex models that humans hardly understands and that are associated with risks which concerns society. (Interview 3, 26.11.2021) Through building awareness in Norway and the European Union on risks and opportunities with developing technical tools and starting to do research on this area themselves, Telenor Research is contributing to changing mindsets.

Another informant argues that creating value for society through their AI work is important for three reasons. (1) Telenor is mainly owned by the Norwegian state which means that the public has an opinion on how the company should behave. (2) In order to be permitted to operate in the countries where Telenor´s BUs are located, the company are oblibed to be good citizens that gives something meaningful and beneficial back to these societies. (3) To keep customers and be a vendor they want to use furthermore, its important to appear as responsible and that their work, products and services are helping to drive society forward, not backwards. For example, through their AI work the team is contributing to making routines and activities more environmentally friendly. Seeing that the predictions from their AI algorithms may actually help to reduce carbon footprints and enable actors to be better equipped to take actions against pollution and environmentally damaging activities/elements. (Interview 18, 02.03.2022A).

The societal value of the team´s AI work thereby shows itself in the form of budling knowledge and competence; making AI solutions oriented towards business and societal

interests; sharing insights and experience with partners. For example, through engaging in partnerships and sharing their insights and experience derived from their work with external actors – such as industry partners, the government, academia – the team doesn't only improve Telenor´s knowledge and competence base, but also society´s knowledge and competence base in general. Additionally, their strategic moves when it comes to engaging in ethical discussions of AI (Telenor Group, 2019A; Telenor Group, 2019B; Donkin, 2018) and picking projects like studying the spread of diseases; making their business operations more environmentally friendly; predicting and analyzing pollution in cities, shows that the team and company wants to take steps of responsibility. Steps towards driving society forward. These results and impacts may be exemplified, illustrated and substantiated by drawing on two relevant illustrations of major AI projects at Telenor Research: The Green Radio-project and The Air Quality-project.

6.2 THE GREEN RADIO PROJECT

6.2.1 Motivations

The descriptions of the motivations behind the Green Radio-project vary. First, several informants looked at it from a historical viewpoint. The Green Radio project began in 2019 when some of the researchers from the AI team were working with the BU Telenor Denmark on another project concerning data analysis and similar matters. The data scientists and engineers in Telenor Denmark were attempting to determine how to reduce their network operational expenses, noticing that the main part of their cost portfolio on the network side went to energy. Additionally, they had begun to reflect on the possibility of collecting data from the base stations that revealed how much data the customers used at certain hours. Based on this, they considered how the data on their radio networks could be used to predict whether there were any periods in the day in which they could reduce some capacity layers. The intention was that some capacity layers could be shut down when the demand for data traffic was low enough to shut down the power and, at the same time, provide customers a level of connectivity. in addition to lowering the capacity at night, they also searched for power-saving windows during the day so they could save power systematically. they presented the idea to the AI team, which then begun to develop algorithms that analyzed historical data from every base station to identify high and low traffic periods, allowing them to determine

which sites to turn on and off. After a successful pilot test with Telenor Denmark, the project and its algorithms were tested at other BUs such as those in Bangladesh and Pakistan. therefore, the participation in this project was seemingly motivated by the possibility to help the company improve (reducing costs and optimizing the management of the networks) as well as providing a beneficial result for society with the reduction of the company´s carbon footprint.

> *"[T]hey came to us with an idea that we though sounded very exciting. And something that both benefits Telenor – if we could save power – and it benefits society as a whole if we then can waste less power and save CO_2. So, it was very clearly one of those win-win projects". (Interview 17, 02.03.2022B; Note: it is the researcher´s translation from Norwegian to English)*

Other informant´s regarded the motivations more strategically. A Telenor Denmark informant outlined some of the main purposes behind the project. First was an attempt to save power in their networks, motivated by Telenor´s ever-present consideration of societal effects, even though its main motivation is to facilitate business. The company´s objective is to help society by improving their internal operations or example, through a digital transformation of its products and services, the saving of power, and reducing the company´s carbon footprint.

> *"[A]s a big corporate we have [a] responsibility for the society (…) I think Telenor was always really [an] advocate for that." (Interview 14, 16.02.2022)*

Additionally, Telenor sought to establish dynamic power-saving windows in its networks and base stations. Thereby, creating a model that dynamically calculated whether some sites needed longer or shorter windows with shut down capacity layers. Lastly, the company attempted to prove to their vendors that this method was possible and inspire them to develop similar solutions. (Interview 14, 16.02.2022)

One scientist of the AI team in the research department stated that the motivation and main though behind the project was to optimize the network operations by turning equipment on and off depending on capacity needs. since the infrastructure in their network is dimensioned for peak load, which means that most of the time it´s unused or not fully exploited. Keeping everything on all the time claims both high costs and energy. Therefore,

the original goal, as here argued, was to see if they could save power and as a consequence perhaps save money through the use of more dynamic configurations of the networks based on data on how the networks were being used and algorithms to analyze and make predictions. They wanted to be able to select the best candidate to be turned off at different hours of the day. (Interview 15, 23.02.2022A).

> *"Well, basically the goal was to connect the customers to what they need. (...) So, that was the clear goal to save power without degrading the customers experience" (Interview 16, 23.02.2022B)*

6.2.2 Approaches to the work

This project first involved collaboration with various internal partners. The AI team worked with several of the BUs in Denmark, Pakistan, Bangladesh, and Myanmar. (Interview, 03.11.2021). In doing so, it reached several of the business arms of the company, and effects several parts of the company. And the fact that the collaborations arguably was good and went smoothly was argued by several of the informants both in Telenor Denmark and the research department. For example, one of the AI scientists stated that working with Telenor Denmark was made easier because their team consisted of people with professional knowledge of data analysis and the domain knowledge of networks. The team´s interdisciplinarity enabled its member to program the algorithms and analyze the data, but they also needed someone to understand what it meant in the networks. The teamwork was interactive, involving many meetings and significant back-and-forth work on the algorithms. One of the reasons for this smooth collaboration was that the project had a fixed subject with a clear goal and vision for ow to achieve it, and the collective effort made the work easier (Interview 14, 16.02.2022; Interview 17, 02.03.2022B).

However, the project also involved interactions with other actors, such as the network operator and equipment vendors. These complicated the work somewhat since the full implementation of solutions required the agreement of all stakeholders. For example, Telia, with whom Telenor Denmark shares a network with, was skeptical about the solutions developed by Telenor itself and preferred seeing an external actor´s solutions implemented in the network instead. (Interview 14, 16.02.2022). The AI team took an applied approach to this project, which implied that the orientation of the project was to support Telenor´s business by

taking on and attempting to solve concrete business problems by experimenting with AI technologies. (Interview 3, 26.11.2021).

> *"There are no publications yet to, you know, be published. And there´s usually not an intention from these projects. The intention is to support the business of Telenor by creating and showing the value of using data and machine learning models for solving a very concrete problem." (Interview 3, 26.11.2021)*

The focus was to test various solutions to issues facing the business and its operational areas, revealing how the AI team works in practical terms to build knowledge and to improve the company; as well as to improve the company. (Interview 3, 26.11.2021). The team developed algorithms with which it was able to analyze historical data in order to identify and predict some power-saving windows. (Interview 4, 02.12.2021). To determine whether there were any differences, the team tested the solution on different groups, with equipment turned off for one group while it remained on for a similar control group. (Interview 4, 02.12.2021).

According to an AI scientist, the project is an example of how the AI team´s projects address internal questions and of how they work closely with the BUs to solve practical business problems, which created little doubt about its relevance and value. (Interview 1, 14.10.2021). The informant later argued that the use of algorithms, such as the ones developed in this project, enables Telenor to multiply the power saving periods. (Interview, 02.03.2022B). Applying this technology to these kinds of problems then confirms that doing smart adjustments of settings in the networks are beneficial towards the business and the environment. Additionally, the AI team chooses these projects strategically based on the degree of social impact and whether or not the project can be scaled across business units. The reason is that similarity in problem and dataset enables the team to easier replicate the project which makes it easier for them to improve the company. Because then they don't need to start from scratch with every new BU, but rater replicates the first models. Strategic chooses such as these are important to make sure the models, they develop will have a greater impact. (Interview, 26.11.2021). The work was, furthermore, made easier by the fact that usual data problems were omitted:

> *"What we luckily haven't had as a problem in this instance is privacy, since all data here is more like – it´s data on radio network equipment. (…) There is nothing on the user level. (It is data generated by machines." (Interview*

15, 23.02.2022A; Note: it is the researcher´s translation from Norwegian to English)

The work conducted by the AI team on this project show how the experimentations of the AI team are contributing to improve the company´s in-house knowledge and competence-base; as well as incrementally change its routines and mindsets surrounding their business operations towards a more digital orientation. This work, additionally, contributes to slowly change the way AI and its areas of applications are perceived in society in general.

6.2.3 Impacts

The Green Radio-project produced several results. Both of direct and implicit kinds. Through using AI to try and solve a concrete business problem, the team showed that the technology poses examples for contributing to cuts in costs, power use, and CO_2 footprint. And proved successful in these efforts. (Interview 4, 02.12.2021). Additionally, as argued by one of the AI scientists, the project also showed itself of value to both Telenor as a business and for society as a whole. It didn't only optimize the network, but also contributed to give something beneficial back to society through the changing their network operations and routines towards more environmentally friendly actions. (Interview, 02.12.2021).

Amongst the concrete results derived from the project, that the reduction of around 2,5% of the energy resources if they ran the algorithm in the whole network in Telenor Denmark. This meant 700 tons of CO_2 per year. Although the number, according to a leading figure in Telenor Research, wasn't particularly high, it showed the potential of the solutions. This made them think about how much they would be able to reduce if they tested it out on their networks in countries where they had a lot more customers – such as in Bangladesh, Pakistan, Myanmar. For example, in Grameenphone in Bangladesh they were able to show good results in reduction of energy use and cutting of cost. However, they also saw the loss of customers when they shut down some of the capacity layers. (Interview 2, 03.11.2021). According to another informant the fact that the project produced positive and effective results meant that they were able to show their vendors concrete numbers and say that they had tested out a solution in their network in their network with the potential of saving a lot of power and being able to potentially influence their vendors of transforming and improving the power saving functionality on the equipment they delivered. (Interview 17, 02.03.2022B)

None of the algorithms developed and tested out by Telenor Research´s AI team are currently in use. (Interview 17, 02.03.2022B). However, several other, more implicit results of value to the business was identified stemming from this project. One of the leading actors further sketched out some of the value and implications of the direct results. Firstly, the value related to learning and building experience from the project. Because they learned that they could effectively reduce their power consumption on base station through the development of a well-functioning AI model. The experiences acquired from the project proved to the BUs that business problems such as these can be analyzed through data lens and approached and solved with the use of AI. This learning value is, according to the informant, helping to transform the culture in Telenor into a data and digitally driven culture. These results were highlighted by the fact that the engineers out in the BUs suddenly knew how to run these algorithms themselves and were beginning to challenge their vendors on topics such as this. (Interview, 03.11.2021). This argument is substantiated by another actors claim that Telenor Research is important in giving advice and support to BUs when it comes to finding ways of addressing concrete business problems. (Interview 15, 02.03.2022A).

> *"[W]e pick project´s that are scalable across different business units. So, we know that the problem is the same. And then the data likely is the same. So, for us to replicate would be easier" (Interview 3, 26.11.2021)*

And as an informant in Telenor Denmark stated:

> *"[A]lthough the Green Radio and the algorithms there are not deployed in our network now, we have alternatives deployed in our networks." (Interview 16, 23.02.2022B; Note: it is the researcher´s translation from Norwegian to English)*

Another informant also claims that the BUs learned enough to follow it up further and contributed to change mindsets by making power saving a focus going forward. (Interview 17, 02.03.2022B).

The project also produced some implicit value in the form of changing mindsets. Which has valuable effects both to society and the business. This was done through demonstrating how to shift how the company thinks about the operation and management of the infrastructure and their equipment. For example, that it doesn't need to be on a hundred percent all the time. The project therefore contributes to changing mindsets in the direction of

using their resources more efficiently and optimally, instead of wasting power, fuel, energy and money. Another example is through influencing their vendors in the direction of developing greener and better equipment. The proving of how to use data from their mobile networks to suggest a new configuration of the equipment in mobility and that they can manage their networks through a little smarter algorithm has value in the fact that their networks can operate smarter and that they are able to make better decisions. The project, as argued by an informant, probably started the processes of looking at AI in the network, base stations and equipment. Subsequently, this may spark ideas for new areas of application and promotes the fact that there is potential in applying AI in other areas of operations. A third example is that the project has contributed to the fact that much attention has come to the topic of saving power in mobile networks. Telenor thus contributes to society because they as operators can help to push the industry as a whole in a greener direction amongst other things through the use of AI. Since vendors of base stations to mobile networks may take inspiration from the Green Radio-project in order to implement AI driven power saving functionality, which may in fact have repercussions in the whole industry. (Interview 16, 02.03.2022B).

Furthermore, the project also had value for society in its contributions to saving energy and reducing CO_2 footprint. Both through actually acquiring experience with how AI solutions can be applied to manage networks in a smarter way to serve purposes such as these. As well as becoming a better-informed buyer of network systems, which makes them in a better position not to waste money on additional functionality that they don't need or costs money using. This shows that Telenor is managing its company rationally which gives signals to equipment vendors of what´s to be regarded as sensible network equipment or not. These implications of the results of the project are beneficial for society. (Interview 15, 23.02.2022A). As argued by a Telenor Denmark-informant, the project has had an impact on society in general through stepping in a direction towards being more environmentally friendly. Because it´s commonly known that in order to address societal problems regarding the environment there´s a need to consume less CO_2 and become more energy efficient. The informant argued that the Green Radio-project created a lot of value through planting some ideas in the management on how to and what to do regarding network operations going forward. It showed that data and AI can be used to make their network operations more efficient and better which has value both to the business and to society (Interview 16, 23.02.2022B)

"I think this project was valuable first of all again cause it´s easily understandable. It´s tangible. Everybody knows that we need to consume less CO_2. (…) So, there´s both a green side to it, that is very up in the media. And then there is also of course there´s the cost saving from it. (…) So, I would say it created a lot of value" (Interview 16, 23.02.2022B; Note: it is the researcher´s translation from Norwegian to English)

6.3 THE AIR QUALITY PROJECT

6.3.1 Motivations

According to various informants the project had its early beginning when an EU court ruled that regulations related to air quality values had been broken in Trondheim. Official institutions such as Trondheim commune are in fact obliged to continuously monitor the air quality. Parallelly, the commune observed the entrance of cutting-edge new technologies (such as IoT, AI and ML) that held the potential to help solve this. In an effort to address their problem, a collaboration between Trondheim commune and Telenor began. In order to monitor air quality, one should have many sensors close together to get good data. Here, however laid the problem of costs. Since the very good, high-quality sensors are both very expensive to buy and to maintain. Therefore, Trondheim have around five such high-quality sensors which only covers part of the city. Telenor accordingly wanted to see if they could make cheaper, smaller sensors that could be placed all around the city in order to get a better coverage. (Interview 2, 03.11.2021; Interview 6, 17.01.2022; Interview 10, 07.02.2022).

"So, the original hypothesis was that: You can compensate for having bad sensors with having many of them" (Interview 8, 02.02.2022; Note: it is the researcher´s translation from Norwegian to English)

Subsequently, a department in Telenor called *Exploratory Engineering* started doing work on developing these small, cheap sensors. This department and Telenor Research had collaborated earlier on a similar mission where they created a sensor package. Although the quality of the data from these sensors was not expected to be as good as the ones from the high-quality sensors, they thought that the data would be possible to use. Additionally, they

wanted to calibrate the data over the network in order to cut costs and avoid having people physically out there doing it. However, the project also had another objective. Getting an overview of the situation with the air quality in the city wasn't sufficient, and there was a wish to actually put tis overview into some kind of use. Trondheim commune wanted to collaborate with Telenor Research to try to get some meaning out of the data. Discussions between the company and the commune started and they had a lot of concepts and ideas for areas of applications. One was a notification system for sweepers and spray trucks. If they were able to identify patterns in the data that enabled, them to predict that the air quality on this street will be problematic in so and so many ours. Then they would be able to send a sweeper or a spray truck that could take care of the polluted air. Today, the routines of these cleaning workers are mainly based on experience. And they go and clean based on a feeling of how it is there and on the weather reports. The second field of interest was traffic simulation. They asked the question: "what will happen if they regulate traffic and how it will affect the pollution?" So, Telenor Research made simulation models where they could close gates and regulate traffic in order to give them a picture of how this cloud have an effect. This gave them several opportunities. Amongst other things, if they could spread out the heavy transport and product delivery in the city more throughout the day. Thirdly, they were interested in decision support to the citizens with regard to choosing greener transport, and for vulnerable groups to avoid certain areas. So, people could plan in advance and keep away from areas which were going to become more polluted. From this the AI team in Telenor Research began to develop an algorithm that was suppoed to analyze the data from the sensors in order to make predictions about where the air quality in the different parts of the city. (Interview 2, 03.11.2021; Interview 6, 17.01.2022; Interview 10, 07.02.2022).

The motivations of Trondheim commune were amongst other things to use the insights from the AI teams work to inform the city´s cleaning companies to prioritize the clearing of specific streets where particle dust was the highest, as well as continuously monitoring whether the strategic cleaning had any effect. Trondheim also wanted to be able to offer apps which built on the data and predictions gathered in this project, which would allow citizens to for example select routes where there was little particle dust. The informant further claims that Trondheim commune wanted to be in front of developing smart infrastructure that could provide useful information every day. (Interview 2, 03.11.2021). Another informant from Trondheim commune stated that:

"Then we intended to make the data more useful for Trondheim city management". (Interview, 08.02.2022; Note: it is the researcher´s translation from Norwegian to English).

The data and AI solutions provided the potential to optimize assignments such as road sweeping missions in the city. Instead of guessing how much dust there was, they had data on how much dust actually was present in certain parts of the city. This lays the foundation for a more data driven commune which approached their city managing routines based on actual knowledge about a real situation instead of mere assumptions. Their focus and interest in the city´s air quality on behalf of their citizens. (Interview 11, 08.02.2022).

Telenor´s motivation behind the project on the other hand was manifold. First, it was the business aspect of it. Seeing that IoT is one of the areas with a lot of opportunities for a teleoperator. Therefore, an exploration of this area therefore would be of interest to the company. Traditionally Telenor holds a position related to connectivity in the value chain. For example, with connecting IoT-devices to the network. This also gives them a position on the platform-side as well, since they provide a data platform. One of the AI team´s motivations behind the Air Quality-project was then to explore whether there was a possibility to expand Telenor´s role both in the form of analysis services and sensors.

"So, that was really the motivation: to increase the understanding of and then over time use our own networks to sensory of this kind. So, the commercial idea was really to get more traffic into our networks and make money on it". (Interview 6, 17.01.2022; Note: it is the researcher´s translation from Norwegian to English).

A Trondheim commune-employee substantiated this by stating that:

"[T]he motivation from Telenor´s side so they saw a huge market her to, if they had first got a cheap air monitoring then. (...) there is a world market here that would really have been possible to establish themselves if one had established a good and affordable solution here that they could deliver straight out of the box. That would have been a gold mine for Telenor then." (Interview 9, 03.02.2022).

Secondly, an informant previously employed in Telenor, argued that another motivation behind the project was to access data one where able to run ML/AI algorithms on. The dataset

from this project presented itself as a prime candidate seeing that it wasn't surrounded by restrictions regarding privacy demands for example.

> *"It didn't have anything to do with Telenor being preoccupied with air pollution at trønderske schools". (Interview 8, 02.02.2022; Note: it is the researcher´s translation from Norwegian to English)*

6.3.2 Approaches to the work

The project involved collaborative efforts with external partners. Through engaging in partnerships with external actors, they are sharing their knowledge, competence, and experience with society outside Telenor. They are not only acquiring these insights for themselves and their own company but are actively engaged in sharing the experience with other actors in order to drive society as a whole forward. In this air quality project, the AI team accordingly collaborated with Trondheim, Commune, Exploratory Engineering (which after a while went out of Telenor and formed the start-up "Lab 5E") as well as NTNU and the Norwegian Open AI lab. Additionally, it was linked to and received external funding through the Horizon Europe´s "AI4EU"-proect. This was a part of EUs strategy with development of AI as one of the drivers of digitalization in the European market (Interview 3, 26.11.2021; Interview 6, 17.01.2022; Interview 8, 02.02.2022). Several informants argued that the cooperation between the partners in this project was good. (Interview 10, 07.02.2022; Interview 6, 17.01.2022). However, one Informant from Trondheim commune argued that the collaboration between Trondheim commune and Telenor Research was very loose. While Trondheim commune has focused on establishing the infrastructure and to let other actors such as Telenor Research´s AI team and university students, use the data. Telenor Research had thus access to data in order to do research and went on to looking into predicting the weather and air quality based on historical measurements. And Trondheim commune, although they had an interest of the possibilities of using data such as this, made sure the AI group got access and maintained the sensor infrastructure. However, they carried out their tasks quite separately and independently from each other. (Interview 11, 08.02.2022)

When talking about how the AI team approaches collaborations, one leading figure in Telenor Research said that:

"So, this is my strategy of working with partners. (…) two reasons. One, Telenor Research is a very small partner. (…) And in order to scale our research, we need to collaborate. But we need to collaborate very strategically. Find projects that have relevance to us (…) Find partners that are working o our data with our problems. (…) And the second reason why (…) because for one of our mission in Telenor is to empower societies. It's important. That's why we exist. We said that early in Telenor Research we want to build AI community in Norway. (…) You know, not any project would be of interest to be very concrete, even if it makes a big social impact. But those projects that would allow us to innovate and improve capacity of AI in Norway. That's what we aiming for. And the example I gave was Air Quality monitoring project. Very good example of that thing." (Interview 3, 26.11.2021).

When addressing this project, the AI team applied collaborative efforts with external partners as well as taking on an "academic approach".

Furthermore, the AI team applied an "academic approach" to the project and were driven by *the* prospect of exploring new market opportunities and acquiring knowledge and experience. Rather than to address business problems and directly help to improve the operations of the company, like with the Green Radio-project. Instead of trying to develop commercial products, they tried to explore and show the different possibilities of different use areas of AI solutions. With this they acquired both knowledge and experience which helped both Telenor improve, as well as strengthening the knowledge- and competence base in society.

With this approach, the AI team´s work has amongst other things revolved around collecting and cleaning data from the cheap sensors deployed around Trondheim city, and then developing an algorithm which tried to predict the levels of particle dust in the city. (Interview, 03.11.2021). Subsequently, the team produced some academic papers based on the results from these successful experimentations and tests. Additionally, they also have worked on co-supervising university students. (Interview 3, 26.11.2021; Interview 6, 17.01.2022).

The AI model developed by the AI team in this project is relatively easy, standardized, known material. They were able to produce a prediction model that could be used and applied to do various things. And seeing that making a commercial product wasn't the intention in

this project, they left it up to Trondheim commune to try and figure out what prediction models such as the once developed by the AI team could be used for. Whether it had any value for knowing the type of pollution that´ll be seen in ten days; if one could use this to steer and control in order to reduce the factors causing pollution in specific areas. Measurements of this kind may be used to ask people to stay away from these areas or shut down streets. (Interview 10, 07.02.2022).

The work put down by the AI team in this project serves as an example on how they contributed to build sustainable a knowledge and competence base both within Telenor and society in general. Additionally, it shows how they are contributing to change the mindsets regarding AI and its potential areas of use. It also illustrates how the team tries to work to benefit both society and the company.

> *"[W]e (...) enabled them with new technologies to be able to get (...) a higher quality. (...) So, I think [the Air Quality-project is] a good example of how we enable societies by the use of technology" (Interview 2, 03.11.2021)*

6.3.3 Impacts

The direct results of the project came mainly in the form of contributing, together with external partners, to further developing a sensory infrastructure in Trondheim city; making an algorithm which were tested out in practice and saw the production of academic papers. This project was thus of a academic orientation. When it comes to research of this kind it often results in publishing articles. And as argued by one of the scientists in Telenor Research these papers are often published and then left to be forgotten. With this in mind it´s very difficult to make an impact on one´s surroundings through conducting research of this kind.

> *"Yes, that is a weakness I see then with academia". (Interview 4, 02.12.2021; Note: it is the researcher´s translation from Norwegian to English)*

However, when research such as this is done in a corporate context it´s more likely to have a greater impact because more there are greater forces around that are pushing for it to have

some more value than merely new knowledge being created. Whether it be through experimenting, testing out a technology in practice, and applying knowledge on real world problems. (Interview 4, 02.12.2021). Although the results obtained from the AI team´s work hasn't been put into actual use (Interview 11, 08.02.2022), there are still some implicit values that may be derived from the work on the project. First, the project was seen to strengthen the company. For once the project seen the exploration of new possibilities and business opportunities for Telenor. The project has been told to serve as an exploratory effort to look into where Telenor may position themselves in the future, what opportunities they should take, and which areas to bet on. By sharing their experience and knowledge internally in the company trough publishing, and holding presentation the hope was to inspire, motivate and promote this type of network and service in all of Telenor´s business areas. And to motivate them to look into new ways of approaching their networks and the capitalize on it. (Interview 10, 07.02.2022).

This also relates to another implication of the project´s results, namely the subsequent changing of mindsets. This may in turn el to or at least enable a possibility for transforming society´s practices and operations. Seeing that, as argued by an employee in Trondheim commune, both Trondheim and Telenor´s AI team has been actively engaged in trying to make something useful out of the data they have had. (Interview 9, 03.02.2022)

One informant stated that the project has societal impact by enabling cities such as Trondheim to use AI and IoT technology to ensure better, less costly, and more accurate detection, which helps them to improve how they manage and care for their city and inhabitants. (Interview 3, 26.11.2021).

Another informant claims that although the project stated as mainly something business related, it changed into being something with more value for Telenor´s reputation and brand.

> *"It started mainly with the business, but sifted over to become more like reputational value then for Telenor" (Interview 6, 17.01.2022; Note: it is the researcher´s translation from Norwegian to English)*

The turn was explained by the lack of creating immediate and direct commercial value. The project, however, received a lot of attention. The area worked on – air quality and air pollution – is a way of empowering societies. Through the efforts and work put in by the AI team in this project they contributed to create opportunities for improving the city´s citizens living conditions. Additionally, the informant claims that they learned a lot about AI, ML, and sensors. As well as about a new potential business area and the opportunities within. And the

fact that they participated in a EU-project and collaborated with several other societal actors contributed to strengthening the company´s network. (Interview 6, 17.01.2022).

An additional benefit of values from this project, an informant argued, is that the use of ML technologies enables them to transform and improve their sustainable activities. (Interview 2, 03.11.2021). The Air Quality project was a social innovative effort since it contributed to improving the air quality by developing tools (such as apps) and routines (more strategic cleaning of the city) in order to fight pollution and its damaging effects. (Interview 10, 07.02.2022)

An informant from Trondheim commune substantiated this by explaining that these types of projects have beneficial effects on society both in terms of people´s health and the environment. The air pollution measurements may contribute to taking actions – such as creating an environmental based speed limit when and where the air pollution is getting bad; and take easier decisions when it comes to starting processes to clean the city – to improve the air quality. The insights may also be used in city planning to say something about air quality I areas where they plan building houses, apartments, schools, kinder gardens and the like in order to stay away from the worst places. (Interview 9, 03.02.2022)

As stated by a previous Telenor employee, the Trondheim commune received an environmental package which, in theory, was designed to improve the city´s air quality in the city better and, therefore, benefit society and the environment. (Interview 8, 02.02.2022). Another informant from Trondheim commune posited that the project revealed how data and AI can be used to predict events and take actions thereafter. This may in turn have beneficial effects on society and the environment through improvement of air quality in cities. Additionally, it may inspire a more data-driven company, societal institutions and everyday operations and activities. (Interview, 08.02.2022) Another benefit is the strengthening of Telenor´s brand with evidence that the company is responsible and acts in a way that is both useful and beneficial to society. (Interview 10, 07.02.2022)

Furthermore, the project can be seen to have helped promote innovation in society and build society´s knowledge and competence. For example, the Telenor´s department Exploratory Engineering separated from the company as a result of internal reorganization during the course of this project and establishment of the startup company *"Lab 5E"*. One informant from the AI team argued that this is a good example of how Telenor Research promotes innovation by enabling spin-off companies. Through Lab 5E´s research and collaboration

with Telenor Research and the AI team, they had already built a product portfolio to get a head start and had already lined up some customers. (Interview 10, 07.02.2022). Another example on how the AI team has contributed to promoting innovation in society is through the supervision of a university student who created a dust-prediction AI algorithm which was better than the one developed by the meteorological institute. (Interview 9, 03.02.2022).

"[M]ost interesting this here with the modeling bit of that student."
(Interview 9, 03.02.2022).

7.0 Discussion

The actors involved in Telenor Research´s R&D-activity on green AI seemingly present an alternative to the depictions that surround the industrial actors and AI with concern and risk. Instead, the industrial actors conducting R&D of green AI are regarded being beneficial to society and given the role as protagonists. This leads to the question: *Do these descriptions represent relevant cases of social innovation oriented towards sustainability?*

This chapter discusses whether or not the descriptions and personal narratives presented in the previous chapter coincide with the concept of social innovation for sustainability to better assess whether industrial actors conducting work on green AI can be considered a case of social innovation aimed at sustainability. The first section examines whether the motivations of the AI team correlate with social innovation directed at sustainability, while the second looks at whether their approaches to the work correlate with the concept. The final section investigates whether the impact of the AI team´s work coincides with social innovation for sustainability.

7.1 MOTIVATIONS

7.1.1 Motivations driven by business interests

When it comes to the motivations behind the team´s work on green AI and whether it correlates with social innovation oriented towards sustainability, it is relevant to point out that both Telenor Research´s Green Radio project and Air Quality project were driven by *business interests.* The Green Radio project began with an exploration of whether a specific business problem could be solved through using AI solutions. It was driven by the intention to optimize how the company operated its networks to reduce costs. (Interview 4, 02.12.2021; Interview 14, 16.02.2022). Additionally, the Air Quality project was motivated initially by the goal to explore new opportunities in the market and value chain for which for Telenor can position itself. (Interview 6, 17.01.2022; Interview 10, 07.02.2022).

As assessed in the literature, it is crucial for firms to conduct R&D if they wish to remain competitive in the market. R&D is associated with strengthening a company´s internal knowledge and competence (see Murmann, 2000; Keesing, 1967). However, as argued by Rothwell (1992) it also is surrounded by a significant amount of uncertainty. Directing such activity towards *societal interests*, therefore, might be regarded as challenging. Although, firms are confronted with the goals of meeting profit targets while reducing costs, they are also pressured to address societal and environmental issues. (Ambec & Lanoie, 2008; Mirvis, Herrera, Googins & Albareda, 2016). As assessed by Ambec and Lanoie, the responsibilities that companies have towards society are often related to the reduction of competitiveness. Additionally, Öberg (2012) acknowledges that acting according to CSR can have a restrictive effect on the business activities of firms. This creates difficult choices for firms to take when conducting R&D which is arguably more pressing when talking about industrial research departments. Since they have one foot rooted in academia with all of the responsibilities to stay truthful and beneficial to society, the other foot in the industry entails the business values and loyalty towards improving the company´s market position and profits. However, the reflections of this section underline the importance that companies might wish to drive their R&D activities mainly towards their business interests, in other words, they choose projects that coincide with their business values.

7.1.2 An alignment of business interests and societal interests

Conversely, a closer look at the motivations described by the informants in this research reveals that business interests were not the sole driver of the work. Although the Green Radio project was initially a business-oriented endeavor, it evolved to include the consideration of societal interests when the team discovered that the project had the opportunity to do something that would be of benefit to society. they saw the potential to also be able to save power and reduce their carbon footprint. This illustrates the team´s ability and willingness to act on, rather than neglect, a chance to fulfill their responsibilities towards the environment and society. As claimed by one informant, the objective of the Green Radio project was to help society by improving the company itself. (Interview 14, 16.02.2022). Similarly, the descriptions of the Air Quality project implies that, in addition to exploring new market opportunities for Telenor, the team also sought to create knowledge and competence for the use of AI in making predictions and decisions regarding urban air quality. As such, the Air

Quality-project illustrate even further how the team is actively seeking to align business and societal interests. Although, the Green Radio-projects was aimed at solving a business problem, the Air Quality-project was an attempt to address a societal challenge. This underlines the fact that Telenor not solely to promote the wish to act upon their responsibility to society and the environment but is willing to allocate resources to do something not directly related to their business. Arguably, the Air Quality project was directly oriented towards trying to improve society. Since this work also allowed the company to with to explore new market opportunities, it is a good example on how business and societal interests might align. (Interview 10, 07.02.2022).

Such an alignment drives actors to engage in R&D-activity regarding sustainable technology and correlates with the argument of Cillo, Petruzzelli, Ardito and Del Guidice (2019) that firms are expected to develop ever more innovations that reconcile economic, environmental, and social goals. It also finds support in Camilleri´s (2017) claim that the active alignment between and embedding of sustainability and responsibility in a firm´s overall corporate strategy is an important part of its social profile. Furthermore, the aligning motivations of the AI team also correlates with Aagaard´s (2018) suggestion that solving persistent environmental and social problems is considered a new inspirational source for businesses in pursuing innovative opportunities. Aagaard considers that the concept of sustainable innovation has promoted the identification of a new behavior among companies that are becoming more interested creating innovations that meet societal needs. Firms begin to view societal challenges as economic opportunities and find that the solutions to these problems are attractive for both society and the companies themselves.

The alignment of business and societal interests, however, is certainly not the case when it comes to every business problem in all sectors. For example, if an oil company wants to improve its efficiency in exploiting oil resources, it very likely would not have been motivated by the same sustainability motivations as seen in the Green Radio project or the Air Quality project. of the greatest possible value for both the firm and society. Projects that align business and societal interests. (Interview 3, 26.11.2021). This corresponds with Öberg (2012) who finds that a CSR focus may lead to innovation in firms. Which testifies to and show the valuable aspect of aligning business and societal interests. To survive in market, it is becoming crucial for companies to align their interests of business with the ones of society and the environment, as various stakeholders – such as customers, employees, the government, non-profit organizations – place more pressure on firms to act responsibly. (Anser, Zhang & Kanwal, 2017; Scherrer & Astrachan, 2018). As described by the

informants, the AI team feels the expectations of governmental stakeholders and society in general alongside the fact that Telenor employees wish to work for a company with societally beneficial values and motivations. (Interview 2, 03.11.2021; Interview 3, 26.11.2021; Interview 12, 11.02.2022; Interview 18, 02.03.2022B). The descriptions of the informants, therefore, challenge the common perception that companies are motivated solely by profit. Instead, they demonstrate that the opportunities for businesses to thrive even while fulfilling their sustainable and societal responsibilities. these opportunities might appear serendipitously or make themselves known only when they are searched out.

The descriptions from the actors involved in the team´s R&D work on green AI, therefore, may be regarded to coincide strongly with social innovation oriented towards sustainability. For example, this is evident in the team´s ability not only to identify how business and societal interests might align but in its efforts to actively find this connection. Moreover, by employing both academic and applied approaches to using AI to meet environmental challenges, the AI team demonstrated that it is willing to allocate resources, time, and efforts into building knowledge, and competence around a particular topic. furthermore, the team goes beyond by sharing its insights.

7.2 APPROACHES TO THE WORK

7.2.1 Building sustainable knowledge and competence

Does the way Telenor Research´s AI team approached the work coincide with social innovation directed at sustainability? On one hand, it was evident from the descriptions of the informants that they work towards building knowledge and competence regarding how AI might be used to address environmental challenges. For example, an academic approach was taken in the Air Quality project, which was driven by the creation of new insights and knowledge through experimentations with solutions, production of papers, and supervision of university students. With the Green Radio-project a more applied approach directed at building practical competence and insight was taken. Through testing out AI models in practice in their daily network operations in several BUs, they engaged in creating knowledge and competence on how AI might improve the sustainability performance of their network operations. The descriptions show that they took real world issues, both on from their own

company and from society, and worked towards creating knowledge around how AI might be applied in order to benefit the environment. Such descriptions arguably correlate to several points made in the literature. Because R&D has is regarded as very important for firms because building a solid knowledge base is related to improvement in their competitiveness and positions in the market. (Murmann, 2000; Keesing, 1967). Since the work had strong orientations towards sustainability, it was evident that they not only seeked to develop knowledge and competence solely to strengthen their own capabilities. They engaged in developing knowledge on how to use new technology to meet environmental challenges. In light of Weber & Rohracher (2012) claim about the crucial role of R&D-activities in facing societal challenges, such efforts speak to helping society progress and thus becomes highly important.

Although the AI team´s efforts may be regarded as meeting expectations about fulfilling its responsibilities to society and improving the company´s social profile, it is evident that they wanted something more. (Ambec & Lanoie, 2008; Öberg, 2012; Anser, Zhang & Kanwal, 2017). Not only did the AI team approach the work to create knowledge and competence that solely strengthened the company. Additionally, they actively seeked to share and spread out what they had learned to various parts and actors in their surroundings. From the descriptions of the informants, it was evident that they wanted to collaborate with both external and internal partners to build experience, knowledge, and create knowledge in other as well as themselves. The Green Radio-project illustrate how the approaches to the work contributed to build knowledge and competence in-house. The team here collaborated with several BUs and thus affected many different parts of their company. In the descriptions of the Air Quality project, it is evident that they collaborated with various with industry partners, public sector organizations, and universities. For example, partnering with Trondheim commune and NTNU, as well as participating in an EU project. Such activities coincide with Parmigani and Rivera-Santos´ (2011) argument that no organization is an island and that innovations seldom occur in isolation. Organizations need relationships to survive and develop. As Dodgson (2014) suggest that innovation always involves many and diverse contributors. Very few organizations today, if any, can innovate without collaborating in some form or another. Finally, as claimed by Powell and Grodal (2005) innovation i collaborative environments contributes to the innovative capabilities of firms, since it might expose them to novel idea sources

Some of the descriptions of the informants, however, indicate that some of the team´s collaborations in these projects were not so strong. (Interview 11, 08.02.2022). This might shed some doubt as to the strength and effectiveness of knowledge transfer. However, this was only stated to be the case in one of the projects and with one of the partners (the Air Quality-project and Trondheim commune). Generally, most of the informants testified that the collaborations between the AI team and their various partners were good. Additionally, one might argue that the informants' descriptions of the various collaborations might speak to how the AI team shared their knowledge, experience, and skills in various ways. Which correlates to, for example, Powell and Grodal´s (2005) observations of more and more diversity of relationship and institutional actors within the industrial innovation process. Additionally, Parmigiani and Rivera-Santos (2012) sketches out different forms of interorganizational relationships, such as alliances, joint ventures, supply agreements, licensing, co-branding, franchising, cross-sectors partnerships, networks, trade associations, and consortia. Which all might be said to possess their own characteristics and benefits. As such the collaborative efforts of the AI team underlines that they seeked to share their knowledge and competence in a variety of ways. Such as partnering with internal actors to solve business problems; participate in and creating knowledge within a European AI network consisting of various partners; and loosely cooperating with the public sector actors under the supervision of supply agreements on data.

Accordingly, these efforts might be understood to correspond with elements of the concept of social innovation directed at sustainability, since they both illustrate how the team builds knowledge and competence on how to use AI technology to address environmental challenges and shares these with different partners in a variety of different ways. These efforts serve to not only to strengthen and improve the sustainable efforts and knowledge of the company, but also their surrounding actor, as wells.

7.2.2 Acting as a sustainable intrapreneur and entrepreneur

However, they didn't only put in effort to simply create knowledge. The descriptions of the informants indicate that the AI team was actively seeking to provide context and an arena where this knowledge might be used. The descriptions of the Green Radio project show that the team took on a concrete business problem and tried to solve it. Additionally, it was emphasized that it was important that this project was applicable not only to Telenor Denmark

but to other BUs as well. In order for the team to scale the project and to work in several contexts. In the Air Quality project, the AI team worked to address a specific problem of an actor in society and experimented to see how AI solutions might be applied to solve such matters. What the informants conveyed in this regard underlines the fact that the AI team seeked to not only create knowledge, but to have an arena to test out the knowledge on. As such the team didn't only work towards figuring out how AI can be used to address environmental challenges, but how it specifically can be used, for example, to change operations of networks and the way air quality is managed towards more sustainable practices. This finds support in the thoughts of Ambec and Lanoie (2008) regarding firms´ particular advantageous opportunity to change the world and contribute to the green transformation of society due to their power and place in the market. Since these descriptions arguably illustrate that the team is using their important role within the company as well as the central position of Telenor in the market to take the opportunity utilize their AI knowledge and -competence to address real-world business related and societal challenges. Specially, the AI team uses its knowledge in specific contexts in order to contribute to the green transformation of society.

Additionally, this may be seen as a way of addressing what one informant describes as a problem when it comes to academia and paper-production. That it is very often the case that scientists write papers and publish it. Then they are finished with it, leave it behind in order to continue on with doing other things and write other papers. (Interview 4, 02.12.2021). Similarly, Penfield et al (2014) claims that the time-lag between research and impact may be considerable. However, by finding contexts and arenas where their knowledge and competence might be utilized, these efforts are potentially contributing to solve such issues. Because they create a direct connection between the knowledge created and areas of use.

Related to this might be the claim that the AI team not only approached the work on this project through creating knowledge and providing a context for it. Additionally, the descriptions evidently show how they also put in efforts to make changes. That is, to make the knowledge and competence they build in these projects actually change routines and practices. For example, to spark transformation in the way their base stations ere operated and approached through the work on the Green Radio project, and in the way institutions such as Trondheim commune monitor and approach air quality management in the city through the Air Quality project. This coincide with the argument of Markard Geels, and Raven´s (2020) that comprehensive innovation and transformation of the whole system – including various actors, institutions, and practices – is needed to enable society to meet environmental

challenges. Additionally, such efforts might also relate to what Scherrer and Astrachan (2018) presents as *sustainable entrepreneurship.* Which is characterized by a strong market-based and innovation-oriented approach to sustainability. Often its implementation implies fundamental changes in organizational structure and culture. As such it might be claimed that the AI team engages in sustainable entrepreneurship through arguably contributing to change structures and culture in society oriented towards improved sustainability. But the fact that the AI team also seeks to change firm-internal structures and culture to more sustainable practices and mindsets, indicate that they also engage in sustainable intrapreneurhip. Which refers to effort to uncover and develop opportunities to create value through innovation and seizing that opportunity within an existing organization. (Antoncic & Hisrich, 2001, 496-498). Such reflections illustrate how the AI team acts as sustainable intrapreneurs and entrepreneurs through the way they approached the R&D work of AI. Nevertheless, what are the actual impacts of the AI team´s efforts?

7.3 IMPACT

The descriptions of the two projects featured a variety of results and impacts, but most important is that the developed AI solutions actually worked. with the Green Radio project, for example, the team managed to reduce power use on the company´s base station that resulted in reductions in cost, resource use, and carbon footprint. The Air Quality saw the somewhat tangible identification of new market opportunities. These are called positive institutional impacts, meaning that the R&D results have a positive effect on the institution in which they were created. This is in line with Ambec and Lanoie´s (2008) assessments of the opportunities that sustainability and the "green shift" presents.

Additionally, the projects were seen to spark changes in practices and routines, thereby. implications of such changes might coincide with both positive institutional and external impacts. An institution benefits when its processes are improved, and society benefits when practices and routines enhance sustainability. Ketata, Sofka and Grimpe "2014) argue that firms should focus on investing in the training of employees as opposed to technological R&D to develop sustainable innovation capabilities. In this light, a positive institutional impact could be traced to Telenor´s strengthened innovation capabilities, and society benefits

when innovation is directed toward environmental responsibility. The building of knowledge, competence, and capabilities regarding sustainability, may be viewed as efforts to improve the ability of society to handle environmental challenges. The two projects profiled in this research illustrate how AI can be used to address environmental challenges. Eichler and Schwarz (2019) emphasize that social innovation. social innovation should meet needs more effectively than existing solutions, improve capabilities and relationships, and spark better use of assets and resources. All of these impacts are evident in the descriptions from the informants.

Accordingly, the projects described in this paper proved that applying AI to environmental challenges creates solutions to handling power use in base stations and managing air quality in the city. Consequently, the results from the R&D work by the AI team positively affected society and the environment. This aligns with Markard, Geels, and Raven´s (2020) assessment that the sustainable transformation of society requires innovations in the entire system. Including various actors, institutions, and practices.

As argued by some of the informants, the direct results might not be significant at the moment, since none of the AI solutions created in the projects are currently in use today, but the work of the AI team might reveal its impacts in 10 years or so (Interview 2, 03.11.2021; Interview 3, 26.11.2021; Interview 12, 11.02.2022). This correlate with the time-gap issue presented by Penfield et al (2014). The lacking of tangible results, sheds doubt on the degree of institutional and external impacts these projects actually generated. As argued by Cillo, Petruzzelli, Ardito and Del Guidice (2019) the sustainable innovation path is longer than the conventional innovation equivalent.

Conversely, the informants describe the projects as producing some small, intangible results, that become more visible in hindsight. As argued by Öberg (2012), a CSR focus may lead to innovation in a company, but that innovation is mostly connected to its regular business and, therefore, is incremental in nature. Consequently, a CSR focus fosters incremental innovation. This statement might find support in Cajaiba-Santana´s (2014) claim that social innovations don't necessarily take the form of a technical artefact but can also be a new social practice that´ll ultimately become institutionalized social structures. Social innovations also refer to the creation of something new that is for the greater common good in society.

For example, the engagement of the AI team in these projects was often described as acts that contributed to strengthening the brand and the social profile of Telenor. Such results might not make themselves directly known right away. However, analysis in hindsight might reveal that conducting R&D work on green AI through projects such as the ones described in the thesis contributes to the perception of Telenor and its AI team as industrial actors who seek to fulfill their responsibilities to society. this might, in turn, improve the company´s market position by strengthening loyalty among customers, employees, and potential partners. As suggested by Scherrer and Astrachan (2018), younger customers in particular demand more and more intelligent and sustainable product and service offerings, and employees prefer working for companies with a proven sustainability track record.

In addition to the beneficial institutional impacts, positive external effects also accrue from CSR activities. knowing that, a company might place more importance on its CSR agenda and inspires others to do the same. For example, this was mentioned by some informants when discussing the Green Radio project, stating that the project´s sustainable profile might inspire the company´s vendors to move in this direction themselves (Interview 14, 16.02.2022). The CSR concept relates to the fact that modern businesses have a responsibility towards society that extends beyond making money for company owners. This underlines the importance of firms engaging in social innovation, which means contributing to social change and playing an important role in addressing societal issues. (SAGE Publications, 2012). Additionally, firms are believed to be powerful market actors who are central role to the transformation of society towards more sustainability. (Markard Geels, & Raven, 2020; Ambec & Lanoie, 2008). Therefore, they might spark inspiration of in others.

It is apparent from the assessment in this section that they had various impacts on their own business company and on the surrounding society. One might claim that the efforts made by the AI team in the Green Radio and the Air Quality projects are, in reality, social innovation. Although the direct impacts of the projects are scarce, they have many tangible results that might lead to the argument that the case of Telenor Research´s R&D work of AI is in fact a case of incremental social innovation oriented toward sustainability.

In summary, this chapter has examined and discussed how the AI team in Telenor Research, exemplified by their Green Radio and the Air Quality projects, is acting to enhance sustainability in both their company and society in a sustainable orientation. Through conducting incremental innovative effort on several levels, the AI team demonstrates how its work is changing company the work operations to create beneficial effects for both the

business and society (e.g., cuts in costs, power use, and CO_2.). In doing so, the team further develop the green AI knowledge and competence base of the company and society, and facilitates shifts in mindsets surrounding AI, and shares insights and experience with internal and external partners.

8.0 Conclusion:

Artificial intelligence for sustainability

Private companies play a critical role in improving society economically. In light of the urgent societal and environmental challenges society faces today, stakeholders put more and more pressure on companies to act responsibly. To orient their products, services, and activity towards benefiting society *and* business.

AI technology is emerging as one of the most vital tools in today's digital world and possesses the immense potential to be applied at all levels of society. The fact that more and more industrial actors engage in its development further illustrates the importance of this technology. In light of the common perception of industrial actors as cynical exploiters, this might raise fears as to the implications and effects this will have on society. Further research and exploration of this technology and its use and development are needed to understand it better.

Accordingly, this was the grounds behind the main research question of this thesis: Can industrial actors conducting work on AI be considered a case of social innovation for sustainability?

This thesis examines Telenor's internal research department and its R&D work on artificial intelligence. More narrowly, the study has looked at the department's AI team and their effort to explore and test how to address environmental challenges using AI solutions. The present study has focused on two projects. First, "the Green Radio project" aimed at reducing power use in the company's base stations. Second, "the Air Quality project" involved improving the management of air quality monitoring. Two sub-question was then constructed to delimit and concretize the study.

First, how is Telenor Research's AI work described by the actors involved? The descriptions presented in this thesis mainly revolved around the research department's work on two of their projects: the Green Radio project and the Air Quality project. The informants described what had been the motivations, the approaches taken, and the impacts of the projects. Here they emphasized the potential of using AI to address environmental challenges and the value and importance of the work they performed. Such descriptions might arguably place AI and its

developers as protagonists who try to address environmental challenges and positively impact society. This, in turn, challenges the concerns around industrial actors engaged in the development of AI and the possible risky implications this might have on society. Concerns that draw similarities to "the Evil Queen in Snow White making her poisonous apple". The descriptions derived from the actors involved looks at the matter from another angle.

This background raises the second sub-question: Do these descriptions represent relevant cases of social innovation oriented towards sustainability? The discussion of this research question assessed that the AI team in Telenor Research acted to improve and change both their company and society towards more sustainability. Both projects illustrate how the team conducts incremental innovative efforts on several levels. Ranging from changing their company's work operations; to developing knowledge and competence on how to use AI to meet environmental issues, inspiring change in practices and routines, shifting mindsets, and sharing their insight, experience, and skills.

Moreover, the informants' descriptions of the R&D activities on AI of the team on the projects arguably correlate with social innovation oriented towards sustainability on several levels. First, this is evident in the team's motivation behind their work. They do not only illustrate how business interests and societal interests in matters such as these might seamlessly align. Additionally, they also actively seek to find ways of making them coincide, as illustrated by the way and the criteria through which they are picking projects. Secondly, through utilizing both academic and applied approaches, they worked with the technology in various ways to prove and show how to use it to meet environmental challenges. These efforts showed the team's willingness to allocate resources, work hours and effort to build knowledge and competence on the topic. Rather than "merely" creating insights and experiences, they also shared them with the rest of the company and society. Their approaches to the work on these projects seemingly contributed to changes in the company and society. Lastly, as apparent from the impacts assessed, the team illustrated, through these projects, making various beneficial institutional and external impacts. For example, by significantly cutting costs and power use, budling capabilities, strengthening the social profile, brand and possibly the company's CSR focus, and inspiring change in others. As such, the descriptions both illustrated how the team contributed to developing AI solutions that worked as intended and proved how their work has several forms of impact. Furthermore, making this case something more than merely an instance of inventions that do not affect its surroundings. Instead of simply developing solutions for the sole sake of its invention, they actively sought to find

ways to make AI that had an impact on its surroundings. The work did not have the traditional Schumpeterian economic, market-oriented effect usually associated with technological innovation (Fagerberg, 2003). However, as the literature on social innovation illustrate, innovative efforts do not necessarily have to be limited to radical and economic impacts. Additionally, they involve various other elements, promoting the possibility that innovation can come in different forms. The case of Telenor Research's AI work coincides with how Eichler and Schwarz (2019) describe social innovation. Seeing that they produced new solutions (the AI technologies for predicting such things as use of capacity in the base stations and air quality) that met the societal need of having to address and fight environmental challenges. Accordingly, their efforts led to more incrementally oriented impacts, such as improving capabilities and using their resources (like power in base stations). This benefited both the institution (Telenor) creating them and the surrounding externalities (like society, environment). These estimations imply the possibility of assessing industrial actors developing AI differently if one looks at the case from the point of view of the actors involved in the work. Thus, demonstrating how R&D of AI carried out by large companies' R&D departments can lead to social innovation that contributes to sustainability.

Their descriptions differ from societal actors such as the media regarding the work from the outside and draws associations to stories such as when "king Arthur drew Excalibur up from the stone". Thereby shifting the focus from the concerns and risks industrial actors and their R&D work on AI poses to society to the benefits and potentials for improvement and empowerment they hold. Here the actors arguably go from sort of "ugly ducklings" to becoming "beautiful swans". This, in turn, underpins the value and importance of both the AI team's efforts and work, as well as the AI technology itself.".

However, some caution must be made. Because although the descriptions of the actors involved in Telenor Research's AI work coincide with the concept of social innovation oriented towards sustainability in many regards, this is just one of the ways of looking at the story. The thesis at hand has examined the case from the points of view of the actors involved. Even though the perspectives were sought to be diversified by selecting informants in different positions, alternative approaches to similar cases and questions might come with other perspectives. For example, a more quantitively analysis of such variables as patents and returns of R&D investments might conclude differently than what is done here. This thesis has presented one way of approaching such cases and questions. To better understand the topic, other approaches and methods (both qualitative and quantitative) in assessing the

connection between industrial actors and their R&D work on AI and social innovation and sustainability are needed.

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