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A sociotechnical perspective of Artificial Intelligence in the context of Industry 4.0

The impact of AI on the social dimension of sustainability

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ABSTRACT (MAX. 200 WORDS):

Due to the increasingly concerning threat of climate change, organizations, including industrial companies, are pressured by various stakeholders to consider their impact on the environment, economy and society. The Industry 4.0 (I4.0) revolution enables companies to use new technologies such as Artificial Intelligence (AI) to address the challenge of making a positive impact on sustainability. However, research has shown that less attention has been paid to social sustainability, especially in the field of AI in the context of Industry 4.0. In this qualitative research, we interviewed AI and sustainability experts to develop a conceptual framework from a sociotechnical perspective that demonstrates how AI influences the impact of the social dimension of sustainability. Based on our findings, AI is used in production to, for instance, automate repetitive tasks and help the worker be more efficient. However, AI is not yet used to its full capacity. Even though social sustainability is measured or planned to be measured in companies, the focus remains on the economic and environmental dimensions. Nevertheless, companies should not neglect social sustainability, and as our research shows, AI, when implemented in the right way with good communication and transparency, can impact positively the social dimension.

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1 Introduction

Climate change is a highly concerning threat and we have to make changes collectively now to have the chance to tackle and potentially solve the crisis. We cannot keep exceeding the planet's resource capacity at the expense of future generations. In 2015, the United Nations set the Sustainable Development Goals (SDGs) which include 17 goals that the UN Member States agreed on to protect the planet and the people (UN, 2015). Goal 12 of the SDGs is Responsible Consumption and Production which attempts to detach economic growth from environmental degradation while enhancing resource efficiency and improving sustainable lifestyles (UN, 2015).

In this research, we want to give our contribution to sustainable development and therefore, focus on the aspect of sustainable production. In terms of sustainable production, the Lowell Center for Sustainable Production (LCSP) defines it as:

> … the creation of goods and services using processes and systems that are: non-polluting; conserving of energy and natural resources; economically viable; safe and healthful for workers, communities, and consumers; [and] socially and creatively rewarding for all working people (2021, n.p.).

From this definition, the LCSP Principles have emerged to enable sustainable production and describe the interrelationships of the three dimensions of sustainability (Veleva et al., 2001).

The three commonly identified dimensions of sustainability are environmental, social and economic (Brundtland & Khalid, 1987; Purvis et al., 2019). An often-used definition of sustainability is described by the 1987 Brundtland Commission Report as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland & Khalid, 1987, p.54). The social dimension of sustainability, or social sustainability, takes into consideration the human aspect of sustainability. According to the GRI (2022), the organization's social impact refers to the effects on individuals and groups, including communities, vulnerable groups and society as well as the organization's impacts on human rights. Organizations can measure their social, as well as their economic and environmental, sustainability impact with the GRI Standards (GRI, 2022). However, the social dimension of sustainability has been neglected compared to the two other dimensions (Margherita & Braccini, 2020). Social sustainability can be measured by different indicators such as working conditions, employment, health and safety, non-discrimination and ethics and privacy (Beltrami et al., 2021).

Due to the increasingly concerning threat of climate change, organizations are pressured by various stakeholders to consider their impact on sustainability (Javaid et al., 2022). Simultaneously, industrial companies are currently experiencing a change due to the fourth industrial revolution, also known as Industry 4.0 (I4.0). Throughout the years, new innovations have disrupted the industry and revolutionized the way organizations and humans work. Beginning from the first industrial revolution in the 18th Century in which the steam engine among other innovations started to replace human and animal-powered machinery in production facilities and fast-forwarding to the industrial revolution currently happening in which Industry 4.0 enabling technologies are automating the production further than ever before (Popkova et al., 2019; Ahuett-Garza & Kurfess, 2018).

Industry 4.0 takes advantage of the new technologies and connects the technologies used in a company coherently and transparently (Vaidya et al., 2018; Jamwal et al., 2021; Ghobakhloo, 2020; Rojko, 2017). I4.0 enabling technologies include, but are not limited to, additive manufacturing-based technologies, Artificial Intelligence (AI), augmented reality, autonomous robots, big data analytics (BDA), blockchain, cloud computing, cyber-physical systems (CPS), cyber-security, the Digital Twin, the Internet of Things (IoT), nanotechnology, simulation and the vertical and horizontal integration (Moktadir et al., 2018; Dilberoglu et al., 2017; Rüßmann et al., 2015; Haseeb et al., 2019; Vaidya et al., 2018; Alaref & Khan, 2021). Bai et al. (2020) point out that the I4.0 technologies do not only contribute to the traditional organizational business and economic performance but also a more sustainable society.

Industry 4.0 enabled technologies can affect all three dimensions of sustainability in both positive and negative ways. The expected sustainability contributions of I4.0 include improving productivity, flexibility and resource efficiency while decreasing waste and energy consumption as well as overproduction (Machado et al., 2020). Implementing Industry 4.0 in an organization can have an impact on social sustainability by affecting employment, wages, working conditions, occupational health and safety, discrimination, privacy and personal autonomy, social health and safety, ethics as well as education (Beltrami et al., 2021; Narula et al., 2021). Technologies can for instance prevent employees from working in dangerous workplaces or doing unsafe activities (Narula et al., 2021). It is expected that with I4.0 technologies the collaboration between stakeholders strengthens and new IT-related job opportunities emerge while the quality of the working environment improves and routine jobs decrease (Machado et al., 2020).

On the other hand, Industry 4.0 technologies can have a negative impact on sustainability as well. Since I4.0 technologies such as AI will automate tasks, the need for lower-level jobs will decrease. In the study made by Bhaveshkumar Nandanram et al. (2020), the respondents show concern about I4.0 technologies reducing job opportunities. In addition, there can be potential energy disadvantages with I4.0 technologies (Bai et al., 2020). Nevertheless, the Industry 4.0 impact on sustainability depends substantially on the technology, industry and considered sustainability dimension (Bai et al., 2020). Wang et al. (2019) identified that AI can optimize the energy consumption and the planning of resources, parameters or strategies, for example. This is also reflected in Vikhorev et al. (2013) study about an advanced energy management system. The results indicate an increase in energy efficiency and can also detect fault diagnostics and even shut down machines when they are underutilized. Additionally, AI can schedule and optimize new machining operations, which reduces costs and increases productivity.

1.1 Research Problem

In recent years, sustainability in the context of Industry 4.0 has emerged as a new research topic (Gajdzik et al., 2020). It consists of the individual research areas of sustainability and Industry 4.0 and explores, among other things, sustainable development goals in the implementation of Industry 4.0 solutions (Gajdzik et al., 2020). It is increasingly being taken up by researchers and practitioners (Gajdzik et al., 2020; Furstenau et al., 2020). Nevertheless, Industry 4.0 remains to be a relatively new research area and therefore, Furstenau et al. (2020) identify it still as immature. Furthermore, there is a lack of research on Sustainable Industry

4.0 in the Information Systems (IS) field (Gajdzik et al., 2020; Furstenau et al., 2020; Machado et al., 2020).

On the other hand, Machado et al. (2020) noted that there is already extensive research in Industry 4.0, especially in the area of energy efficiency or the use of Big Data to analyze the above-mentioned 17 Sustainable Goals. It also appears that Industry 4.0 has many use cases to address sustainable development issues such as lifelong learning or climate change (Sangwan & Bhatia, 2020).

Despite this, the opportunities in this research area have not been fully explored (Machado et al., 2020). Machado et al. (2020) highlight issues such as the impact on global production, human factors and the development of sustainable products and services. Furthermore, the authors point out that the development of different business models and the integration of digital systems, as well as the above-mentioned topics, make an important contribution to research. This is also reflected in the research problems presented by Gajdzik et al. (2020) and Ghobakhloo (2020). They suggest that the research focus should be primarily on the three pillars of sustainability in the implementation of Industry 4.0 technology. Furthermore, Lopes de Sousa Jabbour et al. (2018) argue that there is a knowledge gap in the area of how organizations should design a sustainable solution taking into account Industry 4.0 technologies.

In addition, industrial companies are also under increasing pressure from various stakeholders to act more sustainably (Javaid et al., 2022). There are several barriers such as a lack of government support and a lack of a roadmap that companies can follow. Therefore, there is a need to investigate the Industry 4.0 technologies in the context of all dimensions of sustainability (Alaref & Khan, 2021).

However, according to Beltrami et al. (2021) and Margherita and Braccini (2020), especially AI in the context of I4.0 is not well studied and the research is focused on the environmental and economic dimensions while undermining the social dimension. There is extensive literature on the impact of I4.0 on ecological and economic dimensions. At the same time, the social dimension has not been widely researched. Therefore, we see the knowledge gap, especially in the social dimension of sustainability. Due to the fact that the social dimension is not very present in the literature, it is a relevant problem and Margherita and Braccini (2020) encourage IS researchers to address this aspect. Therefore, we see it as a relevant problem that should be investigated in order to understand how AI is used in industrial companies and what impact it has on the social dimension. This can both contribute to the knowledge gap and inform industrial companies how AI applications can impact the social dimension of sustainability.

1.2 Research Questions

Our research questions are:

- How do organizations implement Artificial Intelligence in the concept of Industry 4.0?
- What is the impact of Artificial Intelligence on the social dimension of sustainability?

1.3 Research Purpose

The aim of our research is to develop a conceptual framework from a sociotechnical perspective that demonstrates how AI influences the impact of the social dimension of sustainability.

1.4 Delimitation

Due to the scope of a master thesis and the complexity of Industry 4.0 as well as sustainability, we could not, in our time frame, make holistic research considering all technologies included in I4.0 and their effects on all dimensions of sustainability instead we needed to narrow the topic down. From the I4.0 technologies, we decided to focus on Artificial Intelligence because it is less researched compared to other I4.0 technologies (Beltrami et al., 2021). Yet, we wanted to consider Industry 4.0 in our research and not only AI since I4.0 is an ongoing phenomenon that is changing the industry. Another decision we made was to focus only on the social dimension of sustainability from the three dimensions of sustainability. Social sustainability and how I4.0 technologies, especially AI, affect social sustainability are less researched in the literature compared to other sustainability dimensions (Ajmal et al., 2018; Beltrami et al., 2021). Furthermore, industrial companies do not only consist of production lines but also have other areas. Therefore, we decided to focus on the production aspect in our research to narrow our topic down.

2 Theoretical Background

2.1 Industry 4.0 Definition and Relevance to the IS Discipline

Industry 4.0 (I4.0) was first introduced in Germany in 2011 as “Industrie 4.0” and since then, the concept has gathered more and more attention worldwide in the academic, industry and government sceneries (Lasi et al., 2014; Ghobakhloo, 2020; Rojko, 2017). Industry 4.0, which was triggered by the Information and Communications Technologies (ICT) development, is considered to be the fourth industrial revolution because it is changing the industry through digitalization, collaboration and automation (Vaidya et al., 2018; Jamwal et al., 2021; Ghobakhloo, 2020; Rojko, 2017). The main objective of Industry 4.0 is to take advantage of the new technologies, such as the Internet of Things (IoT), the smart factory, digital mapping and simulation (Rojko, 2017). Even though Industry 4.0 is a natural consequence of advanced technologies and digitalization, it was formed also to find new potential ways to gain more profit in industrial manufacturing which has been in the state of reaching full capitalization (Rojko, 2017).

Industry 4.0 has various technologies connected to the smart industry and the future of the industry (Alaref & Khan, 2021). These technologies include, but are not limited to, additive manufacturing-based technologies, Artificial Intelligence (AI), augmented reality, autonomous robots, big data analytics (BDA), blockchain, cloud computing, cyber-physical systems (CPS), cyber-security, the Digital Twin, the Internet of Things (IoT), nanotechnology, simulation and the vertical and horizontal integration (Moktadir et al., 2018; Dilberoglu et al., 2017; Rüßmann et al., 2015; Haseeb et al., 2019; Vaidya et al., 2018; Alaref & Khan, 2021). Scholars, as well as government policymakers, have struggled to define Industry 4.0 coherently and to describe the technologies included in I4.0 (Ghobakhloo et al., 2021; Chiarello et al., 2018; Zheng et al., 2018). Since Industry 4.0 is a fairly new and complex concept with a high number of evolving technologies, it is challenging to form a unified definition. The research by Chiarello et al. (2018) shows how even various higher governmental documents have had a different number of main I4.0 components. Likewise, Ghobakhloo et al. (2021) made a systematic review to address the issue of the lack of a clear definition of I4.0. Industry 4.0 is experiencing a shift going from limiting the concept to factories and defining it as the digitalization of manufacturing processes (Lasi et al., 2014) to expanding the definition to the digital transformation of industrial value chains (Ghobakhloo, 2020).

Table 2.1 shows an overview of the more commonly used I4.0 technologies. Studies have classified Industry 4.0 and divided the I4.0 technologies in different ways depending for instance on what values and interests the actors of the various disciplines and industrial actors hold (Ghobakhloo et al., 2021). One of the more used descriptions of I4.0 was originally adopted by Boston Consulting Group (BCG) in which I4.0 technologies are divided into nine main building blocks (Rüßmann et al., 2015). These building blocks are simulation, horizontal and vertical system integration, the Industrial IoT, cybersecurity, the cloud, additive manufacturing, augmented reality, big data and analytics as well as multi-agent systems that include Artificial Intelligence and autonomous robots (Rüßmann et al., 2015; Benotsmane et al., 2019; Vaidya et al., 2018). However, since Industry 4.0 is a fast-evolving concept with various technologies, there are more technologies included in Industry 4.0. Yet, our focus of work is not to redefine Industry 4.0.

To further illustrate the relevance of the IS discipline to our research area, we refer to Benbasat and Zmud (2003). According to them, the IS discipline should involve the IT artifact and its immediate non-technical net. They define the IT artifact as the "application of IT to enable or support some task(s) embedded within a structure(s) that itself activities rather than reflective of more generic is embedded within a context(s)" (p.186). In this context, Industry 4.0 can be described as the application of information technologies (e.g., Cloud, Big Data, AI, etc.) and industry core technologies (e.g., factory production, additive manufacturing, etc.) that can enable sustainability in the production from an economic, environmental and social perspective. Therefore, I4.0 can be viewed as an enmeshed IT artifact (Chiasson & Davidson, 2005). An IT artifact is described as an enmeshed IT artifact when one or more IS technologies are intertwined with core production systems such as the factory production systems and are thus very specific to a particular industry (Chiasson & Davidson, 2005). According to Brooks et al. (2010), it is thus important that IS researchers understand how IT artifacts affect different contexts such as organizations, environments and people. This is also reflected in the definition of the IS discipline from Sidorova et al. (2008), which states that IS research encompasses how IT is developed and how it interacts with different research themes (individuals, groups, organizations and markets).

Considering that I4.0 includes multiple IS technologies that are interconnected with production systems, we view AI as a technology that is embedded in this enmeshed IT artifact. In other words, we define I4.0 as a complex context to investigate how AI impacts the social dimension of sustainability. To understand these impacts, we use a sociotechnical view that includes both the technical artifact (AI) and the individuals (production workers) who use AI and perceive the impact in the context of I4.0 (Briggs et al., 2010). Thus, in this perspective, the technical and social components are considered as a whole, in that the interaction achieves an outcome (Sarker et al., 2019).

Table 2.1: Overview of the more commonly used I4.0 technologies

Technology	**Description**
Artificial Intelligence (AI)	AI creates intelligent human-like machines (Bai et al., 2020; Duan et al., 2019) and solves problems depending on the situation by making decisions intelligently and independently and remembering the adaptive decisions to be used in the future (Jena et al., 2020).
Internet of Things (IoT)	IoT allows data to be accessed anywhere with technology including sensors, computers and human devices that communicate wirelessly (Patyal et al., 2022).
Big data & Analytics	Big data and analytics refer to the approach to analyzing large data sets (Bai et al., 2020). Methods that are used to process a large quantity of structured or unstructured data, knowledge or information can be considered big data (Haseeb et al., 2019).
Cloud computing	The cloud includes IT services that are operated and accessible from a cloud computing provider (Bai et al., 2020).
Additive manufacturing-based technologies	Additive manufacturing-based technologies, such as 3-D printing, create three-dimensional solid objects (Bai et al., 2020). The main characteristics of additive manufacturing-based technologies are a high level of customization and low volume production (Ahuett-Garza & Kurfess, 2018).
Autonomous robots	Autonomous robots are used in manufacturing to replicate human actions as well as work in places where humans are restricted to work (Bai et al., 2020; Vaidya et al., 2018).
Cyber-physical system (CPS)	CPS integrates tightly the physical systems with the software components and is governed by computer-based algorithms (Jena et al., 2020). The main aspect of CPS is decentralization and autonomous behavior of the production process (Vaidya et al., 2018).
The Digital Twin	The digital twin connects the virtual with the physical world (Kamble et al., 2022). In the I4.0 context, the digital twin can make IT systems more integrated so that companies, departments, functions and capabilities are more cohesive with the developing cross-company, universal data-integration networks and automated value chains (Rüßmann et al., 2015).
Simulation	Simulation refers to technologies that use real-time data to replicate a process or system of the physical world (Bai et al., 2020; Rüßmann et al., 2015).

2.2 The Sociotechnical Perspective of AI in the Context of Industry 4.0

Artificial intelligence is a research topic that is receiving increasing attention in the field of IS (Dwivedi et al., 2021; Collins et al., 2021). However, there is no single and clear definition. For example, Berente et al. (2021) describe AI as a concept that solves complex decision-making problems by simulating human intelligence. In this sense, as previously mentioned, machines adopt human-like tasks and learn from experience. According to Kaplan and Haenlein (2019), AI is a system that interprets data, learns from it and enables certain targets. This allows AI to perform complex tasks that otherwise can be performed only by humans (von Krogh, 2018).

Considering that we use a sociotechnical perspective with a technical and social subsystem that interact and influence each other (Bostrom et al., 2009; Alter, 2013), we view AI as a technical subsystem. Lee et al. (2015) describe that such a system is used for specific problems, goals or purposes. In this context, AI is used on the one hand to make decisions, for example, to plan production based on demand or to control quality (Lu, 2019). On the other hand, AI enables robots to take over human tasks (Lu, 2019). Lu (2019) defines robots as a product of AI that can perform complex and repetitive tasks. With the help of AI, they can learn, recognize patterns and make decisions. According to Rüßmann et al. (2015), these robots are becoming more flexible, autonomous and cooperative, allowing robots to interact with each other and learn from humans while working side by side with them. In addition, Alter (2020) describes various facets such as decision-making or performing physical work in the context of fully automated systems in Industry 4.0 that are enabled by AI. These include, for example, robots that automatically make decisions or take over physical activities.

Gorecky et al. (2014) highlight that the I4.0 transformation does not intend a workerless production, so it is important to involve people in this system to achieve the full potential of human capabilities and technologies. Therefore, the social subsystem must also be considered. In comparison, the social subsystem includes the relationships and interactions between people who have a specific problem, goal or purpose (Lee et al., 2015). For Cherns (1976), these are primarily the goal of a challenging job, where workers can learn and make decisions, as well as receive social support. In addition, the work should enable integration into life and provide a desirable future. Specifically in the context of I4.0, Gorecky et al. (2014) mention that workers are given more responsibility and act as creative problem solvers.

To achieve the desired outcome, the technical and social subsystems must harmonize with each other (Bostrom et al., 2009; Alter, 2013; Sarker et al., 2019). On the one hand, this means that AI must support workers in their daily work (Gorecky et al., 2014). On the other hand, workers must be more adaptable and willing to learn (Moniri et al., 2016) to ensure effective and harmonized interaction of the technical and social subsystems. According to Asatiani et al. (2021), this interaction can be ensured by having typical workers co-create the work processes by identifying AI use cases and evaluating as well as validating them.

2.3 Sustainability as an Outcome of the Interplay

According to Sarker et al. (2019), a harmonized interaction between the technical and social systems can lead to improved instrumental objectives as well as humanistic objectives. The

authors describe the instrumental objectives as economic outcomes such as profitability or efficiency while the humanistic objectives are described as social outcomes such as job satisfaction or quality of working life. In doing so, the authors recommend a balance between the two objectives.

However, sustainability is not limited to these two objectives. As previously mentioned, sustainability can be divided into three pillars: environmental, social and economic and the three dimensions should be balanced to achieve sustainability (Brundtland & Khalid, 1987; Purvis et al., 2019). The organization's impact on the three dimensions of sustainability is interrelated (GRI, 2022). While an organization can positively impact, for instance, the economic and environmental performance of sustainability it can simultaneously negatively impact the social performance and vice versa (GRI, 2022).

The systematic literature review conducted by Beltrami et al. (2021), uses the sustainability performance measurements based on the GRI Sustainability Reporting Standards (GRI Standards) in which the social performance of an organization is divided into labour practices and decent work as well as human rights and society. The GRI Standards take into consideration the Triple Bottom Line meaning that it measures the impact of the organization's activities and business relationships on the economy, environment and people (GRI, 2022; Marimon et al., 2012). The goal of the GRI Standards is to increase transparency on how organizations contribute or intend to contribute to sustainable development (GRI, 2022). In addition, the GRI Standards aim to complement organizations' other reports instead of substituting them (Marimon et al., 2012).

The GRI Standards have a strong reputation as a sustainability measurement guideline and since its implementation, the framework has been successful in the rate of uptake, comprehensiveness, visibility and prestige (Marimon et al., 2012; Brown et al., 2009). The GRI Standards are used widely around the world for reporting organizations' sustainability performance (Marimon et al., 2012). Scholars have recognized the GRI framework as harmonized, comprehensible, standardized and objective way of reporting an organization's sustainability performance (Marimon et al., 2012; Narula et al., 2021). In addition, it has been established that the GRI framework is the best available option for sustainability performance reporting because it considers the three sustainable dimensions (Narula et al., 2021; Simmons Jr et al., 2018).

We define the outcomes of sustainability objectives based on the GRI Sustainability Reporting Standards (GRI Standards) (GRI, 2022) and the conceptual framework suggested by Beltrami et al. (2021). Beltrami et al. (2021) review journal articles to define the interrelations between Industry 4.0 and the three dimensions of sustainability and form their framework. The framework measures the social sustainability performance with five indicators which are working conditions, employment, health and safety, non-discrimination as well as ethics and privacy (Beltrami et al., 2021). In our framework, we also take into consideration the environmental and economic dimensions of sustainability. However, we do not focus on it because it is not in our scope.

Beltrami et al. (2021) state that the only found effects of AI on social sustainability are affecting non-discrimination and societal health and safety which is based on the research conducted by Vinuesa et al. (2020). Whether or not AI will support non-discrimination is a controversial topic (Beltrami et al., 2021). The data that trains the AI algorithms can have existing biases that can be transferred to AI which then would increase the discrimination (Vinuesa et al., 2020). In addition, AI if misused, can be a threat to human rights for instance, when AI is used in regions that lack democratic control or transparency (Vinuesa et al., 2020).

Some research considers the social dimension in the context of AI and robots. Gualtieri et al. (2020) note positive effects on a safe and healthy workplace. They recognize that the use of robots improves working conditions and product quality. This improves physical ergonomics in particular, as work is made easier and the employee no longer has to carry heavy loads, for example. In the context of the safe workplace, Gadaleta et al. (2019) also found positive effects in their research in which AI identify an optimized motion speed and acceleration limit. Reducing the speed of the robot can thus reduce the risk of a collision. In addition, it increases energy efficiency, reducing costs and CO2 consumption (Gadaleta et al., 2019; Bukata et al., 2017). Thus, this interaction has positive effects on all three basic pillars of sustainability. Furthermore, in a study that does not include Industry 4.0, it is apparent that the interaction of AI and workers can increase democracy in the workplace, employee empowerment and professional fulfilment (Asatiani et al., 2021).

2.4 Theoretical Summary and the Derived Theoretical Framework

Industry 4.0 is considered to be the fourth industrial revolution since it is changing the industry through digitalization and automation. It is a complex and rapidly evolving concept containing various technologies. However, Industry 4.0 as well as the included technologies have been described differently in the literature. One of the technologies included in Industry 4.0 is Artificial Intelligence which is also getting increasingly more attention in the IS field. Industry 4.0, as well as AI, affects sustainability. Sustainability does not have one unified definition but the concept is often divided into three dimensions (environmental, economic and social). With GRI Standards, organizations can measure their sustainability performance in all three sustainability dimensions. Social sustainability is not as widely researched compared to the other sustainability dimensions, especially in the Industry 4.0 context. Nevertheless, implementing I4.0 technologies in an organization can influence people in both positive and negative ways concerning indicators such as employment, working conditions and wages.

Based on the literature that we used for the theoretical background, we derived a theoretical framework from a sociotechnical perspective so that AI and the production workers interact (see Figure 2.1).

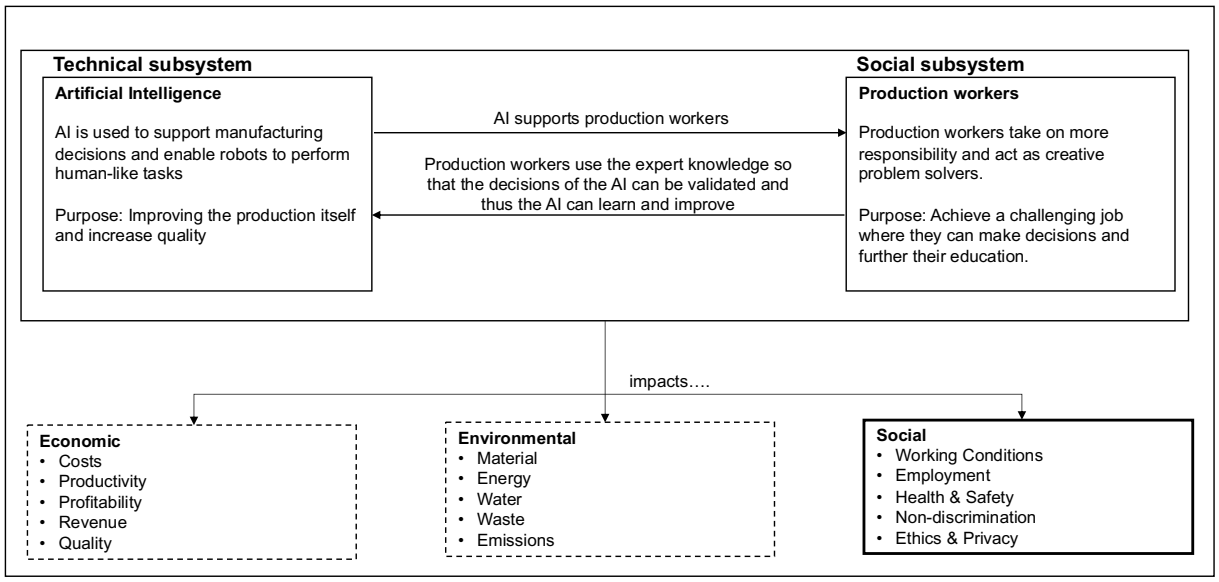

Figure 2.1: Derived theoretical framework from a socio-technical perspective of AI in the context of I4.0

As a technical system, AI is used to support decision-making and enable robots to perform human-like tasks. In doing so, AI has the purpose of improving production itself and increasing quality. However, as mentioned earlier, production workers in manufacturing cannot be rationalized away. As a social system, production workers take on more responsibility and act as problem solvers and can focus on creative and complex tasks. As a result, they have a challenging job in which they can continuously learn and continue to make decisions, thus pursuing a purpose. At the same time, the role of the production worker is changing. Production workers are becoming more adaptable and flexible.

The arrows between the technical and social subsystems show their respective relationships. This means that AI supports production workers in their day-to-day operations and takes over repetitive, recurring tasks, allowing the production worker to perform this new role as a problem solver and free up time for more complex and creative tasks. Besides that, production workers must actively collaborate for AI to be developed. This means they actively shape the development of new AI use cases, for example by adding their expertise to the applications so that the AI can learn or by validating the decisions made with this expertise.

The relations between AI and production workers harmonize through the interactions and enable the instrumental and humanistic objectives. Even though instrumental and humanistic objectives are described from the sociotechnical perspective, we refrain from using this structure because the literature has shown that AI has an impact on all three dimensions of sustainability. Therefore, we have expanded and reformulated this view. To provide a holistic view, we have included the economic and environmental dimensions in the framework. However, we will focus primarily on the social dimension, which is why the other two dimensions have a dashed frame. The framework also serves as a guideline to assist us through the empirical methods and findings.

3 Research Methodology

3.1 Research Philosophy

Since we use a socio-technical perspective in our research to explore the interplay between AI and the employees of an industrial company, we chose to use interpretivism as our philosophical stance, because it is used to gain an understanding of a complex phenomenon in a social world (Goldkuhl, 2012; Saunders et al., 2006). In other words, we viewed our research as a complex phenomenon because artificial intelligence has many use cases in industrial companies that can affect people. In this context, industrial companies are the social world in which we investigated our research problem. Thus, through the interpretivist view, we got a deep understanding of our research topic and were able to understand the interaction between the AI systems and the employees, which is important from a socio-technical point of view to get a positive outcome (Sarker et al., 2019).

In contrast, Positivism focuses on producing credible data through data interpretation, based on objective nature (Saunders et al., 2006). Saunders et al. (2006) point out that positivism may lead to the loss of rich knowledge from complex phenomena through hypothetical generalization**.** Hence, we did not consider positives to be appropriate.

Additionally, as we explored the impact of social sustainability, it was important for our research to understand how the application of AI affects social sustainability. In this regard, interpretivism was appropriate, because it allowed us to gain rich knowledge about the interactions with and within AI in industrial organizations (Creswell, 2009), so we were able to understand the impact on social sustainability. In this sense, the impacts are perceived by people as they relate to them such as job satisfaction, working conditions and so on.

As a result, in terms of interpretivist paradigms of how we see the world and make sense of complexity (Patton, 2014), we assumed that each person has their own reality in relation to social sustainability. Therefore, we assumed an ontological idealism, which states that the worldview depends on human consciousness (Becker & Niehaves, 2007). In this way, we were able to take into account the different individual opinions and views on the impact of AI in each company and understood, for example, why some companies do not focus on social sustainability, as will be explained later in section 4.

In contrast, ontological realism assumes a real world that is independent of human consciousness (Becker & Niehaves, 2007), and for this reason, this view was not appropriate because, as mentioned earlier, social sustainability is perceived by humans and at the same time depends on human behavior or thinking.

3.2 Research Strategy

As already mentioned, AI and the social dimension of sustainability in the context of Industry 4.0 is an emerging research area that is not well defined in the literature. Therefore, we wanted to understand how AI impacts the social dimension and decided to use a qualitative method. A qualitative method answers the questions of ‘how’ and ‘why’(Patton, 2014) and therefore, was appropriate for the nature of our research philosophy and question. This

approach has allowed us to understand how AI is used and how it impacts the social dimension of sustainability. Patton (2014) also describes that through a qualitative approach a holistic understanding of a complex contextual phenomenon based on human experience can be achieved. As mentioned earlier, we viewed our research topic AI and the impact on social sustainability as a complex phenomenon because the impact is perceived by humans and is based solely on experience.

This also led us to the decision to choose interviews as a data collection method because according to Schultze and Avital (2011) interviews are an appropriate method to obtain the experiences of a person. As Polkinghorne (2005) describes, this allowed us to obtain each interviewee's experience of the phenomenon we were studying. In other words, we were able to obtain and explain the use of AI and its impact on social sustainability in each company and interpret the various meanings through the described experiences of each interviewee.

Due to the fact that our main data collection method was interviewing and we transcribed all the conducted and recorded interviews, we had a large amount of empirical data to analyze. Therefore, we used coding as a data analysis technique to analyze the interviews and reduce the amount of data while finding meaningful information as suggested by Recker (2013). We used a hybrid approach as our data analysis method and therefore, we used both deductive and inductive analysis.

To make the context of this gathered data understandable and transferable, we used a “thick description”. According to Holloway (1997), a “thick description” is supposed to allow the reader to understand the feelings, perceptions, and thoughts of the interviewees. This includes meaning and interpretation as well as the intentions of the interviewees so that this description provides a clear view of their experiences in the context of the problem being researched. In our case, this view helped us to emphasize the applied socio-technical perspective because the interplay between the technical and social systems was especially important to us. This allowed us to describe the way AI is deployed and the individual intentions and meanings for the enterprise as well as the purpose of the technical and social system. Inspired by Ponterotto (2006), we described each interviewee and their own intentions to make the findings even more accessible. He mentions that this allows the reader to get a sense of the sample and thus, makes the gathered data transferable.

3.3 Data Collection Method

3.3.1 Interviews

In our research, we used interviews as our qualitative methods to gather our data. Interviews are a well-distinguished data collection method in qualitative research and when properly done, interviews can generate rich data that is targeted and insightful (Recker, 2013; Schultze & Avital, 2011). However, interviews do have also disadvantages and challenges, such as inaccuracy when there is a poor recall of answers and artificiality which might occur since the interviewer is a stranger to the interviewee (Recker, 2013).

Due to the scope of a master thesis and our research topic, we conducted 4 interviews that were between 27 and 58 minutes long. There is no definitive number of interviews required in qualitative research instead, the number is tailored on a case-by-case basis (Baker & Edwards, 2012; Sarker et al., 2013). It is more important to be able to justify the number of interviews

conducted (Baker & Edwards, 2012). Due to our time constraints and scope of the master thesis as well as finding appropriate interviewees that were available, in total, we had 4 interviews in which one interviewee invited his colleague to join the interview. Thus, we had a total of 5 interview partners.

As suggested by Recker (2013), we conducted semi-structured interviews which allowed us to dive deeper into interesting topics but also the interviews were relatively easy to replicate due to the predefined interview structure. Since we wanted to develop a conceptual framework, we used exploratory interviews and mainly asked neutral, open-ended questions (Recker, 2013). After getting the consent of the interviewees, we recorded and later transcribed the interviews. We used the transcription software Otter.ai to transcribe the recorded interviews. We then double-checked the transcriptions by listening to the recording while going through the transcript and then fixed the mistakes the automated program made. We divided the checking of the transcriptions equally but in addition, we double-checked each other's work to ensure the accuracy of the transcripts. During the interviews, we also took individual notes of the aspects that we found interesting.

When conducting interviews, we wanted to keep a balance between excessive passivity and over-direction to maintain the richness of the data (Walsham, 1995). During the interviews, we took turns on who asked the questions. We divided the questions based on the themes to keep the flow of the interviews. We decided that we can both ask follow-up questions any time during the interviews, however, we ended up mainly asking further questions when it was our own theme.

Since our interviewees were located around Sweden and Germany and we did not have the possibility to travel to the interviews, we conducted the interviews remotely with video calls using Zoom. For our investigation, there were no disadvantages compared to face to face interviews (Chen et al., 2017; Cabaroglu et al., 2010), since we could observe the interviewees during the interview and afterwards in the recording through the video call. In addition, it was an enrichment, as one interviewee was able to share her screen and show diagrams that helped her to explain her thoughts. She also showed how the company's software works by sharing their screen.

We conducted the interviews in English since it is the only language, we both speak fluently. This can be seen as a limitation since English is our and the interviewees' second language which can result in language barriers between the interviewers and interviewees as well as the interviewees not feeling comfortable explaining their thoughts which would affect the results. In most cases, the language barrier was not high, however, there were times when the interviewees were looking for a word or a way to say what they wanted to communicate. In one case, the interviewee said some words in German when she did not know how to explain the word in English, however, this was not an issue considering that one of our native languages is German.

3.3.2 Designing the Interview Guide

For the design of our semi-structured interview, we followed Myers and Newman (2007) approach and structured the interview guide into four main points:

1. Opening
2. Introduction
3. Key questions
4. Closing

The topics presented in Table 3.1 were derived from the theoretical frameworks that allowed us to formulate questions, including the individual systems, the interaction, as well as the outcomes. We deliberately left our interview guide incomplete, as such a type of interview requires openness, flexibility and improvisation (Myers & Newman, 2007). Furthermore, as Myers & Newman (2007) describe, we were able to gain and highlight new, surprising insights because sustainability in industrial companies is a complex and multi-layered topic. For example, we have gained insights into the challenges and requirements of such a system that we had not considered before. The knowledge gained is explained in more detail in section 4.

Table 3.1: Interview guide

Step	Themes	Main question	Questions	Supporting literature
Opening			• Describe our research topic • Is it okay that we record the interview for better review?	
Introduction			• Could you please briefly describe what your company mainly does? • Could you please briefly describe your academic and professional background?	
Key Questions	Technical subsystem	• How is AI being used in production?	• Could you list AI projects that are currently being carried out? • What is the purpose of these projects? • How does this project affect the production itself?	(Bhaveshkumar Nandanram et al., 2020; Asatiani et al., 2021)
	Social subsystem	• How does AI affect workers in production?	• What skills must a production worker have? Is there a change due to the use of AI? • How does the use of AI change the workplace?	(Asatiani et al., 2021; Alter, 2020; Bhaveshkumar Nandanram et al., 2020; Chen & Nath, 2008)

			• What does this mean for the role of the production worker? • Are people frustrated about how the new work environment affects their ability to think creatively?	
	Relationship between AI and the production workers	• How do production workers interact with AI systems?	• Are there situations where AI and production workers collaborate? • How do the AI systems support production workers? • What are the specific tasks being supported? • How do production workers support the AI systems?	(Asatiani et al., 2021; Alter, 2020; Bhaveshkumar Nandanram et al., 2020)
	Outcome	• How does AI impact your ability to achieve social sustainability?	• Are there specific areas where AI is having a particularly positive impact? • How do you measure this impact? • Do you believe that there could be some drawbacks in terms of the social impacts of using AI?	(Asatiani et al., 2021; Chiarini, 2021; Chen & Nath, 2008)
Closing			• Of all the topics we talked about today, or even didn't consider: What should we pay most attention to? • What should we think about when we read your interview? • Is there anything, in particular, you would like to add before we finish? • In case you forgot something or want to add something, feel free to contact us. We are happy about your input	(David, 2012 cited in Patton, 2014; Gustason, 2012 cited in Patton, 2014; Patton, 2014)

3.3.3 Selecting Interviewees

In our study, we selected interviewees based on their knowledge, role, availability and willingness to be interviewed. Inspired by Blumer (1954) sensitizing concept, we first considered how AI is used in industrial companies, what it means, and how it offers insights into the perspectives and behaviours of people who use it (Patton, 2014).

Drawing on sociotechnical research on AI by Asatiani et al. (2021), we identified three sample groups:

1) Machine learning or data analytics experts who develop AI systems.
   a) The advantage of this group is that we get direct insight into the development of the systems and for what purpose they were developed.
   b) The disadvantage of this group is that we only get the expert's point of view and thus do not gain insight into the impact on the social sustainability of the production worker.
2) Production workers who work with or are supported by these systems and perceive the impact.
   a) The advantage is that we get direct insights into how production employees work and they can describe to us very well how they perceive the effects of social sustainability.
   b) The disadvantage of this group is that we may not get any insight into how the systems work and for what exact purpose they were developed.
3) Managers who observe both groups and perceive the impact of production work as well as AI system development.
   a) The advantage of this group is that they can give us insights into how they themselves perceive how the two other groups might experience things, thus we can understand the purpose of the AI system, the role of a production worker and its goals and impact on social sustainability
   b) The disadvantage here, however, is that it is the perception of the managers and not the lived experiences of the other two groups

We were aware of the advantage of interviewing all three groups because each group had a different perspective and new angles on our researched problem. However, we decided against selecting all three groups as a sample due to the short time frame. Therefore, we followed the sociotechnical research by Chen and Nath (2008) about mobile work. The authors only interviewed chief information officers' (CIOs), that are people with personnel and project responsibility. In the short time we had, this allowed us to gain insight into both the technical and social perspectives, as well as the interplay that influences social sustainability from a management perspective.

We also had to identify characteristics when selecting interviewees. Based on the problem to be investigated and our research question, we selected the following characteristics:

- The interviewees must work in an industrial company
- The interviewee must be a manager, director or comparable
- The interviewees must have knowledge about AI in manufacturing
- The interviewees must have knowledge about production work itself
- The interviewees must have knowledge about the impact of social sustainability

However, we had great difficulty finding suitable interviewees on LinkedIn and our private network, as AI is not yet very mature in the industry. The search only left us with 3 interview partners. Inspired by Patton (2014), we, therefore, applied a kind of snowball system to find

more contacts. With the assistance of Interviewee 2, we got the contact of Interviewee 5, which turned out to be a rich and interesting interview (see Table 3.2).

Table 3.2: Interviewee table

Interviewee	**Role**	**Organization**	**Size**	**Industry**	**Duration**	**Number of transcribed pages**	**Date**
I1	Global Director IT Sustainability	Company A	Large Enterprise	Mobility, smart infrastructure, digital industries	55 Minutes	14	25.04.2022
I2	Head of Sustainable Manufacturing	Company B	Large Enterprise	Steel manufacturing	27 Minutes	6	26.04.2022
I3	Senior Manager Manufacturing Engineering/head of Industry 4.0 & Sustainable Manufacturing	Company C	Mid-size enterprise	Car/plane seat manufacturing	45 Minutes	11	26.04.2022
I4	Jr. Manufacturing Engineer						
I5	Business development	Company D1 / Company D2	Small enterprise	Development / Contract production for milling and drilling	58 Minutes	13	29.4.2022
Total:					**185 minutes**	**44**	

3.4 Data Analysis Method

We used coding as our main data analysis method. In addition to coding, we used memoing as suggested by Recker (2013) to track down the subjective reflection about how the interviews went and to write down initial ideas of potential interpretations of the data during the data analysis. Immediately after the interviews, we wrote down notes together through conversation on Zoom of what initial thoughts we had. We used memoing throughout our coding process and thus, we kept notes about the thoughts we had about the data and the reasons why we decided to add a new node to the coding template.

Since we worked together, two researchers analyzed the gathered data which according to Benbasat et al. (1987) is advantageous as the accuracy of the data can be trusted more. This investigator triangulation allowed us to compare our work throughout our data analysis process. Yet, there is a possible bias in the data analysis process that needs to be addressed. As Walsham (2006) states, everyone is biased by their own background, knowledge and prejudices. Additionally, coding is a subjective process because the researcher decides to focus on certain concepts (Walsham, 2006). To decrease bias, we kept a clear chain of evidence of our coding process meaning we kept notes of the changes made during the process and the reasons for them. In addition, we addressed the bias with inductive coding since we identified new codes when needed throughout the coding process.

3.4.1 Coding

We had four interviews to analyze. To structure the gathered data, we used coding. Our coding process was iterative and we used a hybrid approach as our data analysis method thus, we used both inductive and deductive analysis when analyzing the interviews. With deductive analysis, we developed pre-established codes that we then used in the initial process of coding the interviews. However, since we used semi-structured interviews and open-ended questions, using inductive coding in addition to deductive coding gave us the possibility to find new codes and furthermore, themes from the data. We started the coding process with deductive coding and continued with inductive coding as we added new codes based on the data. The codes can be seen in Table 3.3 in which the deductive codes are marked as (D) and the inductive codes are marked as (Ind).

We used NVivo as our coding software. According to Patton (2014) and Walsham (2006), the analytical work of data takes place in the researcher's head and therefore, whether the coding is made by hand or by software depends on personal preference. Hence, we decided that coding with the software suited our purposes and timeframe better and still provided a proper understanding of the data. However, we did not use the auto coding feature of NVivo but instead used NVivo mainly as a tool to code the data manually which was faster than if we did the coding entirely manually with a word processing software.

We did the coding in two major steps: initial coding and line-by-line coding. During the initial coding, we went through the data individually to get an overview and code more general aspects of the data. During the line-by-line coding, we went through the data line-by-line to find more detailed information. As we analyzed each interview in more detail, we considered whether we needed additional codes to interpret the findings more accurately. Through the respective round of discussions during the analyses, we added new codes.

Most of the new codes were added during the line-by-line coding of the first interview. First, we added an "Environmental" and "Economic" codes to the "Outcome" theme because the interviewees talked about outcomes in all the dimensions of sustainability and we wanted to see how often the interviewees mentioned the impact AI has on environmental and economic sustainability dimensions. Soon after, we added a "Positive" and a "Negative" code to every code in the "Outcome" theme, to further organize the findings based on whether the impact on the sustainability aspect is positive or negative. The last addition to the "Outcome" theme was "Measurements" which we added to see what companies measure social sustainability and how is it done. We added a code "Assumptions of AI" to the "Social subsystem" theme since we noticed a common trend of the interviewees explaining why implementing AI is challenging and what it requires from the company and the workers. Since the interviewees talked a lot about the requirements to implement AI, we added "requirements" as a code in a new theme "Implementation". After the analysis of the 4th interview, we decided to add the challenges to the requirements to ensure a more detailed description.

Table 3.3: Coding table after both the deductive and inductive analysis

Themes	**Codes**
Technical subsystem: AI	Use cases (D)
	Purpose of the use (D)
	Impact on the production (D)
Social subsystem: Production worker	Role of the worker (D)
	New change in skills (D)
	Change in workplace (D)
	Goal/Purpose (D)
	Assumptions of AI (Ind)
Interplay	Collaboration between AI and production workers (D)
	Tasks being supported (D)
	Production worker's support of AI systems (D)
	AI systems support of production worker (D)
Outcome	Working conditions (D) Positive (Ind) Negative (Ind)
	Employment (D) Positive (Ind)

	Negative (Ind)
	Health & Safety (D) Positive (Ind) Negative (Ind)
	Non-discrimination (D) Positive (Ind) Negative (Ind)
	Ethics & Privacy (D) Positive (Ind) Negative (Ind)
	Environmental (Ind) Positive (Ind) Negative (Ind)
	Economic (Ind) Positive (Ind) Negative (Ind)
	Measurements (Ind)
Implementation	Challenges and Requirements (Ind)

Both of us did coding in all the transcribed interviews and then with NVivo we compared our results to maximize the possible findings and see the differences in the results. We used the automated comparison feature of NVivo with a focus on the percentage comparison. Overall, our agreement percentage was over 90%.

3.5 Scientific Quality

To ensure the validity, reliability, generalizability and overall scientific quality of our research, we follow the set of principles suggested by Klein and Myers (1999). The most fundamental principle suggested by Klein & Myers (1999) is the hermeneutic circle which was the basis for our interpretation and validations. The idea of the hermeneutic circle is that to be able to understand a complex whole one needs to first understand the preconceptions about the meanings of the whole's parts and their interrelationships (Klein & Myers, 1999). Given the interpretivism nature of our research, it was important to understand how we interpreted the language to get rich knowledge. The interpretivist perspective gave us a better

understanding of the worldview and the experience of the interviewees and furthermore, the description of this experience gave us rich knowledge about the research aim.

In addition, Recker (2013) explains key principles to demonstrate rigor in qualitative research which we took into account in our research. These principles are dependability, credibility, confirmability and transferability (Recker, 2013). To demonstrate dependability as well as credibility, we used investigator triangulation while both collecting and analyzing the data. We conducted the interviews together but wrote individual notes which we then discussed after the interviews. We transcribed the interviews separately but we double-checked each other's work. During the coding process, we coded the transcripts individually and then compared the results. Overall, our agreement rate in the coding according to NVivo was over 90%. When there was a disagreement, we discussed the situation in detail until we reached a mutual conclusion. As stated by Syed and Nelson (2015), it is important to see establishing reliability as an evolving process instead of just an end product. Therefore, we maintained a chain of evidence by making precise notes of decisions made throughout the research process. We demonstrated confirmability by reviewing the interview summaries and conclusions that were drawn from the gathered data as suggested by Recker (2013). We demonstrated transferability by providing a detailed and transparent description of our research process as well as the interview transcripts. These can be compared to the other fields of research to find out which context characteristics match as suggested by Recker (2013). In addition, we sent the transcripts to the interviewees so that they could reflect on, review, and approve the interview. This process is called member checking and, according to Netta (2018), additionally increases the validity and credibility of the research.

3.6 Ethical Consideration

Since the basis of our research is interviews, we knew the participants and could not maintain anonymity, so we respected confidentiality. In this sense, anonymity means that no personal data is collected from participants and that these individuals are not identifiable. On the other hand, confidentiality means that participants are known but are not identifiable in the publication itself (Recker, 2013). Following Patton (2014), we pseudonymized the information of the organizations as well as the individual interviewees. This allowed us to evaluate our work in a truthful and purposeful manner (Walsham, 2006), and in case of identified problems or negative criticism, the organizations could not suffer any reputational damage.

While conducting the interviews, we followed Recker (2013) and Patton (2014). First, we always respected the voluntary nature of our interviewees and acknowledged our participants' efforts and time. In addition, we always showed our interest and acted in a friendly and respectful manner that was appreciated by our interviewees. If we recognized that an interviewee felt uncomfortable based on certain questions, we tried to explain the question in a simple and understandable way or skipped it.

Furthermore, Recker (2013) emphasizes ethical considerations in writing, such as plagiarism or the use of appropriate language. In the context of plagiarism, we always acknowledged and referenced the views and ideas of other researchers, as required by the Harvard LUSEM. Regarding appropriate language, we used language that is consistent with our intentions (Recker, 2013).

Despite taking these ethical considerations into account, other ethical issues may arise to which even experienced researchers such as Walsham (2006) have no simple answer. However, taking these ethical considerations into account, we were prepared for some ethical issues and conducted our research in an appropriate manner.

4 Empirical Findings

After analysing the interviews, we divided the findings based on the themes of our derived theoretical framework (see Section 2.3). We also added the new themes that were derived from the inductive analysis. To give some more detailed background of the interviewees, we will begin the empirical findings with an overview of the interviewees.

The transcripts of the interviews can be found in the appendices section. We refer to the transcripts by the interviewee and the section number of the interview. For instance (I4-S26) means that we refer to what Interviewee 4 said in section 26.

4.1.1 Overview of interviewees

Interviewee 1 (I1) is the Global Director IT Sustainability for Company A. I1 has a background in IT and has been working in the field for 24 years. For the past 10 years, I1 has been working for Company A, however, he has had the role as a Global Director IT Sustainability for two years with the responsibility for the strategic context of sustainability through IT. I1 stated how his view on sustainability changed three years ago from not paying attention to sustainability in the IT field to wanting to make a positive impact on sustainability through IT. I1 explained how he started working towards making a positive environmental impact in little engagements with local parties such as various environmental NGOs. However, I1 wanted to make a larger impact and found the opportunity to do so in Company A.

Interviewee 2 (I2) studied engineering physics at Umeå University, however, she has mainly built her career in sales, business development and marketing. I2 joined Company B in 2017 but has worked in her position since November 2021. I2 is responsible for a team in sustainable manufacturing in the digital division of Company B.

Interviewee 3 (13) is a state-certified engineer and works as a Senior Manager Manufacturing Engineering/head of Industry 4.0 & Sustainable Manufacturing in Company C. I3 is responsible for manufacturing in operations excellence, mainly in the area of industry 4.0 and sustainable manufacturing. This means that I3 is responsible for everything which relates to I4.0 such as technology, scouting, process simulations and testing of new technologies, such as AI, virtual reality and augmented reality. I3 is also responsible for new strategies in manufacturing and sustainable production in the company which is done by, for instance, checking energy consumption.

Interviewee 4 (14) has a Bachelor's degree in engineering and works as a Jr. Manufacturing Engineer in Company C. I4 works in I3's team. I4 is responsible for optimization, the underplant for all of the production lines and automatic guided vehicles. I4 works with new technologies such as simulation of VR software and tests the potential outcome of the technologies to see whether they work or not.

Interviewee 5 (15) studied production management with vehicle technology at TU Munich. Now I5 is a mechanical engineer. I5 started in automation and worked at KUKA for over eight years. At KUKA, I5 worked first with automation and robotics and did system integration, automation lines for OEMs and also controlling sustainability for PV manufacturing and PV module manufacturing. Later I5 worked in Innovation Management in disruptive innovation and started working with AI and robotics. From there, I5 found Company D and she has

worked in the company now for three years. I5 works in business development, implementing new projects and new topics.

4.2 Technical Subsystem: AI

4.2.1 Use Cases

According to the interviewees, there are many ways AI is being used and is planned to be used in the companies. However, in many cases, AI is not yet used to its full capacity.

I1 explained how one of the main aspects where they use AI technology is maintenance (I1-S7). Company A uses AI technology for example in train maintenance with finding where maintenance is required to prevent potential damage, errors or outages of trains as well as increase the reliability of the train (I1-S7). Since it is not possible to make changes to the trains in every station, AI is used to see what stations are available to have maintenance on the trains. So, AI assists with automating the maintenance schedule of changing the needed replacement parts (I1-S7). I1 explained also that another way AI could be used in maintenance is by using AI technology in the backend in 3D printing spare parts in places where they are required instead of shipping them all around the world (I1-S26).

AI automates tasks. I1 talked about automation in factories and transportation while I3 talked about automatically filling custom documents. I1 explained how the transportation of components in Company A's is guided by AI (I1-S15). I1 also speculated how the transport traffic from one factory to another could be entirely automated in the future (I1-S20). On a smaller scale, I3 explained how AI fill outs Company C's custom documents automatically which before took days for the workers to fill out manually (I3-S32). For Company C, custom documents need to be filled out when parts are shipped for instance from Europe to China (I3-S32). With AI and bots, the documents are filled in seconds after the part is finished (I3-S32). Bots are also used instead of humans in Company C as the first connection when there is a question for IT (I3-S12).

I2 explained how she sees how AI-based production could be used in the technically advanced factories, however, I2 did not know how exactly or what kind of applications are used (I2-S9). In Company C's case, AI is mainly used in production; however, it is still in the development state (I3-S12). The goal for the company is to use AI in their production scheduling systems and shopfloor control systems (I3-S12). More recently, AI was used as an intelligent safety system during the Covid-19 pandemic in Company C to find hotspots where social distancing was not guaranteed (I3-S19). Company C wants to use AI in the near future in the supply chain to get informed of the risky areas before and during a crisis (I3-S12). The AI could coordinate the supply chain in a way that is going around the hot stop which would keep the supply chain from stopping (I3-S12). In Company D/1's case, AI is used to plan the production of Company D/2's shop floor, however, Company D/1 also sells the AI-based software to other shop floors (I5-S16). With the software, workers can create a production plan in which AI is analysing the plan and gives recommendations to the worker on how the process can be done (I5-S18).

AI can also be used in the design phase. I1 explained how AI is used in the design phase with digital twins (I1-S9). Company A uses the green digital twin approach and AI to both produce

and optimise the company's portfolio elements and products in a more sustainable manner (I1-S26).

4.2.2 Purpose of the Use

AI can be seen as an enhancement to the typical standardised production processes. I1 explained how AI removes manual processes when a large amount of data is transmitted, aggregated and put into use context (I1-S7). This allows employees to focus on the topics that require a human being and cannot be done automatically therefore, from Company A's perspective, AI is an enhancement to the typical standardised production processes (I1-S7). In addition, the use of AI is to increase the reliability of data (I1-S7). AI can also make transportation more reliable. I1 explained how AI could influence the whole area of transport in a way that would make transportation more controllable, safer and reliable regarding timing and transport mechanism (I1-S20).

I3 also explained how AI is helping the manufacturing planning in Company C (I3-S14). Company C gets a large amount of data from their customers where the customer has a demand and they request a specific sequence of the car meaning for instance that the first car has a leather seat, the second a fabric seat and so on (I3-S14). This given sequence needs to be organised in way of a smooth manufacturing balance which could be done in real-time with AI (I3-S14). However, Company C is not able to use AI in its full capacity yet to achieve a smooth manufacturing balance and get the most value out of the production planning since they are lacking the expertise (I3-S14). I5 focused also on using AI to make the production flow seamless. I5 explained how Company D/1's vision of using AI is to have a seamless process in every stage of the production and then to digitalize and further optimize the SME manufacturers (I5-S7). When achieving this, there would not be breaks in the production flow which would save money and time (I5-S11).

Another purpose of using AI is to find ways to make products in a more sustainable way. I1 explained how AI can give suggestions and proposals on how to produce and optimise Company A's portfolio elements and products in a more sustainable way by for instance replacing a component with another one or reducing the amount of material used in the product (I1-S9; I1-S26).

4.2.3 Impact on the Production

One of the impacts on the production of using AI is increasing efficiency and the reliability of data (I1-S7). I2 speculated that the impact of AI on production could be improving the start-up phase by getting the first data or information that is needed to make the jobs as operators quicker and more precise (I2-S16). Both I3 and I5 talked about how AI helps save money (I3-S65; I5-S11). I3 explained that every move the operator makes costs money and therefore when AI supports the operators, the operator can work simultaneously on other operations, which will save money (I3-S65). I5 stated that when the production flow breaks, the company will lose both time and money (I5-S11). AI and automating the processes can help with reducing mistakes made which furthermore, would mean that there is less need to rework tasks which can be expensive (I5-S11).

I3 explained how AI can impact production by an example from a robot company called KUKA (13-S16). The KUKA metrics production concept is driven by AI and is changing the

conventional manufacturing strategy by having a matrix organised production shopfloor and a matrix organised organisation in which the AI is controlling the complete manufacturing flow from premanufacturing phases to the final assembly phases (13-S16). Thus, the AI is doing, for instance, the production scheduling which ensures that the full capacity of manufacturing is achieved (13-S16). In Company D/1's case, the AI is giving recommendations for the production plan and the AI will be trained for the customer's machines and process times (I5-S16).

4.3 Social Subsystem: Production Workers

4.3.1 The Role of the Worker

I1 explained how the main change that AI has on the role of the workers is that workers have the opportunity to focus on more demanding tasks while the AI does the more repetitive tasks (I1-S7; I1-S11). I1 continued by saying that the AI can do tasks or lower the effort of doing those tasks that no one would otherwise want to do (I1-S11). While AI is taking over the simple, repetitive tasks, the workers can focus on tasks that create purpose as I1 mentioned:

> *We do see AI as an enhancement to ensure that people are able, once again, focusing back on those tasks who are really making changes and who are creating purpose* (I1-S11).

I1 also explained how there is a demand for either people doing certain tasks or machines replacing humans on those tasks (I1-S20). I1 gave the example of truck drivers and how there is at the moment demand for truck drivers due to the war in Ukraine which is leading to issues with the supply chains (I1-S20). I1 continued to say that a solution for this problem could be automating the transportation system so that there was no need for humans to drive the trucks anymore (I1-S20).

It is important to note that AI will not solve everything as I1 said "*I think AI, it can't be seen as the world's solver of issues in every way.*" (I1-S15) and there are limits to what AI can achieve at this day. This affects the role of the worker since AI cannot yet do too complex tasks and the worker's expertise is needed. I5 explained:

> *We don't see that this AI will make the complex things there. We will still need the experienced people, the experts … So, there we see here the possibility to support them not to replace them* (I5-S16).

I5 also explained how there is an opportunity for the experts to convert their knowledge and experience with AI so that algorithms can learn from the experts (I5-S7).

I2 speculated that AI would improve the stations of work, however, I2 did not have any data to base that assumption on (I2-16).

4.3.2 New Change in Skills

I2 and I3 talked about blue-collar workers and how there is not much change in skills due to AI (I2-S14; I3-S21). I2 was unsure whether AI would affect the skills of the production workers because of the information AI or machine learning gives (I2-S14). I2 said: *But I am not*

sure they will have to be trained on their job in another way just because some of the information they will get is based on machine learning or AI (I2-S14).

I3 had the same opinions since in Company C they differentiated the production workers from the maintenance operators and IT experts (I3-S21). I3 explained how the production workers do not have the training for programming or using AI instead it is done externally (I3-S21). However, in some specific cases, the IT experts can do AI teaching but it is not common since there is not much expertise on all IT sites according to I3 (I3-S21).

On the other hand, I1 emphasized how factory workers need to understand the technology and how this should be done by giving workers good guidance and communication (I1-S11). I1 continued to say that Company A has a lifelong learning concept in which the employees are supported and guided by the company to complete programs which give opportunities for learning (I1-S11). I3 highlighted that when they start implementing AI, they cannot just replace something without explaining it to the people who did the tasks manually before and now are supposed to do it in a different way digitally (I1-S11).

I5 explained how the workers' skills needed will depend on how long the AI has been used meaning that the longer the AI has been implemented, the less skill the workers need since the AI has learned from the experts already (I5-S22). Nevertheless, I5 highlighted how AI is supporting the workers, not replacing them and in the end, the workers are making the decisions based on the AI's recommendations (I5-S16; I5-S18).

4.3.3 Change in Workplace

I1 explained how AI guided robots have automated the transportation within the factory (I1-S15). Therefore, Company A's factories do not transport anything manually anymore which has changed the workplace since everything is automated (I1-S15).

I2 and I5 said that AI can make the work more efficient (I2-S16; I5-S16). I2 explained for instance how AI can help in the start-up phase by giving the initial data or information needed to do the jobs as operators (I2-S16).

I3 compared AI to a crystal ball explaining how AI is changing the workplace by giving information about the near future for example the next minutes or hours (I3-S23).

4.3.4 Purpose/Goal

Two of the interviewees agreed that AI changing the work environment will not cause frustration in the worker's ability to think creatively (I1-S13; I5-S26). The interviewees believed that it will enhance creativity and problem solving since AI will handle the repetitive tasks which then will allow workers to focus on more complex and creative tasks (I1-S13; I5-S26). I1 explained how creativity needs time and space which workers often do not have due to all the day-to-day routines (I1-S13). I1 said: *It [creativity] requires the ability to lean back a bit, not in a physical way, but to lean back mentally and look at things from a bit more distance* (I1-S13).

On the other hand, I2 agreed that workers might get frustrated with AI changing the work environment and impacting the worker's ability to think creatively in Company B (I2-S18). I2 stated how the workers can feel as if their know-how or skills are being threatened (I2-S18). I2 explained that process planning is an art form that requires high skill (I2-S18).

4.3.5 Assumptions of AI

All the interviewees talked about how the general assumption of AI is that it will replace humans and so many people will lose their jobs, therefore, many people are afraid of AI (I1-S11; I2-S18; I3-S25; I3-S63; I4-S26; I5-S39). As I1 stated: "*AI is in certain areas seen as the evil, which is replacing human interaction and human beings with machine.*" (I1-S11). However, I1 continued by stating how it is not new for humans to be afraid of new technology and it has happened often throughout human history (I1-S28). I5 also talked about how for years various technologies, such as automation, have been seen as job killers (I5-S39; I5-S50). Thus, it is not new for people to be afraid of new technology and think it will replace them. However, most interviewees argued against this assumption stating the advantages of AI and also arguing that AI will also create new jobs (I1-S11; I3-S63; I4-S26; I5-S39). For instance, I1 said:

> *On the other side, what and how we treat it as humans is that AI is helping to focus on the real tasks, which only can be done by human beings and which require human interactivity, and helps lowering the effort on those tasks, which anyhow, no one really wants to do* (I1-S11).

I3 and I4 talked about how age and being open-minded affect the assumptions of AI and acceptance of new technology (I3-S25; I4-S26; I3-S59). I3 argued that the older one is, the more likely one is afraid of new technology and the more difficult it is to convince one that the new technology, such as AI, will be useful (I3-S25). I3 explained that the younger one is, the more likely one is familiar with technology such as mobile phones and apps since one grows up with it (I3-S25). I3 argued that operators that are over 50-year-old, for instance, might be more scared to use the new technologies (I3-S25). I4 added that the question is not just about age but also about how open-minded the person is (I4-S26). I4 explained how they have had experience with younger people who are afraid of technology replacing them and with people over 50-year-olds who are happy with the new technology and think more about how the technology can help them and make their jobs easier (I4-S26).

Therefore, even though age can affect the assumptions of AI, also the mindset of the person makes a difference. One explanation for the fear of AI is not understanding what AI is or what AI can actually do and therefore, thinking it will replace the humans (I5-S16). To avoid this assumption, I5 explained how in Company D/1's case, they explain to customers how AI does not have information when it is implemented in the first place and therefore, it can be seen as it is in training and it has to be taught by the workers (I5-S16). I5 continued further by explaining how in the end humans make the decisions and AI is just the one recommending the decisions (I5-S16).

4.4 Interplay

4.4.1 AI Supporting Production Workers

AI supports production workers by supporting tasks that are repetitive (I1-S11). This can help the production worker to finish the tasks faster (I5-S37). AI can also help by automating tasks, such as transportation in factories (I1-S15) or automating simple tasks such as emails and other day-to-day routines (I1-S24). In addition, AI can help with aggregating data and ensuring that the data is reliable (I1-S11). In Company D/1's situation, AI helps in for instance

making the production plan and giving a complete work schedule on how the products have to be produced (I5-S20). As previously mentioned, in Company C, AI is helping with filling out custom documents that used to be needed to fill out manually (I3-S32).

AI supports production workers by allowing them to do simultaneous work on various operations instead of waiting around for a machine to be ready with their tasks (I3-S65). In Company C, AI also helps with the end-of-line check and with the help of visual inspection systems, visual inspection (I4-S34; I3-S35). I5 explained how they are working on getting the AI software to the machine to reduce the setup time of the machine and support the CAM programmers (I5-S28).

I1 explained how the collaboration between AI and production workers needs to be strong and should not be one-sided (I1-S13). I1 said how he thinks it is a combination and hand-in-hand type of enhancement between AI and the factory workers (I1-S13). An example I1 gave was that the experts who have worked in the factory surroundings can train and influence AI (I1-S13). The difference between the experts and the AI making decisions while working on machines in a not very focused area is that the experts might start taking decisions in an automated way as a routine build from having to make those day-to-day decisions while AI repeats the decisions logically from the algorithms (I1-S13).

I2 reflected that production workers and AI collaborate since there are many factors that can be influenced in machining (I2-S20). These factors are influenced based on the workers' competence, know-how and experience (I2-S20). I5 noted that when their customer is beginning to implement AI, the AI does not have any information and therefore, the workers need to give the AI the information so that it can learn and over time the AI will become better and better (I5-S16).

4.4.2 Production Worker's Support of AI Systems

I1 explained how the best kind of interaction between the production workers and the AI systems is no requirement for interaction (I1-S18). This would mean that AI is enhancing the humans and taking over tasks and responsibilities that can be done automated but were done manually before (I1-S18). However, I1 continued by explaining how there needs to be an interaction between humans and AI since if something goes in the wrong direction, there are adjustment control requirements that humans need to interact with (I1-S18).

I2 talked about how there have been discussions on using the input from workers to improve the machine and machine learning models (I2-S12). I3 commented how the expertise to implement new technologies such as AI, in Company C's systems and IT environment, comes externally (I3-S30).

4.5 Social Sustainability Outcome

When asking more specific questions on social sustainability, the two of the interviewees had not considered the effects AI has on social sustainability (I2-S23; I3-S40) while two interviewees had been concerned about the topic more or could come up with something specific after asking the question (I5-S35; I1-S24). Without asking specifically about the other dimensions of sustainability, I1, I3 and I5 talked about how AI affects environmental sustainability

and I1, I2 and I5 talked about the impact AI has on the economic sustainability dimension. Since this was a common trend, we added the findings in our coding table, however, what the impact of AI is on environmental and economic sustainable dimensions is not in the scope of the research and therefore, we do not expand the findings more in this section.

4.5.1 Working Conditions

The main finding of how working conditions are affected by AI is that AI if used properly, has the potential to have a positive impact by making work more focused and tasks being done more efficiently (I1-S15; 15-S15). As I1 said:

> *But it does enhance if it is used in the right direction, if it is guided in a responsible way, I think it does help to make our lives more focused and more focused on those areas, which are creating a good environment for us to work on a day-to-day basis* (I1-S15).

One negative aspect of how AI can affect working conditions is AI decreases social interaction since it automates processes (I5-S35). I5 explained how AI can reduce personal interaction since the worker can simply click on the button and the task is done automatically (I5-S35).

4.5.2 Employment

I5 argued that AI is supporting employment and continued by saying that it is not killing jobs but rather changing jobs and the job definition (I5-S39; I5-S50). I5 explained that it is a kind of evolution in which some of the old jobs stop existing while new jobs emerge (I5-S50).

I1 said that in the future there will be jobs that do not need to have high education (I1-S20). I1 also talked about how it is common for having resistance when people start feeling like they are being replaced with technology. However, as did I5, I1 also noted that this is not new in human history since every new industrial revolution has led to resistance against new technology (I1-S28). I1 stated:

> *… but in general, it could have definitely a resistance of those who still feel replaced by technology, but this is a topic which we always had in the history of human beings. I mean, this is not particularly now new for AI* (I1-S28).

I3 said that AI has a positive impact on Company C's social environment since employees are satisfied with their production environments (I3-S48). On the other hand, I3 talked about how one negative impact of AI on employment is employees leaving for another company after getting the training for using AI (I3-S50). I3 explained how it happened to Company C in China where they educated new operators and after they got skilled enough, they left for another company which meant that Company C had to start from the beginning (I3-S50).

4.5.3 Health and Safety

I3 explained how since AI can help with estimating the near future, it can improve the health and safety of operators. As mentioned before, I3 compared AI to a crystal ball reading that looks to the near future. I3 explained how, therefore, AI is improving the operators' health

and safety a lot since the operator knows what they had to do next or what is coming next which gives them the feeling of safety and security (I3-S23).

AI can help with mental health by doing the repetitive tasks humans would need to do otherwise manually (I1-S11). AI can also improve physical health. Since AI can automate factories, it can minimize the risk of workers harming them while manually transporting large components (I1-S15). I1 explained how there is a zero-harm culture regarding safety issues and accidents because the factories are automated and so AI technologies are helping the factory workers to stay safe (I1-S15). I2 said that AI can impact safety by helping monitor whether or not the safety guidelines are followed. I2 said that she has seen examples where an application can monitor whether everyone is wearing the right safety equipment, such as helmets (I2-S27). I3 explained how AI helped their workers to keep social distance during the Covid-19 pandemic (I3-S19). AI helped with finding hotspot areas that did not guarantee the 1.5 meters distance between people (I3-S19).

I5 said that there are only minor impacts on health and safety such as making life easier for workers. I5 mentioned how the impact between the machines and workers decreases since the decisions are made in the cloud which makes the workplace safer since there are fewer collisions (I5-S37). However, I5 said that she did not see any impact on health aspects from the production side (I5-S37). The reason for this is mainly that Company D/1 works on the cloud (I5-S37). I5 mentioned how there might be negative health impacts with AI since there are social interaction decreases with the use of AI (I5-S35). In addition, I5 said another negative health impact would be sitting on your desk all day which is possible since the work happens in the cloud (I5-S37).

I1 speculated on what AI could do in the future and how it could affect the health and safety aspect of social sustainability. I1 focused on the transportation aspect and explained how transportation could be fully automated with AI technology which could help make the transportation process more reliable as well as avoiding any employees from staying away from their families for days since they are driving trucks (I1-S20).

4.5.4 Non-discrimination

Based on the gathered data, not many effects can be seen on how AI affects non-discrimination in the Industry 4.0 companies. Three of the interviewees did not comment on non-discrimination. I5 said she cannot think of a direct impact on their software (I5-S41). I1 did state their concern on AI and implementing it in a responsible way (I1-S34). I1 said:

> *And AI in particular, again, it does have a lot of opportunities, but we need to be very much cautious in putting it in a responsible way and placing that with those in mind to might not have access to right now* (I1-S34).

4.5.5 Ethics and Privacy

Of all the outcome indicators, ethics and privacy had the greatest number of negative comments. I1 and I2 were concerned about ethics with AI (I1-S28; I2-S38). I1 highlighted how important it is to think about ethics already from the beginning when implementing AI. I1 explained:

> *I mean, human beings would take a decision, most likely intuitive, and AI is able to do something intuitive. It's taking decisions based on code. And that's exactly where we need to have ethical aspects already treated right from the beginning* (I1-S28).

I1 explained how there should be common ethical standards defined for AI (I1-S30). I1 stated: "*We do have ethical standards defined for human beings, but we don't have ethical standards so far defined for machines. And that's exactly what we need to come up with"* (I1-S30). I1 explained how these guidelines should be put into governmental instructions but also how it should be done not in a competitive way but instead in a joint approach (I1-S30).

I5 said that Company D has no issues with privacy with AI since they are following the privacy laws that are implemented in Europe (I5-S43).

4.5.6 Measuring Social Sustainability

In Company A and Company D social sustainability is not measured while in Company B and Company C it is measured (I1-S32; I2-S29; I3-S44; I5-S45). However, I1 stated that they should measure social sustainability (I1-S32). I5 said that they are talking about measuring social sustainability but they are still in an early stage of developing their products and bringing them to the market (I5-45).

In Company B, social sustainability is measured with yearly surveys which are consistently followed up (I2-S31). I2 explained:

> *.... we have yearly service, and then the quarterly updates to that survey. And some of the questions are regarding this, the social, the social aspects about safety and health and being yourself and, you know, all of those aspects* (I2-S31).

In Company C, social sustainability is also measured with surveys but in addition, the company conducts psychological studies. Company C uses a KPI dashboard to see how the employees are feeling and to see what kind of impacts new initiatives have on the employees (I3-S44). Company C measures the psychological effects on the employees whenever a new operator or new position has been developed (I3-S44).

4.6 Implementation

4.6.1 Challenges and Requirements

I3 mentioned that many companies are talking about AI. However, not in-depth. There is no information about use cases and the benefits of using them. Thus, I3 believed that industrial companies have not yet exhausted the full maturity of AI and are only at the beginning to explore it (I3-S57). This was explained by I2 who recognized that one of the challenges is that production is a conservative field (I2-S33). I5 confirmed that especially the DACH region (Germany, Austria, Switzerland) is a conservative area (I5-S13).

This is also evident in the case of Company C. I3 and I4 shared how they have difficulties convincing the executives to invest in new technologies such as AI (I3-S59). I3 explained how it took them over a year to convince their senior leadership team that virtual reality and augmented reality can be beneficial for the plans in the development departments (I3-S59).

The same happened with convincing the leaders to see the benefits of simulations and how simulations can help with seeing a bit into the future (I3-S59). I3 commented on how decision-makers often think short-term and if the technology is not giving a profit, for instance, in three months, the decision-makers do not want it (I3-S59). It is understandable considering that I3 also mentioned that money is a big problem for smaller companies (I3-S59). I3 explained that it is a matter of money, as the expertise, hardware, software and skilled operators are needed, which is expensive (I3-S46).

In addition, there is a lack of expertise in production. I5 explained that the situation is based on the huge generational change in which baby boomers are retiring and the younger generations are taking their places (I5-S7). However, these younger generations do not have the same experience as the retiring generation, nevertheless, they would benefit from the experience of the older workers (I5-S7).

In addition, there is a lack of expertise specifically in sustainability and the sustainable use of and around IT (I1-S46). I1 explained how even though Chief Sustainability Officers are starting to be established, it is rare for a company to have someone responsible for sustainability within IT and therefore, most of the time the CIOs are taking care of it (I1-S46). This lack of expertise can explain I1's reflection on the problem of different technology adoption and human interaction (I1-S34). In the world, the use of AI is handled differently and can lead to misuse, among other things. I1 stated how the world is already separated concerning technology adaption and human interaction (I1-S34). I1 explained how there is also a risk of misusing technology (I1-S34). On the contrary, I1 described the other extreme that some people do not have access to certain technologies (I1-S34).

Considering sustainability, I3, in contrast to I1, did not describe the extremes but focused on the aspect of money (I3-S46). As already described, this represents the problem of smaller industrial companies. Small companies, therefore, usually do not have the opportunity to focus on sustainability. I3 explained:

> *I always say that sustainability is for rich companies … So, before you start thinking sustainable, you have to go into your pocket and put a bunch of money on the table. And it's the same with AI … They [technologies] will change the future, but you need the pocket with money to buy it and to implement it* (I3-S46).

Given this, the statement of I1 becomes clearer: *We have to take things serious and we have to join forces, we have to take it as a collaboration approach towards a direction and not competitive* (I1-S39). In other words, it requires collaboration between companies to work together to use AI as an enabler to achieve Sustainable Goals. With that in mind, it also requires a good understanding of what it is and what the real topics are, that creates a purpose (I1-S48). In order to convey this understanding to the employees, it requires above all transparency and communication (I1-S11; I3-S28; I3-S63; I4-S67; I5-S16; I5-S50). I3 and I4 mainly explain the benefits of the technology and show consistently employees how technology like AI can support their tasks so they can focus on other tasks (I3-S63; I4-S67). I4 highlighted how important it is to explain to the workers regularly what the technology will look like later and make sure the workers understand the situation and how it will help them in the future (I4-S67).

I1 also mentioned that it is important to have an all-around view and not just look at one side (I1-S37). Both sides must always be considered so that in the end the solution that is created supports the sustainable goals (I1-S37). I1 reminded that it is important to not just come up with a solution for one problem without considering how that solution affects other aspects

because, without the consideration, one might replace the solved problem with an even bigger issue on the other side (I1-S37).

5 Discussion

5.1 Technical Subsystem: AI

From a sociotechnical perspective, the technical subsystem is used to serve a purpose (Sarker et al., 2019). In this sense, the empirical results have demonstrated that AI is used to automate repetitive and complex tasks and to make decisions and recommendations, which is consistent with the theoretical representations discussed in Lu (2019), Berente et al. (2021) and Alter (2020) and also with our theoretical framework. In this context, only Lu (2019) mentions specific AI use cases such as production planning or control quality. These are also consistent with the use cases already developed by I1 and I5, which make production planning efficient and prevent errors.

However, the findings showed that the use cases are not limited to this and have far-reaching applications like an Intelligent Corona Safety System (I3) or the automation of transport routes within the production line (I1). The findings thus also revealed further application examples that industrial companies can consider that are not addressed in the previous literature, due to the nature that AI in the context of I4.0 is not yet widely researched as Margherita and Braccini (2020) and Bai et al. (2020) point out. This may be an indication that industrial companies are still at the beginning of using AI as I3 describes. Nevertheless, the focus of these AI use cases is primarily on increasing efficiency and ensuring smooth production (I1, I3, I5). In addition, this saves money and employees can work simultaneously on other operations (I3, I5).

5.2 Social Subsystem: Production Workers

The social subsystem takes into consideration the interactions between people and the specific purpose (Lee et al., 2015). As two of the interviewees agreed, AI will support the production workers and give them time and space to get creative and work on more challenging tasks (I1, I5). This is achieved by AI taking over repetitive and time-consuming tasks that were before done manually. This finding matches the derived theoretical framework (Section 2.3) where the production workers act as creative problem solvers in the social subsystem. On contrary, AI taking over tasks can also cause frustration for the workers, as I2 speculated since it can make the workers feel like their know-how is being questioned. AI automating tasks is changing the workplace according to our findings. For instance, using robots with AI technology in transportation within a factory has replaced manual transportation (I1). AI can also be used as a tool to predict the near future (I3).

I4.0 can enhance lifelong learning which is one of the sustainable development aspects (Sangwan & Bhatia, 2020). Whether or not AI impacts lifelong learning seems to depend on the company. For instance, two of the interviewees did not see a major change in the workers' skills needed due to AI (I2, I3) while I1 did highlight how it is important to teach and support the workers with the new technology and not digitalize tasks without guiding the workers how that affects their work. Therefore, AI can enhance lifelong learning since when implementing AI, the workers need to be guided and given the opportunity to learn.

When implementing AI, there is an opportunity for the workers to convert their knowledge to AI (I5). This is also included in the derived theoretical framework in which production workers need to collaborate with AI for AI to be developed. As Gorecky et al. (2014) state, the people need to be involved in the system to achieve the full capacity of human capabilities and technologies. This also means that the I4.0 transformation does not mean workless production (Gorecky et al., 2014). However, as found in the study conducted by Bhattacherjee (2012), employees are afraid of losing their jobs due to technology. This was also our finding since all interviewees commented how employees are concerned that AI will replace them. One reason for this is that people are afraid of what they do not understand (I5). Many people have different assumptions about what AI can do and therefore, think that AI can do everything and that implementing AI will replace them. Another reason for scepticism towards AI is age, as I3 stated how older people tend to not be so willing to implement AI and other new technologies. However, also open-mindedness plays a role in how well AI is being received (I4).

5.3 Interplay

As mentioned earlier, in a sociotechnical system, the technical and social subsystem is considered as a whole to achieve an outcome (Sarker et al., 2019). This means that the technical and social subsystems must interact with each other. From our theoretical framework, it can be seen that both systems complement each other. I1 clarified here that the interactions should not be one-sided and there must be a hand-in-hand type of enhancement between AI and the production workers. We ensure this in our theoretical framework through the two-way relationship.

On the one hand, AI supports production workers in their daily business and takes over the manual, repetitive tasks, allowing them to act as problem solvers and focus on creative tasks as described earlier. On the other hand, production workers need to share their knowledge so that they train and influence AI. Thus, there are also similarities of Asatiani et al. (2021) sociotechnical system in our findings, as the typical worker influences, evaluates and validates the work process with AI.

5.4 Outcome

Machado et al. (2020) state how the quality of the working environment will increase due to Industry 4.0 technologies. Based on our findings, AI can have a positive impact on working conditions by making the work more focused and tasks more efficient (I1, I2, I5). However, AI can also decrease the social interaction between people which can be seen as a negative aspect (I5).

Machado et al. (2020) state how it is expected that IT-related jobs will increase when implementing I4.0 in an organization while routine tasks will decrease. This is supported by our findings. Both I1 and I5 explained how AI can be seen as a job killer, however, the interviewees agreed that it is changing the job description instead of reducing jobs. According to Narula et al. (2021), this is a controversial topic since many people could loose their jobs due to automating repetitive tasks while other jobs emerge. However, our findings pointed out that AI is assisting the production workers with succeeding in their tasks. For example, I5

mentioned that the knowledge of the production worker is necessary to train the AI. This is consistent with the statement from Gorecky et al. (2014) that a production cannot be worker-less.

Whether or not AI impacts non-discrimination in a positive or negative way is debatable (Vinuesa et al., 2020). Based on the findings, there is no direct impact of AI on non-discrimination. However, I1 did mention how it is important to implement AI in a responsible way while keeping in mind those people who do not have access to the technology yet. Two interviewees had concerns about using AI the right way and the ethics regarding AI (I1, I2). The threats of misusing AI have been discussed in the literature as well (Vinuesa et al., 2020).

Narula et al. (2021) state how technologies can prevent employees from doing dangerous work and therefore, make the work environment safer. This is also noted by Gualtieri et al. (2020). The authors state that robots and AI can have positive effects on the health and safety aspect of workers, for instance by automating transportation so workers do not have to lift heavy loads. This is consistent with our findings since all interviewees agreed that AI has at least minor effects on the health and safety of the workers. For instance, automating the transportation in factories has replaced the manual transportation which has made the workplace safer for workers since workers do not have to carry heavy loads which has resulted to a zero-harm culture (I1). In addition, when making decisions in the cloud, the impact between the machines and people decreases which makes the working environment safer (I5).

Based on our findings, social sustainability is measured in some companies but not in others. One interviewee stated that social sustainability should be measured but is not (I1) while another interviewee said that they have been talking about measuring social sustainability but have not yet since they are still in the development phase. Interestingly, even though social sustainability is measured in two companies, the focus is still not on social sustainability but rather on other sustainability dimensions. The companies measure social sustainability with surveys that have questions regarding social aspects such as health, safety and how the employees are feeling. Also, psychological studies are used to measure social sustainability.

5.5 Implications, Future Research and Limitations

From a theoretical point of view, our study integrated different concepts such as AI, Industry 4.0 and sustainability and showed how AI can influence the social dimension of sustainability. In addition, the study also highlighted further aspects that need to be addressed, which we did not cover in our theoretical framework such as fear of using AI. The interviewees described that this can be overcome through good communication, understanding and transparency. Therefore, we extend the theoretical framework to address the stated requirements to provide a more detailed conceptual framework to guide further research (see Figure 5.1). This can, on the one hand, reduce the fear of the new technology and, on the other hand, exploit the potential of AI applications. It, therefore, enables collaboration between AI and employees, as Chowdhury et al. (2022) also point out.

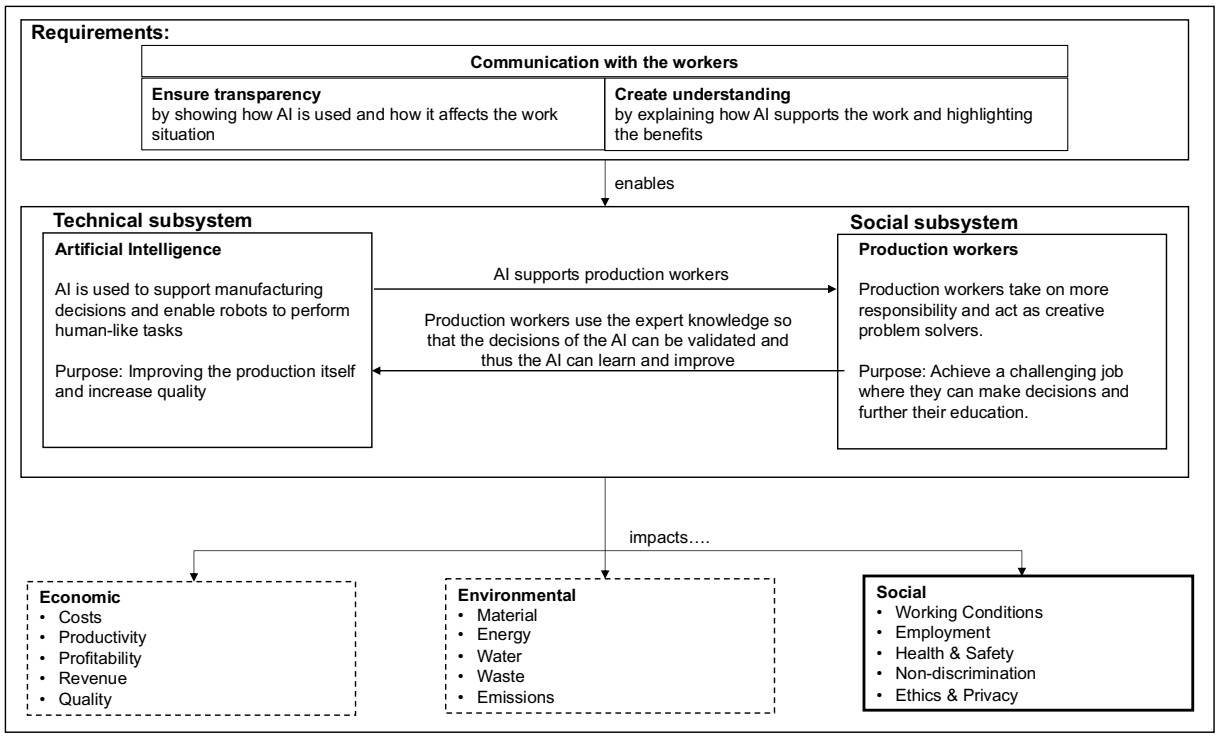

Figure 5.1: Extended conceptual framework from a sociotechnical perspective of AI in the context of I4.0

By using the sociotechnical perspective, we demonstrate that it is suitable to explore both the technical and social sides to support sustainable goals. This is especially supported by I1's statement that not only one side should be considered. He highlighted the importance of looking at the whole picture so that a solution can be developed that does not replace one problem with a bigger problem on the other side.

Keeping in mind that the three dimensions of sustainability should be balanced to achieve sustainability (Brundtland & Khalid, 1987; Purvis et al., 2019), we extended the outcome of the sociotechnical perspective to include all dimensions so that our conceptual framework can be used for further research. The results showed that companies are focusing on the environmental and economic dimensions of sustainability and use AI primally to improve them. This is also reflected in the literature review by Beltrami et al. (2021), which reveals that the impact of AI on the economic and environmental dimensions is the main area of research in the context of I4.0.

It is important not to limit this all-around view to the social dimension or any other, as we have done. However, due to the time frame and scope, we could only cover one dimension. Therefore, we engage researchers to address this limitation and investigate the use of AI to achieve a balance of the three dimensions of sustainability. Furthermore, we only interviewed managers who perceive the effects differently than the production workers themselves. This leads to the conclusion that it is useful to consider this aspect in further studies as well and to investigate the perceived impacts of the production workers. In addition, our conceptual framework is not empirically tested and can, therefore, be applied in different companies to further validate it.

Moreover, we engage managers and decision-makers not to neglect the social dimension. In this context, our research reveals how industrial companies can leverage AI to address the social dimension, so that, for example, working conditions can be improved. The various challenges cannot be generalized due to the differences in the companies, such as money, lack of

expertise or outdated thinking patterns. Yet, we recommend jointly addressing sustainability, as I1 describes since it remains after all a global problem affecting all equally. This also provides the opportunity to create a clear roadmap, which according to Alaref and Khan (2021) is needed.

6 Conclusion

The purpose of this study was to develop a conceptual framework from a sociotechnical perspective that demonstrates how AI influences the impact of the social dimension of sustainability in the context of Industry 4.0. This led us to the form the research questions:

- How do organizations implement Artificial Intelligence in the concept of Industry 4.0?
- What is the impact of Artificial Intelligence on the social dimension of sustainability?

To answer these questions, we started by conducting a literature review which led us to form a derived theoretical framework (see Figure 2.1). We then conducted semi-structured interviews to gather data. We interviewed AI and sustainability experts to gain insight into how AI is implemented in industrial companies. After coding and analyzing the interviews, we made an extended conceptual framework (see Figure 5.1).

Based on our findings, AI is implemented in production for instance in automating repetitive tasks and making work more efficient. However, AI is not yet used to its full potential. The challenges of implementing AI include high cost, lack of expertise and outdated thinking patterns. In addition, many have a fear of using AI because of the assumption of the technology replacing humans thus, reducing jobs. Based on our findings, AI is at the same time reducing lower-demanding jobs and creating new jobs. To achieve a smooth implementation of AI, it is important to have clear communication and transparency between the workers and the decision-makers. This way the workers know what the AI is capable of doing and ensure that it is implemented to help the workers and give them space to do more demanding tasks, not to replace them. When implemented right, AI can also have other positive impacts on social sustainability. The use cases show how AI is positively impacting especially the working conditions and the worker's health and safety.

Even though social sustainability is measured or planned to be measured in companies, the main focus is still on the environmental and economic dimensions of sustainability. We want to encourage companies not to neglect the social dimension of sustainability since all the dimensions should be balanced to achieve sustainability.

Appendix 1 – Coding Overview

To give an overview of the individual codes we identified with Nvivo, we performed a matrix query to see in which interviews each code appeared (see Table A1).

Table A1: Exported matrix query from Nvivo

Themes	Codes	Interview 1	Interview 2	Interview 3	Interview 4	Total codes
Technical subsystem: AI	Use cases	8	1	5	5	**19**
	Purpose of the use	6	0	3	6	**15**
	Impact on the production	1	1	2	3	**7**
Social subsystem: Production worker	Role of the worker	9	1	0	2	**12**
	New change in skills	2	1	1	1	**5**
	Change in workplace	1	2	1	1	**5**
	Goal/Purpose	4	1	0	1	**6**
	Assumptions of AI	2	1	3	5	**11**
Interplay	Collaboration between AI and production workers	6	1	5	3	**15**
	Tasks being supported	7	0	1	3	**11**
	Production worker's support of AI systems	2	1	2	4	**9**
	AI systems support of production workers	3	0	2	5	**10**
Outcome	**Social**	1	2	3	0	**6**
	Working conditions	1	0	0	0	**1**
	Negative	1	0	0	1	**2**
	Positive	1	0	3	4	**8**
	Employment	0	0	0	1	**1**
	Negative	1	0	1	1	**3**
	Positive	2	0	0	2	**4**
	Health & safety	2	0	1	2	**5**
	Negative	1	0	0	2	**3**
	Positive	5	1	3	3	**12**
	Non-discrimination	1	0	0	1	**2**
	Negative	0	0	0	0	**0**
	Positive	0	0	1	0	**1**
	Ethics & privacy	7	0	0	1	**8**
	Negative	4	1	0	2	**7**
	Positive	0	0	0	1	**1**
	Economic	1	0	0	1	**2**
	Negative	0	0	0	0	**0**
	Positive	1	0	1	1	**3**
	Environmental	2	0	3	0	**5**
	Negative	1	0	0	0	**1**
	Positive	8	0	0	2	**10**
	Measurements	1	1	3	3	**8**
Implementation	Challenges and Requirements	12	1	10	12	**35**
Total codes		**104**	**16**	**54**	**79**	**253**

Appendix 2 – Transcription of Interview 1

Interviewers: Patrick Egloff (PE), Salla Rautiainen (SR)

Interviewee: Interviewee 1 (I1)

Section	Person	Transcription
1	PE	So, then we would start with the introduction and I give the word to Salla again.
2	SR	Okay, um, so the first question would be, could you please briefly describe what your company mainly does?
3	I1	Yeah, it is an industry with 330,000 employees worldwide. It's a complex enterprise and we do have mainly three aspects of portfolio elements. So, there is mobility, responsible for train signalling techniques and electrification of transport, then we do have smart infrastructure, which is mostly around building efficiency. And third is digital industries, which is taking care of industrial components in factories, in any way of digital surroundings. What is not part of my responsibility, because not part of the company anymore is a COMPANY NAME in healthcare area. So, the health care sector is been separated from us. And what is separated as well is energy. So, energy as an own legal entity, is the part which is responsible for any kind of plants, electrification, windmills, and stuff. So, this is completely separated. So, my role as global director IT sustainability is within Company A, focusing on the first three mentioned aspects.
4	SR	That's very interesting. Could you please describe a little bit of your professional background?
5	I1	So, my background is indeed IT. So, I'm an informatic. I just started with my career 24 years back in IBM, and always had very much strong operational roles in any kind of IT related background, so from data centres to end users to network to service ownership of various different topics. So, the latest role I'm within Company A since 10 years now and the latest will I used to be at company a has been globally responsible for virtual collaboration. So exactly tools like the one we're using right now. And since two years I'm Global Director IT sustainability responsible for the strategic context of sustainability through IT and within IT for company a as a company as a whole.
6	PE	For the next question, we want to know how is AI being used in the production?

7	I1	So, many AI is helping us to increase efficiency to increase the reliability of data. So, whenever there is a huge amount of data transmitted, aggregated and put into any kind of use context, AI is being used already for removing any kind of manual processes to just focus the employees on those topics, which are really required to be done by humans. So, AI is from our perspective, an enhancement to the typical standardised production processes what we do have in place. So, one of the main aspects where we just use AI technology is for example maintenance. So, if you just take the example of trains, at least you in Germany, Deutsche Bahn is operating various different trains from Company A. So, the reason order, I think it had been 32, ice three news from Company A, and the train themselves, they produce a whole lot of data on a secondary basis and sent it out via signalling techniques. And the data the IoT data is then being processed automatically with AI technology, within hours Company's A tooling within mind sphere, for example, to identify when there is any kind of maintenance required to prevent any kind of damage, to prevent any kind of errors and different outages of trains to increase the reliability of Deutsche Bahn as transport experts here in Germany and to avoid any kind of errors then I said already and what it does in addition is it just helps them to put the replacement parts to already scheduled maintenance in an automated way. Exactly at that point where the train is arriving at Stages and in areas where there are maintenance opportunities because Japan is operating all over Germany, and even across borders and different it's not everywhere possible to exchange breaks or any kind of parts of the train. So, it's already tried. And this is done by AI technology. So, it's not human beings. Just trying to identify Well, it could be that the train is arriving in Munich in two days. Let's just schedule something there. This is completely done automatically. So, there is a technology already behind
8	PE	How does AI affect the production? Do you have some use cases here? Because we talk a lot about maintenance? And yeah, it would be interesting to know if there's some use case?
9	I1	Well, there is without any doubt, I'm not the AI expert, as Company A is very fragmented and very specifically in certain areas. So, my focal area is sustainability. And therefore, the avoidance, for example, from their point of view, in regard of energy, or in regard of an outage of any kind of production topics. I know that we're tremendously working with so called digital twins slash green digital twins, which is already taking place in the production in the design phase of a product. And I know that AI, for example, is used, therefore, as well, already in the design phase to identify where there could be, I don't know, less components be used, or where the combined a combination of various different products could make the product more sustainable in regard of recycling or recyclability. So, this is something which I know that takes already place. And I don't have concrete examples, I could come

		up with a mess. That is my focus is more in the sustainability area. But I know that this is taking place.
10	SR	Okay, um, so how does AI affect the workers and the production? For example, what skills must a production worker have? Is there changed due to the use of AI?
11	I1	Well, there is definitely, I mean, I'm not painting it black and white, but AI is in certain areas seen as the evil, which is replacing human interaction and human beings with machine. On the other side, what and how we treat it as humans is that AI is helping to focus on the real tasks, which only can be done by human beings and which require human interactivity, and helps lowering the effort on those tasks, which anyhow, no one really wants to do. I mean, just from a mental health perspective, there is so many things which are to be repeated on so many times. It's not focusing on the IT aspect, again, if it is about aggregating data, if it is about collecting data from one source, putting them to another source, ensuring that the data is reliable, and conversion from one format to another is done in the right way. I mean, let's be honest, no one wants to do that on a day-to-day basis, eight hours in a row. So that is exactly something where we do see AI as a enhancement to ensure that people are able, once again, focusing back on those tasks who are really making changes and who are creating purpose. So, this is what we see. Coming to your question what is required then for factory workers, what is required to those people were confronted with it. First of all, it requires a good communication every requires a good guidance. So as soon as we start implementing AI somewhere, we just can't put it and just replace something, we have to explain it. And on the other side needs to have an understanding then of technological processes, to those people who probably did not do that before in such kind of a digital way, but mostly then manual. So, if it comes to factory, I think it is your understanding technology, which goes back to the term anyhow, of Company A, not quite sure if that comes later at this stage in your interview, but we do have a so-called lifelong learning concept. So am everyone within Company A is supported with people excellent programmes, which is then leading to a lifelong learning opportunity. So, everybody is supported and guided within Company A, and not let just people alone with what is coming across.
12	SR	It's very interesting. Um, then what does? Or how does the use of AI change the workplace? Like you said, of course, some jobs will be automated by AI and stuff like that. But in general, is there other ways it's changing the workplace?
13	I1	Well, I think what it does, as I already said, is it will grant people, once again, the opportunity and the experts the opportunity to get creative and to get innovative. Because what you mostly don't have in your day-to-day routines is time for creativity and creativity itself requires space. It requires the ability to lean back a bit, not in a physical way,

		but to lean back mentally and look at things from a bit more distance. And this is possible as soon as processes which you've done mostly, maybe 50% of your time is not automated, which doesn't necessarily mean that you have plenty of other things to do which automatically immediately fill that space and that free space, but maybe it grants you the opportunity to get creative and to look into things maybe a bit different. So, this is on the positive side. On the other side, I think what AI does is it requires a strong ethical aspect to be treated all the time. And the experts who are working on on machines sometimes do day to day decisions in not even a very focused area, they do that just because they're used to that the routine is leading them to take decisions in an automated way. And AI most likely won't do that, because AI is just repeating things which are logical from the algorithms. So unlogical from human perspectives, and logical treatments is something which I think the experts who did work in the factory surroundings now are able to train and influence AI. So, it has, again, the strong connection between both, so there is not just on one side AI on the other side, factory workers, I think it's a combination and hand in hand type of enhancement.
14	SR	Yes. Okay. Um, also, the next question will be what does this mean for the role of the production worker? So, it changes with AI? Right. But is there anything you want to add?
15	I1	Well, I mean, what it definitely does, in addition is, I think the world of the future will anyhow be way more digital than what it ever had been in the past. And if and I'll take the example of transport within factories, in former times, there used to be manual transport from human beings from huge components. And there was, I think, always a huge risk of any kind of health problems carrying strong things carrying heavy things, then there was the risk of accidents in any way. So, in the meantime, everything is automated. Just if you take the modern factories of Company A, no one is transporting something from A to B within the factory manually, this is completely done by machines by robots. And they are guided by AI technologies. And so therefore, there is a 00-harm culture in regard of health issues and in regard of accidents, which is helping them the factory workers there as well. And, as I said, I mean, I think AI, it can't be seen as the world's solver of issues in every way. But it does enhance if it is used in the right direction, if it is guided in a responsible way, I think it does help to make our lives more focused and more focused on those areas, which are creating a good environment for us to work on a day-to-day basis.
16	SR	Cool back to Patrick.
17	PE	So, it's not about like the combination of AI and the production worker, they need to work hand in hand and I would know a little bit more

		about this. So, the question is how do production workers interact with this AI systems?
18	I1	Very good question. I mean, at the end, the best interaction is that there is no requirement for interaction. So, if AI is just enhancing and taking over tasks and responsibilities, which used to be done in a manual way, in an automated way, what on the other side, I think there is always interaction requirements. So as soon as something is going not in the right direction, if there is control requirements, if there is an adjustment control requirements, then human beings need to interact. But to be honest, I mean, there is mostly programmers like IT guys in the backend, which then do have the direct connection, on one hand with those who are directly influenced and the operators and those who are then just maintaining and programming then the AI, components, whatever that might be.
19	PE	How do AI systems support production workers, we talk a lot about the improvement of health of the production worker, but are there any other cases that you would like to add or mention?
20	I1	Well, very good question. I mean, there's multiple cases and the big question always is what is the differentiation between machine learning and AI? I mean, this is a big question which many have needs to be discussed. And a lot of what we do on a day-to-day basis, I would not consider as AI but as machine learning because this is just the simple basic tasks which are trained ones and which are then just repeat it on a day-to-day basis. This is not AI technology and broader spectrum. Well, looking a bit broader and looking a bit more into what the future could bring. I think independence, traffic independent transport traffic from maybe one factory to another could be completely automated. So, any kind of transport, which is not able to be put on trains, which isn't able to be put on short tracks, but needs to be transported by trucks, for example, it could be done, automated. So, the whole area of transport could be influenced in that direction and could help again, to make things more controllable makes things more reliable in regard of timing and regard of transport mechanisms, and more safe once again, as well. And could focus just more people than on again, being creative. And on the innovative side, instead of just taking care on the simple basic tasks no one wants to do. And this is not about, I'm just trying to prevent any kind of misunderstanding there. So, I'm not trying to put everybody more now into words, the science surroundings, and every one of us needs to have a PhD. To fulfil his job later on, we need to have jobs and we will have jobs in the future which require people which don't want to study or just don't can. And the topic here is, I think the current situation just clearly indicates that we do have already a huge demand on either more people doing topics, or we do have a strong demand on machines replacing those people if you take trucks. And that's exactly why I come up with an example, transport and logistics at the moment, they do have a huge issue with truck drivers. So, they don't

		get truck drivers, mostly due to the war in Ukraine, because a lot of that truck drivers came from there. Now they are defending their country, and definitely not able to drive the trucks anymore. And this is leading to a huge problem with the supply chain and within time delivery. So how about imagining that the whole transport and the whole truck things, which anyhow is for sure nothing anyone wants to do sit in on truck 10 hours per day, on seven days in a week and being deported from their families. Why not put that in an automated way? Why not put the truck with AI technology which is developed at the moment as we speak anyhow. And you know that better than I do? Why not replacing things like that. And that's exactly the same thing. On the other side, there is always a huge risk that we're trying to automate things which should not be automated so caretaking people, for example, in hospitals, I know that the first pilot cases are already ongoing currently, from our colleagues at healthcare area. So, there is caretaking robots being put into hospitals. Do I like that idea? No, I don't because caretaking is always about human beings. And human beings require interaction and require physical attendance of someone who is hard and has a brain and has a mental and social understanding. And this is something which AI never can come up with. So that's a bit of always balancing between both areas. But I think it does have a set already earlier the opportunity to support us tremendously, but needs to be done responsible and sustainable then as well.
21	PE	It's an interesting view. How do production workers support the AI systems? So, the other way for example, in another company, their production workers help to develop AI. So, they give their knowledge about a problem or maybe about an issue they have. Do you have something similar?
22	I1	Yeah, there's I mean, it's not something which is done centrally from research units or from development units and then put into place in factories. Starting at the acceptance, first of all, we need to come up with exactly those concepts that teams who are doing a task today are supporting and developing AI technology or automated tasks and processing then of those tasks. Now right from the start. So, they are involved into this. And there are working groups in factories without any doubt who are strongly connected and in a continuous improvement process being put into that topic, right from the start and through the whole process and they are the ones then interacting with the development teams and with those who are responsible for programming of AI functionality and technology then in the backend and interacting with them.
23	SR	Okay, um, so the next question would be How does AI impact your ability to achieve social sustainability?
24	I1	Well, now it comes to my home turf and thank you for that. I was a bit afraid that we would never reach there but now we are led. Well, I just

		think if we take the whole aspect of AI serious and put it in a sustainable way, then there is a huge chance to improve because we create transparency, whether it probably is none, we are able to create with the combination of data and with the aggregation, automated aggregation of data, and any kind of process optimization. awareness where people never would come to due to the pure and sheer amount of data. If you take the example of Company A 330,000 employees worldwide, so there's a huge amount of data being created on a day to day basis, if you just bring it down to a very simple thing, if I'm texting emails on a day to day basis to a particular amount of people, and AI would just remind me and replace maybe my day to day routine with something suggesting, well, if you just stopped emails, and if you just maybe start sharing your topics somewhere in a central store, this would lower your carbon emissions by a certain percentage. And if you multiply that with wind and 28,000, this is just taking huge influence. And that's exactly where I do see AI as a optimization, and a supportive area. On the other side, the sheer amount of data is the next issue. So, if you just don't take things serious in that direction, and collect everything, and AI is producing then additional data and additional transfer of data from one to b, then we do have the next issue in our hands, because then the amount of efficiency is being eaten up mostly by the energy which is required to drive AI and to drive the backend systems of AI.
25	SR	Cool, um, then the next question would be, are there specific areas where AI is having a particularly positive impact?
26	I1	Well, we at beginning of things. So, what we currently try to do is, we try to create a transparency in regard of our own products. So, coming back to the green digital twin approach, which we've just said earlier, the idea here is to produce and optimise our portfolio elements or products in a more sustainable way with getting AI suggestions and proposals How to Replace maybe one component with another how to reduce the amount of material which has been used, making the product maybe lighter. So, I mean, Company A is involved in so many different areas. So, I don't know, plane engines, for example. So Rolls Royce is using Company A software to produce train and plane engines and the plane engines in particular, the lighter they get, the more sustainable they are. And the problem itself is construction in a physical way comes to borders. And if you don't have AI technology, maybe a suggestion you to reduce a little bit there. And to come up with a little bit more there, this would then help to produce a more sustainable plane engine, and then leads to in later point to less consumption of kerosene in the plane. So there is I think the biggest influence currently, so digital twin, green, digital twin production and design of components and of products. So, this is the one thing. Next thing is indeed then coming back to the maintenance aspect. If we do have 3d printing for components, for example, where is helping to create spare parts, right, where they are required, and instead of shipping them around the globe and producing them somewhere and shipping them to the other end of the

		world. It could be done with 3d printing and the AI technology in the backend is helping to do that in a reliable and stable way then what the original project would be.
27	SR	Yeah, um, what about maybe any negative this impacts that AI might have in the social sustainability aspect?
28	I1	Well, it could have and this is no not particularly for us at Company A, but in general, it could have definitely a resistance of those who still feel replaced by technology, but this is a topic which we always had in the history of human beings. I mean, this is not particularly now new for AI. I think every new industrial realisation and revolution led exactly to this and the resistance against new technology is always there. The second thing which I do see is and more focusing on Yeah, human beings as a whole. If you don't put AI into ethical context, then it always has a strong risk that machines are taking decisions different than what human beings would do. And it's always question then who is behind that? Because if you just start with something, I mean, let's be honest, AI is something where code where a colour where people human beings started with something, so they take decisions left or right, wrong or right, black or white, and that's exactly where we have to be very cautious. says that the ethical aspects are taking into the start of AI technology right from the beginning, and that we don't end up. I mean, the examples are already there, I think they're quite well known to you. If it just take automated cars and self-driving cars, deciding whether I'm hitting now the car against the wall, or just drive over the passenger, which is on the street where it shouldn't be. So, what is the decision and the right decision? And I mean, human beings would take a decision, most likely intuitive, and AI is able to do something intuitive. It's taking decisions based on code. And that's exactly where we need to have ethical aspects already treated right from the beginning. But this is not more or less in the sustainability or corporate social responsibility era. This is more against humanity and the whole aspect.
29	SR	Yeah, that's true. But it's still a very important point, though. What's your opinion? How could we address that issue, like the ethical issues and other negative impacts that AI might have?
30	I1	Well, it requires exactly as my role for a responsible for sustainability within IT requires someone who is responsible for ethical aspects and social aspects within AI. So there needs to be. And we do start with that, since about three months, I guess, from the timing here, we do have in that remark, the clear demand on establishing positions who take things serious and on the second side influence standardisation on the market and the market means we will have to define standards, ethical standards, which are then valid for all companies, which shouldn't be done in a competitive way it should be done in a joint approach. And therefore, it requires to be put into governmental instructions then as well. So, I mean, such as European Green deals, or directives, which

		are coming across are defining and regulating sustainability in certain areas for companies, we need to come up with the same thing for AI and ethical standards, then in that direction as well. We do have ethical standards defined for human beings, but we don't have ethical standards so far defined for machines. And that's exactly what we need to come up with.
31	SR	That's a very good point. Um, how do you ensure humans measure the impact AI has on social sustainability?
32	I1	Currently, we don't to be honest, we do. We do measure it in the direction of efficiency and cost efficiency, and in regard of people interaction, but we don't measure it in because so far, okay, well, but we need to,
33	SR	Yeah. Okay. Um, and lastly, do you believe that there could be some drawbacks in terms of the social impacts of using AI?
34	I1	Well, the, it's a very good question. I mean, drawbacks is always a matter of definition. The problem with I do see is, we already have a very separated world in regard of technology adoption and human interaction, and if we not take us in European industrialised surroundings or in maybe American industrialised surroundings as the example. Then there is other examples on the other end, which do have absolutely no access to such kind of technology. And then there is misusage of such kinds of technology. So, I'm not particularly pointing to China now. I have to be very cautious with that for political reasons. But I mean, it's treated different and the way China or autocrat market democracies are taking things and they treat things a bit different than what we are used to. And defining a standard therefore and create the right understanding, not in a competitive way, not in a balancing against each other, but coming towards a good understanding for humanity as a whole. This has a huge risk, from my point of view. And, again, back to my responsibility, sustainability always means neither one behind and leave no one behind means we always have to keep those in mind to do not have access or to have different understanding of what we're doing. And AI in particular, again, it does have a lot of opportunities, but we need to be very much cautious in putting it in a responsible way and placing that with those in mind to might not have access to right now.
35	SR	Nice. I'll give it back to Patrick.
36	PE	Yeah. We already coming to the end and of all the topics we talked about today, or even didn't consider what should we pay most attention to?
37	I1	Well, based on my responsibility, I do have always the request or the demand to in particular young people like you are starting their careers.

		Please put a 360-degree view on everything what you are doing. And please keep in mind that solutions are maybe problems on other sites. And we do have to be very cautious in what we create and how we create things, do not come up with a solution for one problem, but replace it with an even bigger one on the other side. So, what I would like to ask you for is take things serious in regard of sustainability in regard of human beings. Technology is for sure, an enabler. I mean, take the current world climate report from IPCC, and they clearly came up with technology is the required solution for a lot of our problems. But we need to be very much careful not to put it in a bigger scope than into the next big problem. And that's exactly what I always ask people for, because and that's something which I'm very frankly spoken. Honest to you. I didn't take in the 24 years of my career, within at least the last three years, it just came up to me and towards my attention. And this is why I'm not putting all of my passion, all of my power, and my strength into this. But the first 15 years of my career that I didn't take care of, at all, to meet technology, and IT was everything. And IT is the future. And everything, which is related to digitalization is wonderful and excellent. But this is not what reality looks like. We are all human beings. And we need to have a complete focus on everything. And we need to take a left view and a right view. And only then in our own simple world, which is mostly very much different to what reality looks like. So, this is why I'm asking the young kids and the young people and future professionals like you to take things serious in that direction as well.
38	PE	That's really interesting, because our view is on both sides. So, we use a social technical perspective, that means we look into the social things, and the technical things and the outcome, the sustainability. So, we try to tackle all but it's of course hard because it's a really complex topic, AI and then in industry companies. So, coming to the next question, what should we think about when we read your interview?
39	I1	What you should think about when reading well take that as an opportunity and be optimistic and positive. Because to be honest, listening to you exactly what you just said, makes me think positive and look positive into the future. Because that means that there is a generation who is focusing on that my generation did not. And the generation a bit older than myself. So, my parents are the one in between, they had been the one sorry for that harsh was they fucked it up. Now it's on us to find solutions for something now to change things towards a better future and take things serious in that direction. And listening to you makes me think optimistic that there is a generation who is looking into this and that direction and the combination of both. So, this is how you should read that interview, how you should listen to that interview. And be optimistic, don't put head in the sand and just think everything is already done. We don't have a chance anyhow, yes, we do, we do have a chance. But we have to take things serious and we have to join forces, we have to take it as a collaboration approach towards a

		direction and not competitive. And I mean, this is what I always come up with, if I'm put on stages somewhere, the times of intellectual property or over to me, it is now to join forces to work together towards one goal. But we have seven and a half years left. And the seven and a half years do not allow us to have any kind of well, I'm better than my competitors. And therefore, I'm just keeping that as a secret. We don't have the time for that anymore. I know that even in my headquarters, people don't really like to hear that. So, there is a couple of people in the managing board here at Company A, who are still trying to think things need to be treated a bit different. Well, this is understood. And we're an enterprise we're earning money for what we do and for patents and everything which we invite, but in the direction of towards a more sustainable and better future. There is no time for that anymore. So that's just my 50 cents on view.
40	PE	Yeah, first of all, thanks for the compliment. We really appreciate that. And then yeah, we're coming to the last question. Is there anything in particular you would like to add before we finish?
41	I1	Nope, totally fine. Thank you very much for listening to me. Thank you very much for your time. I said at the beginning I'm not the pure expert in factories and in any kind of AI usage in those areas. So, I just tried to give you a brief view on how I look at it and how very rare and flight level 10,000 feet I do have an understanding for. My understanding and you just easily identify that based on the answers I gave is more understandability area within IT and through IT and digitalization. So therefore, this is where the basic information came from. But besides that, thank you very much for listening and I am very much looking forward, if you are able to share the results in a compressed way with me, I would be very much interested in reading that.
42	PE	Sure, we will share it. And in case you forgot something, or want to add something, you can contact us anytime. We are happy about your input, and I just can say thank you again.
43	SR	Thank you so much.
44	I1	Yeah, my pleasure. Always my pleasure, if you have anything else afterwards, if you want to know anything else, if you find anything unclear of what I've said, just let me know, please, and I'm always happy to come back with an answer.
45	SR	I actually would have a quick question, because you said that the first 15 years, you didn't think about the sustainability aspect. And now like three years ago or something, something changed. So, what happened? Change? Change your mind on that?
46	I1	Very good question. So, I mean, I did think, in regard of environmental care, since my childhood, so this is something which is already there,

		and which used to be there all the time. But the combination of, of digital and sustainability never really had been in focus of myself, well, the basic things like powering off the device or recycling it instead of throwing it away? Well, yes, for sure. I mean, this is basics, and everybody should take that into consideration. But the idea of data transmission requires energy consumption and the demand of cryptocurrencies in regard of energy, which is the same, by the way, then Switzerland per year. So, this is just crazy numbers, if you just read about that, that was not really my focus. And it was based mostly on the increased demand on sustainability all over the world, I mean, I have to be very much thankful to Greta, everybody can think about Greta Thunberg, whatever he wants to, but she had been the ones putting things into the centre of our day to day living. And that's exactly what I'm deeply, deeply grateful for. And it happened to myself as well. And I might just I started thinking, well, what could I do, and I said, I started my environmental aspects, mostly in very local engagements. So very tiny, little engagements in local parties, and any kind of, of environmental NGOs. But the influence therefore had been just way too little. And working for a company with the financial background of Company A, with a name with the brand, Company A, with the influence and with the financial opportunities, which are coming across and then having the opportunity of digital as an enabler. And the combination of sustainability just made me think and let me be honest. At the beginning, I didn't even have a clue of how to start and where to start, because there was nothing. And it is still very, very basic. So, if it just now, Google for my role, for example, you will hardly find anyone within that surroundings and enterprises. Who is responsible for sustainability within IT? There are CSR responsibles, there are Chief Sustainability officers starting to be established, but there is no particular role, and now three in Europe, who do have the same role than I do have. Mostly it is the CIOs themselves to take care on that. But it's very rare that there is people in people in particular responsible for that. So, it made me think, how could I establish something which is taking real influence? And the fundamental reason is my kids. I mean, if I stay up on a day-to-day basis, I'm looking to their faces, I just want them to have a future on the planet that just want them to have a childhood, which is worth living on a day-to-day basis. And I don't want to be the one telling them anyhow, in the future. That Well, yeah, I didn't take things serious enough. And yeah, well, I did my day-to-day job and live my life. And now well, now we fucked it really up, and there is no way to find solutions anymore. But well, you did. You daddy had fun. You don't. But I have. And that's exactly the way I don't want to go. And the passion towards that, therefore is driven by the pure idea to take influence as much as I can on a day-to-day basis, not in the private surrounding only but in my business on topics as well. And that's exactly what led me to where I am today.

47	SR	Wow. That's amazing. It's very promising that like, you can change the or your view you can change so much.
48	I1	Yeah, definitely. I mean, I can just, again, if coming to you. What's your last question, Patrick, you what is what should people think of if they're Reading it or listening to that interview? Well, nothing is impossible. And in particular, if you're now in roles in companies in enterprises, you can always take an influence at Company A we have a term which is called on your career and that on your career, aspect is a lift culture within Company A, I mean, that role that position I am in today, it was never published, it was never a demand. No one ever said, not our CEO, no one from the Managing Board ever said we are required to have maybe someone who's taking care of sustainability with energy, let's just ask someone who is maybe interested? No, it wasn't there. So, the position itself was created by myself intentionally. So, I started to come up to our CEO, and just pointed towards the existing topics within Company A and asked Hannah, our CEO, if it doesn't make sense, from her perspective, as well to establish such kind of position in Company A and Company A IT, and she agreed in starting to work on a concept in a strategy. I presented that to her after a couple of weeks. And she agreed on let's give it a try. And let's just see what the outcome is. And it took exactly half a year, that she had been the one from herself, saying, well, it was the best idea I've ever had in the last couple of time. And we need to put additional topics then toward that role. And maybe you could just enhance it with some of your colleagues working together as ambassadors and create a circle. In the meantime, that circle is 50 people a big so that you have 50 Ambassadors, who are not in particular having the role of sustainability people and experts, but they are supporting it, in addition to their standardised jobs on a day-to-day basis, because they are very much passionate as well. So, I do have a virtual team based on 50 persons all across the world in different areas and different perspectives, which are just doing that because they want to, and the purpose which is created through that is tremendous. And I mean, this is now besides the aspects of technology, bringing the war of talents to a new aspect, and as well, because I mean, people in your age leaving universities, the first question, which is always coming up in interviews, if it is, then an open question for both sides is, well, could you explain what your strategy looks like in regard of the future? What are you doing as a company in concrete on a day-to-day basis towards a more sustainable world? And I'm not interested, by the way in a annual report, which has been published somewhere with nice marketing slides, let me be honest, what is the background behind that? So that is the question 90% of young talents, which are coming and joining Company A, are asking those questions. And if I don't have an answer to them, they will work for us, they won't work for Company A. And I mean, the Company A employees are our future, it's not the brand, it's not the patterns of what we have today, the future and the next, I don't know 2550 years of Company A

		requires to have talents. And that's exactly where we need to be honest and look into that direction as well. So, there's all various different aspects, which are coming together towards that, why it is of importance to change, and to change the mindset and the behaviour then as well. And sometimes it doesn't even require a huge change, it doesn't require 180 degree change in turn in towards another direction, it sometimes just requires to have a good understanding of what it is, and what the real topics are, which are create purpose. And just as a final example, I do have one colleague in particular, who never had been interested in sustainability and never had been any kind of, of understanding or mind in that direction. And about two years back, one of the first projects I had was a donation of equipment, close to Christmas to charities in Austria, which has donated over 520 laptops, to young kids who lost their parents in their surroundings and help them to support distance learning and home-schooling at the beginning of the pandemic, and he had been the one being locally in Vienna, he had been the one handing those devices over. So, he had been there physically and handed the devices, that colleague turned 180 degrees out of nothing he just pointed towards, well, what could I do more, and I'm so engaged now. And I'm so passionate for doing things, and let me just be the one supporting you 100%. And since then, he is, I mean, this is just he got the understanding of what real purpose means. I mean, if you just take what you are doing on a day-to-day basis, we're just doing everything digital, we're nothing doing with our own hands, we are mostly moving the mouse around the desktop and clicking and emailing and googling and whatever things but how much of purpose is there behind not too much, let's be honest. And if you then have the opportunity of doing something which is close to our heart, which is an understandable outcome of that what you did is helping maybe the future helping the society helping the environment helping people then it is starting to create a different perspective on things and it just defines what is of purpose and what is of value and what is really important in that regard. I mean, there is not without any doubt the saying which is purpose beats salary, and that's exactly what it is. I mean salary at the end will grant you luxury will grant you flexibility in life, but does it really make you happy? It don't and purpose that so therefore that's now that the last couple of sentences I wanted to share with you because I'm And you can see that I'm very passionate for what I do. And I think there is a lot of people who do have the same passion in them they just need to release it they just need to have the chance to start working towards something like this
49	SR	That's very inspirational for sure.
50	I1	Good so thank you so much again for having me thank you very much for interviewing and talking and I said if you have anything else afterwards coming up to watch to mind any questions just please don't hesitate contacting me and I'm not sure if you're both on LinkedIn but if so, please don't hesitate contacting and I'll be happy to connect network is

		everything and maybe we just cross our paths in the future then as well. Would love to and if you are maybe in the future looking for any kind of good working opportunities, Company A might be an address.
51	SR	Thank you so much.
52	I1	Thank you very much and talk to you soon then.

Appendix 3 – Transcription of Interview 2

Interviewers: Patrick Egloff (PE), Salla Rautiainen (SR)

Interviewee: Interviewee 2 (I2)

Section	Person	Transcription
1	PE	To give you a better overview of who we are, we will choose introduce ourself briefly, I'm Patrick. 25 years old. I am interested in digitalization and AI. And I have researched about it a little bit before. And in my free time, I love to hike and to dive.
2	SR	Yeah. And I'm Salla, I'm 23 years old. I'm from Finland, actually. And I'm very interested in the sustainability aspect of how technology can help to contribute to sustainability. And in my free time, I mainly play volleyball and beach and watch Netflix occasionally.
3	I2	Okay, good. So, yeah, I can say a few words about myself as well. So, from Sweden, I started in Umeå University in engineering physics. In a long time ago, it feels like but I have I joined Company B in 2017. Have basically, even though I, you know, I wasn't in engineering, I spent most of my career in sales and business development and marketing. So, this, and also in Company B since when I joined, and since November last year, so basically, what is it five, five months or so? I mean, r&d, responsible for a team in sustainable manufacturing. So, but in my division is Company B. It's, it's a digital division. So that's what we do. It's software, we have software. So, let's flip back around.
4	SR	Thanks for the background. So, we can go the first question. And that will be can you please, again, briefly describe what Company B mainly does?
5	I2	Yes, sure. So, Company B if you may live with the name. And maybe I know that this one of the larger companies in Sweden, it has background in steel, steel manufacturing. And steel mills, Company B owns the patent on how to make steel with coal, called the Bessemer method, which has been used up until now when you're talking about green steel and fossil free steel instead. But steel, steel alloys, metal alloys, that's the kind of the foundation on Company B to Company B group since 150 years, I think. So, it's a very old company, a lot of heritage and validity of course. And the steel part is still part of Company B, it will be divested during next year. But it's still one of three main business areas within Company B right now. The other two one of the other two is mining and rock technology. So, let's machines tools. Yes, for crushing screening above, below ground, so everything that has to do with taking rocks and metal out the mines. That's basically around

		40% of the total revenue of Company B. The metal part but I mentioned in the steel part is around 15%. And the remaining is the business area I belong to, which is SMM, Company B machining and manufacturing solutions. And that's actually two divisions in the same so it's a part which make cutting tools. So, for milling, drilling, making parts and metal, we have four divisions that make cutting tools at Company B. Seiko tools are the most, I would say, at least in Sweden, the most known, we also have all the tools in Germany to begin and we have Derma primate which is Italian based. And then it's the part I belong to, which is Company B manufacturing solutions. So that is our digital division select design and planning automation. It is additive manufacturing. And it's also metrology. So, measurements and those kinds of activities on your product and product production lines. I mean, yeah, I'm, you know, sometimes people know what Company B like, well, and sometimes, you know, one part of Company B, and sometimes they don't know at all. So
6	PE	It's really interesting. So, I know some parts of Company B but no, I know a little bit more about it.
7	I2	Yeah.
8	PE	But yeah, I will come to the first question. It's like the technical part. So how is AI being used in the production? Like in manufacturing?
9	I2	Oh, that's, I know, there have been ideas on how to use it quite a lot. I can't really say, to be honest, I can't really say some of the factories within some week have a lot of they are very, I would say, technology, advanced tech, technically advanced factories. So, they are connected. And they have sensors everywhere. They are very much like industry 4.0 type of factories. However, I don't know about the technologies that they are using, I'm just thinking that they could be potential AI based production in there. But I'm not sure in which application to be honest with you.
10	PE	Well, then, I guess it's better to go directly to the next question. And I'll give the words to Salla.
11	SR	Okay. So how does AI affect the workers in production?
12	I2	Ah? No, I think there have been discussions on having the input from workers, kind of improving the machine, machine learning models in everything they do. So, from the operate levels, that they the input they give on things is kind of feedbacking into the machine learning models and making them better. So, you have the input from the workers as well coming in. But I, it's a bit also, since I, I'm not sure how they use it today. I'm not sure how to answer that question. But I know there have been discussions about that, for sure.

13	SR	What skills must production worker have? Like? Is there a change due to the use of AI?
14	I2	I would think. I would think no, that for the operators or the more blue-collar workers, they will get probably better, maybe better advice or maybe better input data to what they do. But I am not sure they will have to be trained on their job in another way just because some of the information they will get is based on machine learning or AI. I don't know if that answers your question. Or if there's you know, they need to be trained in other ways just because there is an AI technology behind or
15	SR	Yeah, it does answer that question. Also, to elaborate more. How does the use of AI change the workplace then like if it doesn't really necessarily affect the worker? Does it affect the workplace in general more?
16	I2	I would, I would assume at the effects stations of work that we're doing. But that's just my assumption. So, I don't have any real, real data to base that on. But at least those are the discussions we have internally that day, it will improve. Maybe the start-up phase, maybe it will improve how they kind of get the first data or information that they need to do the jobs as operators to make it to make it quicker, maybe the start-up phase or the warm up phase or something like that, but it makes it more efficient. Such more precise. It's not only I mean, it's a lot about you know, this. A lot of the workers they have been there for quite some time, at least on the operator level, and they usually base their know how long what they build up themselves. So, I think it will be it will make the process more efficient. Much more.
17	SR	What about, do you think people can get frustrated about the new work environment with AI affects the workers ability to think creatively?
18	I2	Yes. I live in, in our industry. And I'm thinking not only within Company B, but the customers that we serve, which are doing a lot of machining, etc. Many times, when they do the job, and they do process planning, for example, to machine the part this is they are more like artists, they know how to do this is an art form, basically, they are usually very high skilled in how to do this and how to kind of make what they want or what they need, in a good way. So, I think it will be a bit threatening to their you know, their know-how or their skills on there? Yeah, that's what I think.
19	PE	Next question, how do production workers interact with such systems like, as you told us now, it's like an art and they are doing things by itself? So, are there any situations where they collaborate? Maybe?
20	I2	Yeah, I think they collaborate a lot. And they discuss a lot with each other today. It's, I mean, there's so many there's so many factors that you can influence when it comes to at least machining which is our

		industry. You have so many choices that you can influence and it's very much based on your competence and your know-how and your experience. So, there are always people with a lot of experience in the production that can probably influence and help others I believe.
21	PE	Give the word again to Salla
22	SR	okay. So, we are focusing on social sustainability in our research. So mainly the human of aspect of sustainability, such as working conditions employment, health and safety, non-discrimination and ethics and privacy and such things. So, my question is, how does AI impact your ability to achieve social sustainability in Company B?
23	I2	Oh, that's a super, super hard question. It's the social part is a huge part by itself and it has so many different aspects and factors that I can imagine that it could affect it somehow but I haven't I haven't really considered I, it's too hard to. I have to think about that one. It's a difficult one to answer.
24	SR	Yeah, it's definitely a big question.
25	I2	Yeah, exactly. Because it's all about this being good employer and taking care of your, your employers and your teams, etc. So, it's all of those questions and how AI could affect that. I can't really, I have to think about it, I can't really say,
26	SR	Yeah, do you have an idea, if there will be some specific areas where AI could have more positive impact or negative impact?
27	I2	Maybe on the safety part, I am just, I have no idea. Now I'm just thinking. At least in Company B, we're super concerned about safety. And it's all from, you know, psychological safety to be like, being allowed to say what you think, etc, to really like, safety shoes, helmets. And those kinds of things, which isn't very hard, hard safety. So, I'm thinking that it could affect on that area, I have seen examples on where you, you can see if you know, everyone is using the right equipment, or the right set of safety equipment, for example, helmets, etc, that they are applications where you can actually monitor that. And I'm thinking that that could be an application field, for sure. Just from the top of my, my mind.
28	SR	Yeah. Do you measure the impact of social sustainability?
29	I2	Yes, we do.
30	SR	How do you do that?
31	I2	We have, we have yearly survey, and then the quarterly updates to that survey. And some of the questions are regarding this, the social, the social aspects about safety and health and being yourself and, you know,

		all of those aspects, there are questions about it. So, we are we are measuring.
32	SR	Nice. And lastly, do you believe that there could be some drawbacks in terms of the social impacts of using AI?
33	I2	I would, I'm just thinking that this production is quite conservative field. Maybe it could, but I can't see how really.
34	SR	Okay.
35	PE	Then, we also coming to the end of our interview questions. And to the end, I want to ask what we should pay most attention to in terms of social sustainability?
36	I2	Can you give any given examples? Like what could that be?
37	PE	Yeah, for example, it could be working condition, health and safety, ethics and privacy.
38	I2	Yeah, I would say ethics and privacy isn't that always a kind of difficult domain to navigate, especially when you have, I mean, machine learning based applications and all of that. It's very, it's a grey area, but I can't say any typical applications where it could be a problem or where it could be a benefit or, but I'm just thinking that that is an area where it could be difficult to navigate more difficult to navigate than maybe health and safety because that's more black and white, I would say. Ethics is hard. It's really hard.
39	PE	And what should we think about when we read your interview?
40	I2	Oh, I don't know. Maybe that's one thing that is important to know about Company B as a company is that it is very very decentralised. Meaning that there is no, there is very, very few central decisions taken. So basically, all the decisions and you know, the how the company is run is very very decentralised out in the individual business units. So, it's very, this is very hard to understand everything that is going on in Company B because it's just very far from you know, where you are yourself. So so that's why it's, it's super difficult for me to answer some of the questions because I basically don't, there is no way to, for me to check it, there is no way to know what's going on in all of those different areas. So, it's, it's a good thing to be aware of how Company B operates, because it's very different from maybe from other companies where you do the opposite to centralise some of the common functions and to kind of make it make it easier to make decisions. But here is the totally the opposite. It's very, very decentralised, the most decentralised place I worked in so far. So that could be good to be aware of when you kind of looked at Company B as a, as a

		company, it's actually, you know, almost 100 companies. That's how you can see it.
41	PE	The last question is, is there anything in particular, you would like to add before we finish?
42	I2	I don't know, if you, you would like to get some recommendations for other companies to make interviews with in this domain or because I have one, one of our partners in mind that might be interesting for you to talk to, in this domain, because they do a lot of AI based applications for our industry, which is, you know, machining and manufacturing, there are a software company. So, if you're interested in that would, you know, I could recommend you to talk to them, as well.
43	PE	That would be really nice, because we still looking for interview partners. And we appreciate it.
44	I2	They are based in Germany, in the Bavaria region, in Germany, and we're working very close with them. So, I can maybe I can send you an email with their contact details.
45	SR	Nice that would be amazing, thank you.
46	I2	They are actually they have a software. They are a software company. But they have next door they have a machine shop or production facility with 150 people where they tried to implement some other, you know, AI based applications into the production. So, it could be interesting for you to talk about that, you know, because they have a lot of hands-on experience.
47	PE	Thanks. Yeah, in the end, we want to say thank you for your time. And in case you forgot something, or you want to add something, feel free to contact us anytime. We are happy about your input. And so, yeah, I just can't say thanks again.
48	I2	Yeah, the same to you. Please come and have any more questions or something comes up. Don't have submit the contact me again. I would be happy to support you.
49	SR	Thank you so much.
50	I2	Thank you.

Appendix 4 – Transcription of Interview 3

Interviewers: Patrick Egloff (PE), Salla Rautiainen (SR)

Interviewee: Interviewee 3 (I3), Interviewee 4 (I4)

Section	Person	Transcription
1	PE	Then we would start with a quick introduction. I will start. I'm Patrick 25 years old. And I'm interested in digitalization, and especially in AI, and how these technologies can add value to people. And in my free time, I love to hike and dive. And that's all of me, I would give the word to Salla.
2	SR	Hello, I'm Salla, I'm 23 years old. I'm from Finland. And I'm especially interested in how technology can affect sustainability in a positive way. And in my free time I play volleyball and beach. And then occasionally watch Netflix and listen to podcasts.
3	I3	Okay, then I will continue. Hi, I'm not that young. I'm Interviewee 3, I'm 43 years old now. And yeah, I'm responsible for manufacturing in operations excellence, mainly in the area of industry 4.0 and sustainable manufacturing. Everything which related to industry 4.0, like technology, scouting, testing of new technologies, as well AI, virtual reality, augmented reality, process simulations, new strategies in manufacturing, new strategies in how we can produce sustainable. This means checking energy consumptions, all of that things. I'm working together with Interviewee 4. He's part of my team. We do all of these fancy, nice and cool things together. In my spare time, I tried to enjoy mountain biking. But I really am really, really young in that, let's say mountain biking thing. I started to practice it. But it feels like that I'm over 60 and not 43. But it's working. Let's head over to your Interviewee 4 now.
4	I4	Yeah. Yeah, as Interviewee 3 mentioned, I'm doing all the cool stuff for him. So, working together, and everything we found the new technology and so on, like simulation of VR software. So, on Company C, we have an I'm doing all the stuff here and our plant tested in different situations. Yeah, and we want to get as much as possible the outcome of it and tested if it's working or not. And if it's okay for us in the production, so on. So, we're doing all this stuff. Yeah. And also, I'm responsible for optimization, the underplant for all of the production lines, and also for automatic guided vehicles. So that's what I'm working on today. Yeah, in my spare time, I'm playing handball, and also guitar. And sometimes if the time is enough, then I like to cook for the whole family. So yeah.

5	SR	Well, thank you again, for giving us your time. And we can start with the first question. So could you please briefly describe what your company mainly does?
6	I3	What we do is we produce auto seats. Every third car seat in the world is manufactured by us. What we're doing as well is aircraft business class seats. We produce business class seats for Hawaiian Airlines, which is a joint venture together with Boeing. We do mainly everything on the seat. Starting from engineering, going over to manufacturing and then to the whole supply chain. So usually, we are located where the customer is. We have a really, really short reaction time and a really, really short delivery time to our customers. Sometimes it's just a robot is picking a seat from our manufacturing line. It's going through the wall and directly into the car. Yeah, this is what we do.
7	SR	Right. Then can you please briefly describe your academic and professional background?
8	I3	My professional background? State Certified engineer, it's called like that. So, it's before the before the bachelor's degree.
9	SR	And you Interviewee 4?
10	I4	I am bachelor degree. But engineering.
11	PE	Thanks. So, coming to the next question, the more technical question, how is AI being used in the production?
12	I3	AI is. Currently it's in development state in our production. We would like to use AI with regards to production scheduling systems, and shopfloor control systems. Everything which is related to manufacturing execution systems, and the linkage between the execution systems and the ERP system. This is where we use AI. We use as well bots, which is not really related to AI, but it's a part of it. Whenever we are in contact with one of our IT guys somewhere in the world, we firstly connected to a bot, which is replying all of our questions. And when the question is like, we do the singing, all the time, we will be directly forwarded to a physical person and not to a bot anymore. But AI mainly is used in our production. In the near future, we will use AI as well together in cooperation with one of the companies to look at the supply chain to see risky areas that we will be informed before a crisis. Let's say we have a conflict in a city where we have war in Ukraine, something like that, that the supply chain will be directly changed, that we're not hitting that spot. It will be coordinated around that hotspot. And that we see directly at the very beginning impacts on our supply chain, because there's where we lose a lot of money. There, we would like to go in touch with the supply base and say, hey, we need your support. And this is mainly driven by AI.

13	PE	Really interesting projects, then we're coming to the next question, what is the purpose of this project? Do you want to achieve specific goals with these projects?
14	I3	In supply chain, it's important that we that the supply chain function is given. Whenever we have a stop in the supply chain, we have a stop in the customer delivery, which means that at the end, you will not get a car which you ordered already. This is what happens right now. Everybody's waiting for semiconductor chips, they will not deliver it because there's a stoppage in the harbour in Shanghai in wherever. This is causing the direct delivery to our customers. And as well our manufacturing base. When we talking about AI in manufacturing planning, it's more than that we have a lot of data which is coming from our customers. They request they have demand, they request a specific sequence of the car. It means the next car will be a leather seat, then we have a fabric seat, then we have a full option seat, a massage seat, a ventilation seat. This is a sequence which will be given by the customer and to organise that sequence in let's say smooth manufacturing balance. We need then AI to do that for us in real time. For us currently, it's not it's not possible to do it in real time, because we don't have the let's say expertise in that one. This is why we say okay, when we get the order and the next pre orders, then the AI should deliver us the right sequence where we say we have a smooth production and we can get the most value out of the production planning.
15	PE	Seems to be really interesting. How does this project affect the production itself? Could you elaborate?
16	I3	Yeah, oh, when we talking about AI, so you know that usual production concepts. Which is producing in one direction, producing from the outside to one main line, producing an in-use shape producing an H, X, Y shape, whatever. This is the conventional manufacturing strategy. In the near future, there's a really good example from KUKA from this robot company, and it's called Cooper KUKA matrix production concept. And when we go into that Cuca metrics production concept. This is mainly driven by AI because this is doing all of the production scheduling for you. That means you have a matrix organise production shopfloor, you have a matrix organised organisation. This means all of your organisational charts your functions as well. They are organised in a matrix organised organisation. And then you have the AI which is controlling your complete manufacturing flow like pre assembly or pre manufacturing phases, coming to the final assembly phases and everything will be controlled by the AI on that matrix field. It's like a chess field, it looks it's looking like a chess field with a lot of squares on it, and whenever it is square is free. This means the full capacity of manufacturing is done, the product is done, then the AI will get a signal a I'm done within the next 20 seconds or whatever. And then the AI is controlling the complete delivery of materials. The Intralogistics and

		then as well the manufacturing of that cell. Whenever the cell is finished, it will be sent a signal to the AI and then the AI is guiding the finished goods to the end of line inspection, whatever and then later on to the sequencing system and to the storage system.
17	PE	Thanks. I will give the word back to Salla.
18	SR	Thank you. Now to go more to the social side of this. How does AI affect workers in production?
19	I3	Workers in production, we really figured that out during the pandemic crisis. We were looking at hotspots where we don't guarantee that 1.5 metres distance. AI is helping in that case, so that AI can figure out a way here in that hour, maybe shift change, you have a hotspot in the showers or whatever, then AI can help you to figure out which areas are the hotspot areas of that one. This is the social impact. Social impact with regards to health and safety, AI can support in health and safety areas. What do we had? It's an it's an intelligent safety system where AI is supporting the health of our employees.
20	SR	Cool, what skills must a production worker have? Like, is there a change due to the use of AI?
21	I3	We are really talking about blue coat workers. Most of that workers, they do a really it's easy operations they do, they do not more than three operations at one time. And most of them are not really trained in doing programming or using AI what they can use as apps. They are pretty good in using all of the different apps you have on your mobile phone. But they are not most of them are not familiar with programming apps or programming or teaching an AI. For this for that we have different levels of operators. We have maintenance operators, they do robot programming, they do PLC programming. And in some cases, we do have IT experts which can do AI teaching but they are really really specific and we don't have that much on expertise on all IT site. This is why we go external and say okay, this expertise whenever we need it, we buy it from external.
22	SR	What about in general, how does the use of AI change the workplace?
23	I3	It changed the workplace in that way, let's say like that, it's a bit like crystal ball reading. The AI it will be the crystal ball and can look a bit into the future, not days or whatever, but minutes or hours and that is improving the health and safety of operators a lot. Whenever an operator knows what he has to do or knows what is coming next, then it gives him the safety and the secure. What is security that the right word? The safety I guess, in his operations.
24	SR	What about do you think people get frustrated about how the new working environment affects their ability to think creatively?

25	I3	There's a study available from company Deloitte, which is looking at the operators, and how familiar and how scared they are when we talking about digitalization and new work, etc, all of the things. I think it's, it's a question of age. The younger age they're familiar with, with mobile phones was app programming with all of these things, they grow up. I see it with my kids, they grow up with tablet PCs, they can use the tablet PC, like, I have absolutely no clue, they figure out apps, which I never thought about, but they can use it. They grow up with it, they are, let's say, digital Afin. Digital Natives. When we are talking about operators, age of 50 plus, maybe they're a bit more scared to use the new technologies. And the funny thing is, this is what happened in most of the companies when we're talking about planning, planning, of manufacturing, planning of supply chains. You do not have the younger generations in it. Most of the times you have experienced mid age employees, they do have the experience because they are in the company within, I don't know, more than 15-20 years. And they do have the experience to do that. To convince that guys by using AI or doing programming of apps or whatever. They are really scared to do that. I think it's a question then of age really, if you're open minded. We had the same, we had the same question. Interviewee 4 and myself we are, we are in a project where we do process simulations in 3d. And to do that simulations, you have to import data. And most of the data, they need to kind of have Python programming. I did PLC programming in the past, I know how it works. But to be honest, I don't have the time to step into Python programming and to learn it. But Interviewee 4 said, Hey, no problem. I take this, I take that I put it together and it's working. For me. It's like a miracle. But for him, it's daily business. That makes sense.
26	I4	Yeah, from my side, I think it's like Interviewee 3 mentioned, it's always the same, it's depending on the person. So, if the persons in the shop floors of mind, so sometimes I have to situation that also young guys are a little bit afraid of new technology, because sometimes they are thinking, oh, yeah, this technology can replace myself. So that was one of my situations I got. And the other one was some guys up to 50. And they were really happy with the new technology. And yeah, they're open mind. So, the looking different on the topic, and also think maybe it could support myself and help me to do my job easier than this. So, it could be always different.
27	PE	How do you address this issue to get the people not afraid of such a situation because, for me, it seems like really difficult to do such a thing.
28	I3	Like, be transparent with whatever you do. What we do is whenever we test new technology, we did it with virtual reality. We had a lot of discussions and introductions with suppliers. We summarise all of that information. And we made it really transparent to the shop floor people and as well to our senior leadership team. We were on a promotion

		tour. Let's say we were knocking at doors and saying hey, look fancy technology. It's working. And it's supporting you. And it's really cool. Check it out. And most of the guys, they said, oh no, I don't want to wear that mask. I have problems. I cannot wear it. And I said, hey, look, my eight-year-old son did it. And if he can do it, why can't Why cannot you do it? And that's this is what we did. We invited shopfloor operators and say hey, look, this is a new technology. You don't have to be familiar with AutoCAD with 3d planning tools. Just put the goggles on and check it out. And after five to 15 minutes, they said Hey, it's quite easy. I can do a complete set up often have an environment. That's amazing. And I can check machines and distances and I can see my surroundings. That's really cool. And this is what we always do. We invite them, we present everything and we say, look, don't be scared. It's daily business for us. Yeah, it's new for you. But don't be scared. Check it out. You can test it by yourself. And then you can say, okay, it's working, or I don't need it, I don't want it. But important is transparency, and communication. This is how we handle all of the new technologies.
29	PE	For the nice example, you told us how it works with virtual reality. But how does the work interact with the AI system?
30	I3	This is not this is not related then to shop floor. Whenever we do something, which is going to AI or blockchain or whatever, we have to be in touch with our IT department. And they're really open minded in using that technologies. They do have expertise, and they do use external expertise for that one. But we are not a software company. Whatever we, we have in our IT environment, it's coming from external and will be implemented into our systems. This is how it works. And most of the IT guys come on, to be honest, they're really nerds. They sit in 24 hours in front of their PC, and they're saying, hey, I do have a bot for that one. And that should be great. If I have a bot for that, one, why not using AI to do that one. And this is how that function is. It sounds crazy. But we really have that nerd sitting 24/7 in front of their PCs and doing that kind of things.
31	PE	Okay. Are there situations where AI and production workers collaborate?
32	I3	I don't know if that is really a part of AI or of programming. But we do use Cobots. Cobots, they have a kind of routine in it. But they are working together with our workers. But usually, our operators they are not really touched with AI. They really get a print out of their production sequence what they have to deliver, or they see it on the screen. They do scanning operations, they do manual assembly operations, or they're pressing a button on a machine and that's it. Most people which are in touch with AI are our customs and trade compliance department. They are they are using AI to fill out all of the custom documents. Whenever you ship a part from Europe to China, you have to fill out

		custom documents and that filling out of that documents take a lot of time. And a lot of processes and AI and bots are doing that for us. Whenever we say that part is finished, it takes us a couple of seconds. And then the complete documentation for custom clarification is done. In the past, we did it manually and we wasted days. And currently or actually, the AI and the bots are doing that for us.
33	PE	Are there any other specific tasks that are being supported from AI?
34	I4	So, I think the only one I could imagine would be for us maybe something like the end of line check. So that we have something like a support tool to support our workers by find some of our mistakes on the products sometimes on the surface, just to support them, but it's the only case.
35	I3	But this is this is most of the times it's a collaboration between visual systems and AI systems. We do we do visual inspection of seats. And it's always a combination between the visual inspection system like cameras, etc video cameras and then the programming system or AI system which is driving the end of line inspection or blind audits.
36	PE	And is there any specific case where the production workers help to develop their AI systems, for example, give the developer ideas what problems they have and maybe the IT guys can tackle or trust this specific problem?
37	I3	We do have we do have Power builders, let's call it like that. We call them power builders that are really experienced operators. And those operators, they help in developing our machines, new workstations, new processes, etc. But as I've mentioned, they are not in touch with AI or any IT solution they will be contacted whenever we have an issue with machines with ergonomics with designed for assembly, for example. Whenever we ask, Is that possible? Can you reach that screw on the seat by your manual operation and then we get the feedback directly from that skill operators?
38	PE	Thanks, then I will give the word back to you Salla.
39	SR	Thank you. To go more on the social sustainability side of things, since that's our focused on the research. So social sustainability takes into consideration the human aspects of sustainability such as the working conditions and health and safety and so on. So, the question is, how does AI impact your ability to achieve social sustainability?
40	I3	To be honest, I never thought about that one.
41	SR	Okay.

42	I3	When we are talking about sustainability, we are more focused on the on the scope one, scope two and the main focus is on scope three, our supply chain is producing a lot of co2 emissions. When I from my perspective, looking on sustainability and manufacturing, I'm just looking at consumption. This means water, gas, fuel energy consumptions. This is where we are looking at, then we do have we are really focused on the 13 sustainability goals from the United Nations. Yes, we do have well-being something like that, where we take care of operators, we do have initiatives where we say hey, stop smoking, stop drinking alcohol, live healthy have a green environment, looking at our canteens? Do we have vegan food available? Diversity inclusion? Do we have women in senior leadership positions? Do we have I don't know? What how is it called? pregnancy leave? Can they come back? Do they have a safety place for their kids when we go to work all of these things? But this is all done manually. We never thought about using AI to support in that case.
43	SR	Do you measure the impact of social sustainability?
44	I3	Yeah, we do measure it. We have a we have that initiatives, where we really can see how the feedback is. Before we do all of that initiatives, we start a survey. We can see it directly. If an initiative has an impact on or social environment, so we do we measure we do have that KPI where we say okay, how many sickness leave do we have, how many incidents reports we have all of these things. They will be tracked, we have a KPI dashboard, where we can see how the, the heartbeat of our employees is, let's say like that. We can directly see what will have an impact or not. What we do as well is that we do a psychological study. Whenever an operator or a new position, a new workplace will be developed, we look at the psychological effects of that. We directly get not just the environmental and economical impacts we get as well as the psychological impacts by using our psychologists, which are then related to health and safety department. They are really into that process. They're really deep sticking into that process and doing the psychological evaluation of operators.
45	SR	Okay, very interesting. Okay, so the next question would be, are there any specific areas where AI is having a particularly positive impact on social sustainability?
46	I3	I think it will have a positive impact. It's just a question or a matter of money. How much does all of that things cost? I mean, AI, it's not cheap. You need the expertise. You need the hardware, the software. You need skilled operators that all costs not stones. It's hard money. And if you're approved, if you're in a preview producing environment, money is one of the big drivers of it. And as well as sustainability, I always say that sustainability is for rich companies. It's, it's not for companies, which are really focused on lean production, saving money, etc. Before you start thinking sustainable, you have to go into your pocket

		and put a bunch of money on the table. And it's the same with AI. All of these fancy technologies, they're really great. They will change the future, but you need the pocket with money to buy it and to implement it.
47	SR	Do you believe that there could be some drawbacks in terms of the social impacts of using AI?
48	I3	If it has a positive impact on my social environment, for sure it will have. If my employees are really satisfied with all of their production environments, and they are implemented, and they do have transparent communication, etc, and it's for sure it will have a positive impact.
49	SR	What about any negative impacts?
50	I3	If all of the companies are doing that the negative impact can be that people are leaving for go to a better company. Now, this is what we figured out years ago in China, so you do education in China, you teach operators, and once they are skilled enough, they change the company. And then you're starting from scratch. And again, and again. And again, this is what happens in all of the companies and this will be one of the negative impacts then as well for the future.
51	SR	Now back to Patrick
52	PE	Then, we are already coming to the end. So, of all the topics we talked about today, or even didn't consider, what should we pay most attention to?
53	I3	Most intention is this is what we figured out is when you're talking about or when you're talking to companies, most of the companies, they do have this expertise in house, and they do not know it. Just an example. We think about doing programming in simulations. And we know that we have Python experts because they doing Python programming in their spare time, are they in a position where they previously had something to do with Python programming, they are familiar with that one, they're experts in that one, but it's not their main focus, they do it on their spare time, or whatever. And we figured out that these guys, if we touch these guys, in kind of social network groups, it's like, it's like jammer, or Yama, like into intranet, or something working like Facebook a bit. When you figure out what the what people are doing in their spare time, you will be impressed of how much expertise you can get out of that one. We have people which are familiar with photographs, photograph, they do pictures of I don't know, landscape, or whatever. And they're using a lot of equipment with that one. And most of them are in touch with companies we never thought about. They do have camera solutions where we never thought about because we don't know it, but they know it because it's their hobby. Or we have people which are which doing videos with drones. They're

		using drones, they can programme it, they fly drones or whatever. And when you bring that people together that expertise together and the kind of social network, then you will have a benefit then later on in your company. Because you can use that people there passionate, they work 24/7 without thinking about a break because it's part of the hobby, they like it. They like what they are doing, and when you support that people that will bring you a huge benefit in your company.
54	PE	And what should we think about when we read your interview?
55	I3	My interview?
56	PE	Your interview.
57	I3	I'm not sure. I would say that most of the companies, they are really talking about doing something. But they are not ready yet. They think about using AI. They speak about, yeah, we do have AI, but they never stick into the deepness of AI where you really can use AI? Or what's the benefit of AI? They say, it's more like I say that I do it. And I hope that nobody is visiting me and checking it.
58	PE	You mentioned it's a money problem. But are there also other issues? Why is it not really major?
59	I3	One thing is money. The other thing is really dinosaurs in leadership positions. And I really mean dinosaurs. For them, the computer is high tech. And using a mobile phone to its best, it's not the solution there. When we present something like paperless production, for them, it's like, whoa, we present something new. One thing is money. And the other thing is really, if your leadership is not open minded, and they are willing to do or to test something like that, AI is a good example for that one. If you have a dinosaur in your IT department, who says, "We haven't done it in 20 years? Why should we do it now. Everything's working well." Then you're completely lost. You will not win the game. That's one of the problems we have when we say we have a new technology every time what we have to do is to convince the senior leadership team and say, "Hey, this will have a benefit. It's not having that benefit now, but in five to 10 years, maybe." Yeah. And sometimes most of the people say, we don't want to use it yet, if it has not a return of investment within three months. Makes no sense.
60	PE	I see. Seems to be really difficult.
61	I3	Yeah, it is, it took us more than one year to convince the senior leadership team that virtual reality and augmented reality has a benefit for the plans for the development departments. And it took at the same time to convince our senior leadership team within simulations and say, hey look with simulations, we can look a bit into the future. It was more than one year, and it was not just one leader.

62	PE	Then, is there anything in particular you would like to add? Before we finish? Both of you?
63	I3	Yeah, for me, Interviewee 4, I would like to start, then it'd be quite be as whenever you go into a company and you would like to implement such kind of systems, artificial intelligence, etc. be as transparent and do a really good communication. Most of the most of the cases, the people they are really scared of using new technologies, if you don't show them it's a benefit for you, it will not reduce your workplace, you will not be deleted, but you can focus on other important things, then it makes a huge difference. Most of the people that really think this is what Interviewee 4 mentioned is okay, when are using that technology, I'm useless. They can fire me. But it has to be clear and really good communicated that no, you will not be fired. But you can focus on other things which you can do to support. That's important.
64	PE	Well, before we come to you (Interviewee 4), I would like to ask another question. Because you're at, you mentioned other important things, what are the most important things can you elaborate a little bit more.
65	I3	I'm coming from production. Whenever I press a button and the machine is working, I will not stand in front of the machine and wait until the machine is finished. I can go to the next step operations or I can do in the operation which comes first before the machine and do some operations on that one. This is what I mean with other important things for us as always, if you stay and it's just the second this is wasted money. Every move an operator is doing is cost as money. And this is why I said okay, if we don't focus on that point, because AI is supporting us. In doing that operations. The operator can do simultaneous work on other operations. And this for me is saving money. This is what I mean when I say do other important operations.
66	PE	I'll give the word to Interviewee 4 now.
67	I4	Thanks. Yeah, for me, it's the same like mentioned from Interviewee 3. Yeah, the most important point is to be as transparent as possible. And also, to communicate with the people as they are normal people zone, not something like you are here, and upper, and so on. So, it's always important to explain as much as possible, he can understand. So, it's really important to go often there, explain them, how it will look like later. And in which point it can support you, for example, that's really important for them to understand the situation, and also how it could be in the future. So that's really important, just to imagine themselves how it will look like.
68	PE	Okay, thank you very much. And in the case that you forgot something, or you would like to add something, you can contact us anytime.

		We will be happy to more than yeah, to get more input. And yeah, so thanks a lot.
69	I3	So, if you have if you have questions in between you have my email address. Just ping me and I try to support.
70	PE	Thank you!

Appendix 5 – Transcription of Interview 4

Interviewers: Patrick Egloff (PE), Salla Rautiainen (SR)

Interviewee: Interviewee 5 (I5)

Section	Person	Transcription
1	PE	First of all, we want to start with a brief introduction. I would start. I'm Patrick. I'm 25 years old. And I'm passionate about AI and the digitalization and how AI can add value for human. In my free time I love to hike and dive. I would give the ball to Salla.
2	SR	Thank you. So, I'm Salla. I'm from Finland and I'm 23 years old. And I'm especially interested in how technology can impact sustainability in a positive way. And in my free time I play volleyball and beach and listen to podcasts watch way too much Netflix.
3	I5	Yeah, then me I should introduce myself. I am NAME I'm 40 years old. Yeah, from my background, I am a mechanical engineer, I did study at TU Munich production management and I study with vehicle technology. So, at all, I was happy to have a work with cars. But due to the fact that that I started in automation. Building how cars will build. I come to KUKA and had there a long, long time with KUKA in automation and robotic starting doing really system integration, doing automation lines for OEMs, but also for controlling sustainability for PV manufacturing, PV module manufacturing. Afterwards, I worked for the CEO and the CTO at KUKA for looking into the future so called Innovation Management but disruptive innovation so I came into touch to AI and robotics and so I come into touch Company D. Company D didn't exist but I met the founder of Company D and was impressed about his vision about industry 4.0 and bringing AI and manufacturing together. Now I'm working for three years now for Company D. There are two companies behind. The shop floor who's doing manufacturing process and the software company who's doing the AI behind. They're responsible for the business development, implementing new projects, new topics. Yeah, that's my job. I'm personally my hobbies. I love my garden and my kids right now. Yes, right now, besides work my hobbies are my kids and my garden and my family.
4	SR	Thank you for your background. Can you please briefly describe more what your company mainly does?
5	I5	Yeah. Company D/1 is a development company whose vision is to digitalize SME manufacturing stop shoppers. So, of course, this do many. We are focusing on subtracted stop shopper. So, they are doing milling, turning. Based on this that we have in the background, our one-

		stop shop with Company D/2 who is doing contract production for milling and drilling. And for starting from Company D/2 because this was the initial company is so called One Stop Shop. So, they're the customers comes and said, "Okay, I have assembled parts, can you produce it for me?" So normally they come with designs, we have the service to optimise these designs based on the manufacturing if it's milling, drilling, or additive or sheet metal. And in the end, we also can assemble the complete mechanics. Also, in our factory and provide these to the customers. So that's Company D/2, which is the basic. Yeah, and the input giver for Company D/1 that was squeezed out and funded out because Company D/1 was the former software development department of Company D/2. And there the first idea was, hey, today we sell our products via excel and fax. We make the offers and bring it up and maybe hey, let's build up a platform where people can upload the step files, the PDF, manufacturing files, and based on algorithm is behind the get immediately price and can order it. This idea was launched in April 2018. And now it's called "website name". So, this is the, but then we realised first of all the classic customers of a chop shopper is not using it it's more b2c Who is using these this platform or people who are doing additive processes or want to have an additive process, but not for the classic milling and drilling, but we realised the algorithms behind calculate the analysing this CAD file, how it is produced and also make their the recommendation how it is produced in which price based on the machine hourly rate of machines and hourly rates of processes. This helps not only Company D/2, this helps all SME manufacturers and then the idea came up also due to the fact that we are cooperating with DMG Mori and are working together with big milling players to machine manufacturers. The idea came up hey why not offering these services to other SMEs and so, a propose was funded as the software development company. Company D/2 is still the input giver how called the beta tester for the software and so, we made a 180 degree turn and set up the software in a new way and said okay, we are setting it up like services and we have right now two services on track. The idea behind is based on the 3D CAD file. Today there are no PMI information so PMI informations are like fittings, like crossings, how is the pipe draft maybe I'll show it later on if you want in real and based on this information which to the designer into in one hand in the 3d CAD file in the other hand in the PDF manufacturing file, how it has to be produced and how it has to look in the end we do these analysing starting right now with a very let's say the market is still very rudimentary 3D parts and all information in 2D drawings but starting there there's a change in the in the market that they implement more information in the 3D CAD files. So based on these we analyse these 3D CAD files and make their recommendation how it is produced. But also, to with the goal to have a seamless flow from the order income till the end to the quality. For us, our vision is based on the data out from the customer data which we were started right now then with the production data in the in the manufacture, on the shop floor. So which machines are in there? What are the specific hourly rates of the of the

		shop what's the feedback how it really took to produce this. Until to that how has it to be programmed on the machine also to work with this data? This is the idea of Company D/1. Yeah, maybe I'll show you a short i if it's okay if you're I can visually show this shortly, I think that would make sense that you get a better feeling about as I just have to if there it is. Oh, can you please allow me to share the screen?
6	PE	Sure, now you can share your screen.
7	I5	Okay. now it works. Yeah. So, what I explained in words now. You can visually see that for us is simply reset oversimplify manufacturing. Because today maybe I have to explain also how it is done today. Today the calculator is calculating, best case in an ERP system. But normally in an Excel sheet. Based on his experiences normally the calculating chop shopper is a guy who worked for years at the milling machine or the turning machine, and has the experience how the strategy has to be done. So, this is the idea about our first where we are now in the market with Cloud basic in Cloud and Company D/1 calculation to say, hey, there, you have the chance to convert the expert knowledge for the SMEs. Because currently, especially in Germany, I think it's almost all over Europe, we have also a generation shift. There's a big generation shift. The baby boomer generation is retiring and their children coming on track and they don't have this experience, but they would benefit from experience from the older ones. There is a possibility to conserve because due to that, that the people are using continuously this calculation sequence, the feedback is coming into our algorithm. So, the algorithms can learn also concern. And this flow, we want to continue with, of course, the feedback from the shop floor. Also, the feedback which tools they are using also the feedback with CAM, and also back to the production end, of course, but this is really the vision that concerning quality management. And our vision is to have their the seamless process in it to get in every stage the feedback as well, to optimise and digitalize the SME manufacturers because then this is this is our vision or our idea. And then it comes back by I'm from robotics automation for software company, because then it is possible to make to optimise the SMEs in a reliable way. Because today they are robots in this nice robots, but they are bored in such a manufacturing, because every 10 minutes, they have to load a machine and unload a machine. Even though we have these nice Cobots right now, where you can move it on one machine and the other machine, it's still in high impact to get them up and running for SMEs when they are not trained when they don't have the people. So, and this is the vision and also my ambition to say we have to digitalize SMEs before we optimise them. Yeah, maybe I'm or I'm talking too much, maybe.
8	PE	It's okay. You already answered a lot of questions. I mean, we talked about how AI is being used in production. Now, we would like to know what is the purpose of this project you talked about?

9	I5	The purpose you mean, concerning why we do this?
10	PE	Yes, exactly.
11	I5	Okay. Because from the history, the founder of Company D is an informatic guy and he took over Company D/2 with eight people now they're almost 100 people. And he realised, first he thought it's just Company D/2, which is so old fashioned in bringing the parts to the market, because of course, you see in the in the media, always the nice robots where producing cars, but you also have to know that the lot size here is much higher and the variety is very low. So, automation makes sense and he said, Hey, why can't we do this in a SME and then he realised that due to the fact that the high variety of different parts they are producing and this yeah minor lot size or this load lot size, there has to be done something where some seamless production. Then he also realised, he gets from the customer to the drawings to calculate. Then he sends out the calculation back. It comes then the order. There is than a 3D step file, because on the machine, you need the 3D step file to programme, the milling, for example, so that you can't work. But you also needs the 2D to get the information is the fitting right is everything right? And based on these breaks in the production workflow, you lose time you lose money. And at the end, when you're in the quality department, you realise, oops, we forgot something. And we have to rework something. So, parts make it quite expensive. And due to the fact of the globalisation, even though it's more than the mega trend is going to deglobalization, but due to the fact that these stop shops in Europe has to compete with global competitors, there is an issue to how to make it more efficient. Of course, you can make it more efficient with an ERP system with some kind of MES system. But this just makes sense, when you have higher lot sizes, because the inputs is quite intensive, time consuming. And that's what's the idea they must be something easy, more easy. And so, he started with the idea. The idea was in 2011 already existed. But fast internet, AI, machine learning algorithms were there somewhere at university, but not in real life. So, he was too early with this idea. And it let's say in 2018 with these political, let's say political boost of industry 4.0 that everything's in industry 4.0. He had the chance to set his idea up and bring it in.
12	PE	It's a really interesting vision and seems to be really nice. Coming to the next question. How does this project affect the production itself?
13	I5	So right now, we're good in to forcing this digitalization because we're at the very beginning in this market. When we were first on a fair and started with this idea, people looked at us and said, that's cool. But then they started, who is using it? What is doing that? So, this is also something where we see this, especially in the DACH region. It's a very conservative area branch, we know is Eastern Europe, for example. They are more open to this. It's curious. It's very interesting. I didn't know this. Because when we talk to customers from Eastern Europe,

		even though we have right now, trusty English is a German product. They say, hey, that's cool. Yes, we worked with that. And, and that's no issue. But the DACH region, which was our focus is a very tough market to bring this in. So, our focus is really to make this to enable the SMEs with a digitalization for sure. Getting feedback from the machines from the milling machine makes brings us into the hardware. And they're also phase let's say, we lay there the base for the for automation, but with the vision and the idea what is now behind with our company vision. It's enough.
14	PE	Thanks, Then I will give the word to Salla again.
15	SR	Thank you. Sorry, there is some construction work outside. So, if there's some noise, that's why. Let's go more to the social side. How does AI affect workers in production?
16	I5	We see this from our experience. First of all, of course, they think they get up. Look, oh, will I be replaced? What what's going on there? Of course, the typical. I don't know it, I'm afraid of it. That's I think, like every human being, but when we try to explain what's the purpose is that their knowledge will be stored in there. And we always say maybe I go a little bit to explain our AI and then Maybe it's better than for you to understand. I'll show you one slide. Based on the human first of all, of course, when we talk to customers, or sorry, when we talk to customers, these are mostly the company owners. And they say, okay, and working with AI, and we have all cloud-based services, they first get afraid and say, hey, will my knowledge somewhere else, then in my company, because their USP is the machine part they do have, and the process is how they machine the parts. That's, that's their USP. And we always say, no, we are not interested in your USP, we bring just, and we splitted our AI essay like this, because in the back there, of course, machine learning algorithm, there are some kinds of AI algorithms, but they are some specific and we bundle this. So, when we say we have a core AI, which we deliver in which we will be fed, and this court in the AI disrupts what of the component that has to be manufactured. So, like, again, geometrical features like that, there is a control there, there is drilling a thread there, for example, or unhealed there, these, we do describe, and based on this, we recommend a process. But how this process will be done. This is we call it our AI shell. This will be in the own, we say the own AI of the manufacturer. So, he has its own AI because these AI will be trained about his machine, his process times. So, this is something that we can't influence what the manufacturer can influence because it's his USP. So, this is the only thing where we, where we see to respect this and that there is no big brother's watching you where all the knowledge comes together and will be collected like Google when you use it, it's really so that we say no there is a completely split, your USP is your USP, our USP is our USP that we offer it to you. And based on this the shop or the colleagues see here, or the customer see here, the possibility to save their expert now how it

		makes it fast and more efficient. This is the first where we have and then of course, they have to enforce their calculators, their people from the shop floor to use it. So, on first of all, oh, they are afraid because they don't know and they think they will be replaced. But we always say, our AI when it comes to a customer, it's at training, the second trainee was doing milling because he don't know exactly how the one-stop shop looks like. The AI has no information. So, these people have to give the AI it can learn and so it helps the calculator to make not replace him because he has to decide is that right or not, I've made a I have in the in the last instance of the human being doing the decision and not the AI. The AI just recommends. So, they have the full power of it. And even they can influence the AI by adapting for example, the working plan. That's also something and due to this, that they can influence it, they can they will train the AI and the AI will get better and better and will come to the shop floor concerning the feedback. The people who are doing milling and drilling they are maybe first afraid Oh, they look into my fingers. But based on this that they also get it easier that we directly connected to the machines and we have a very so we have a very big issue on the shop floor. We have a lack of experts. So, these experiences people let's say it in this way. We don't see that this AI will make the complex things there. We will still need the experienced people, the experts, but these getting the less and less so and they often have 60% of easy parts where they have where they just say, hey, when somebody could help me, then it can focus more on the complex parts. So, this is more of the support for their people, for these people with the AI, how it will be produced? And maybe how can you bring it on the machine with the process progress on the machine, so easy parts easily. There is no big effort for the AI but a big time consuming for the specialists. So, there we see here the possibility to support them not to replace them.
17	SR	That makes sense. Um, what skills must a production worker have? Like, is there a change due to the use of AI?
18	I5	I can show you what the AI is so quite simple. Even I can use it and I'm not somebody from stop shop. I one second, I just look which does this mean email? Sorry. Continue. There I have, but I go into the life system of Vi M. So, I'm scrolling quite fast in some areas due to the fact that these are NDA topics. But when you have to look here, so the people who are working there, it's like yeah, I was in German Klickibunti. It's like using other software and I said, Okay, I have here this cloud basic I have here where I can set up my resources. Resources means the machines which are in my shop floor, I can easily add them. So because every step is where you asked, maybe I bring here noon, I don't want to make it because I want to squeeze up my colleagues and confuse them and bring I go there into this for example, in this Hamler it's a milling machine, I go in there and then I can bring it in, I can place them my hourly ranch setups rates, my hourly rates, I can define the process group all the information to bring it in of course, this is

		something which has been done manually or if you have a very good ERP system which can go automatically but you have to check it in the beginning you can bring you in your materials quite easily which material for example, you can add it over here with the density raw materials in this case is always what is the basic you bring into the milling machine. I also didn't know this before that there's a difference. Then you have here the possibility to make your customers and of course, the big thing you can bring in your pots. And this is I think the most interesting thing for you can upload here the pot this is where the AI right now works in the background. You can implement this and you can create a production plan and this is where the AI is now working, is analysing this part, is showing which part where can it be done, which process can be done. Do you see it?
19	SR	Your screen? No
20	I5	Oh, sorry. Don't be so polite. Sorry, I changed. So here you are. Sorry. Oh, I go back. So, I explained here this raw materials how you can set it up? I'm very sorry. Yeah, so the resources you can easily load these and when you go into the pot and I have here a pot, it's a good test part. I'll show you in here is by the let's say the AIs are the machine the algorithms behind a working. Of course, when I have here this STEP file with the boreholes with Yeah, all the features which are in and here when I click this button, create production plan these geometric algorithms behind the information from the shop floor which machine which hourly rates all will be done there in creating the production plan, how it will be produced. And so, then you get based on your one-stop shop recommendation. You as a user say, Okay, I want to make a million because it makes sense I have the raw materials yet the resources, I've already price in there. And there, I get the complete work schedule how it has to be produced. I can add here, for example, resources or additional costs. And based on this, I can retrain the algorithms behind because based on the historic data, which while you're using and bring it in, of course, the AI like every machine learning and AI algorithms is working is recommending and is learning on this make it better and better the algorithms and the outcome. And then of course, you can share the calculation with other colleagues maybe on the shop floor, hey, can you have a look around? Or, hey, it's an order I give it to you, you can use it or it can save and send out a notification. So sorry for not sharing it.
21	SR	No worries.
22	I5	Of course, in the first you need experts. So, who are knowing is this? Am I doing the right recommendation? But the longer you're using it, the less skill people you need.

23	SR	That makes sense. Um, another quick question would be that are people frustrated about how the new work environment affects their ability to think creatively?
24	I5	Sorry, can you repeat, please?
25	SR	Of course, yeah. Are people frustrated about how the new work environment with AI affects their ability to think creatively?
26	I5	No, I don't think so. They I think they of course, first are scared about but frustrated about creativity due to the fact that the focus is here, that the people get their support with boring parts, not with challenging parts where they have to think about, and I think this helps them to have the time to think to be more creative on the other side. That's in general, this what I seen AI is that due to the fact that they do this basics, often or you think you have more time, but you do it with other things to be creative? Because this is my really personal thinking. The creativity does not have the AI can support us to be the people that the people be more creative.
27	PE	Thanks. Then, I will go to the next question. You showed us a really nice example, how production workers interact with the AI system. Are there any other cases that you would like to mention?
28	I5	Yes, let's say in the in the development phase, we are also to say, okay, when we come to the machine and how part will be machined. The people has to programme it. Today, it's completely manually. So, then you see apart what I showed you this, this ankle has production time from, let's say about it has a run time of half an hour. But the setup time, and the programming takes more than half now. So, and there this half an hour for the setup time, there's somebody bounded onto the machine or in a CAM programme on the computer. To programme this how the machine has to manufacture it. And of course, when we already know the geometric data, which are behind and we know how it will be manufactured without boreholes, there are some other features there are threads in it, you already know how it has to be produced, which tools has to be used. And so, the way to generate their code for the machine is very narrow even though it's a challenge to go from AI software to the machine. And we are working but we were working on this and we had already the first successful test that this works out and this can be done in a very good mood. So, bring reducing the setup time, support the CAM programmers make the throughput or that of the such a machine increase the throughput especially then you see when you do the machines today even in quite high automated manufacturing's have throughput of 30 to 40%. And increasing these. Yeah, these availability of the machine by 10% was safe, a lot of power, a lot of energy, a lot of people as a people in this claim that they can do other things and has not been on the machine due to the lack of the expert what we have in within Europe. So also, this concerning making

		the shift to sustainability, we see here potential to say, okay, due to the fact that we can bring more parts fluid, we don't need so many machines, we don't need much, so many resources, and also to manufacture parts, you also have to do one or two test parts and drones. And these will be then thrown away or, of course, Recycling's. It's a good business. But to avoid this is better.
29	PE	Thanks. How does the AI system support the production worker itself? We saw the example. Are there any other cases?
30	I5	No, Of course, the support system is easy available for everybody in the cloud. He sees what the recommendation is, can correct it or get a feeling how fast it goes through the production. And also, of course, when the product with the code is setting up, then it will be the next case but not more. No.
31	PE	And the last question from my side. We talked about that production workers need or have to give the knowledge to the AI. Are there any other things? How they support an AI system?
32	I5	Um, I'm thinking about it. No, because I think that's, that's the main purpose that they feed it with their experience with their Yeah, by using it. No. No, other than that, I have shown you.
33	PE	Thanks, I will give the word back to Salla.
34	SR	Thank you. Okay, so that go more on the social sustainability part of it, because that's what we're researching or focusing on. Like social sustainability takes into consideration the human aspect of sustainability, which is working conditions employment, ethics, and privacy and so on. So, the question is, how does AI impact your ability to achieve social sustainability?
35	I5	Just thinking about it, because this is a really interesting question. Based on this, when, concerning the working conditions, okay. We support them that he can do things he don't like, much faster, like doing the calculation or preparing simple parts for the production running. The thing is concerning the healthiness working conditions, today, our people from the sales are going into the production talking with them. This may be to be really honest, and critically. Maybe also a negative impact, because then you click on the button and it goes automatic. And there so the social interaction, the personal interaction will be reduced. So maybe this is some kind of a critical topic, what has to be seen in this. Even though we see that he has more time to talk about complex things in the production with the people? But yes, it has two sides.
36	SR	Yes, definitely. Um, what about how does AI affect health and safety aspect?

37	I5	Um, I think our AI due to the fact that we're still in the cloud has concerning the safety, less impact or no impact due to the fact that we, even though when we go to the machine with the code there, of course can be effects because we have there, like some validations or collisions and everything, but the machine itself is yes. In the safety mode when even though there is a collision in the machine, that it has to be worked by the machine. So, in safety aspects from the production side, I don't see any impact concerning the health also said, in general. So, the health, I think, to supporting the people to be more creative, creative, I see there a positive aspect that they get, get a little bit more out of the beside in German "Hamsterrad". I don't know the English word. Patrick, you can later on explain it. To this is maybe the chance that they come out of the "Hamsterrad". Oh, I have to make this quote. And these are 30 parts I have to quote and they have to finish it by today. And so, they have the support to get faster and can focus on the creative side of the offer talking to the people, clarify with customers things. From the healthy side, I have to say, all the manufacturer has to take care about the desk, which they can move up and down. Because when you're sitting only working in the cloud, as every as your students also know, it's not good for your back. So, from the healthy aspect, I don't think that there are major impacts, I have to say this a minor impact for sure to make life easier for the people. But not these direct transplant impact. This is the impact from this AI by using it.
38	SR	We talked about how a lot of workers feel maybe threatened from AI and like, what if it AI takes my job and stuff like that. The next question would be How does AI affect the employment? Like in general?
39	I5	From my side it supports. But this discussion I have now for 28 years since I was at university studying automation and digitalization, it's always automation is top killer. digitalization is job killer. And now it creates new jobs. Both we see the best example is automation automotive industry through automation. Of course, their jobs changed. But we have such an I think almost complete Germany. And sometimes I have the feeling is some kind of working for automotive industry. And when this shows up, even there's automation, the jobs changed. But the people that didn't get less when you go to Volkswagen to BMW into a factory and look into the factory, I don't see less people. I see. But I see other jobs. And this is the thing, digitalization will also output will change the job definition of people. And this may be afraid them because they are afraid of new things they don't know. Yeah.
40	SR	What about how does AI affect the non-discrimination?
41	I5	I don't see any effect from our software that it makes better or less maybe due to the fact that in personnel, the people are less communicating it can help that the girl from the sales is counting Oh, now she don't know. Sorry. This or it's not a direct impact, I would say.

42	SR	Okay, what about ethics and privacy? Does AI affect that?
43	I5	Based on our AI? I would say no, because we are taking care about the privacy laws we have in Europe. And so, we don't see it of course, what makes more transparent. This is maybe the critical part due to the fact that you can always see when something has changed and also in our product we have in history who did change it when some people might be concerned that based on this their quality will be the work quality will be affected but I always say when you do that performance, maybe without digitalization, it takes a little bit longer to see it than with digitalization, but it will come out in any way. So, and due to the fact that this is something also personally I know from the ethics side and the union side is you get money to make a job. And based on this, you have a target to how to do this job. And that's why you get paid for it. It's not your free time and so you have to Yes, except for my personal opinion, this is really a personal opinion, this that this job will be monitored then in private life. And this is I think, also in very interesting discussion today in society because in private life, you're much more open then at work so with Instagram with all the Twitter's and then you bring out your private life completely bad when you're when you do the job, which are you paid for and you're your boss is talking about this outcome and the content, there has to be built really big restrictions. So, this is from my point of view, a discrepancy.
44	SR	That's a good point. Um, do you measure the social sustainability?
45	I5	Not yet, really, I have to say it because we're really early stage to develop these products and bring these products to the market. But this is a really good point. And we were already talking about this all sort of customer about this, but we don't do this right now.
46	SR	Okay, do you have an idea how you would measure it?
47	I5	Let's say ideas Yes, a lot of ideas but we didn't focus yet on one idea. We are let's say we're on this stage just for information that we make it. I haven't maybe it's also interesting connection from you, I have one student who is doing his bachelor thesis about how SaaS Software as a Service can ride can be monitored, he wants to set up a methodology or looks for mythology how fast can be can be calculated that for SMEs how it is reliable. So of course, with the cost-utility-analysis you will have a basic but what impacts are in and also, he brings also these social impact in. This is maybe the first step we would go in this direction but I have to say the focus is more on the economic side to say okay, how can we internally check if the product we're selling is reliable for a customer? And of course there the impact comes in concerning the social or I had this discussion last week with him that the social impact has to be also be a part of this analysis of this methodology.

48	SR	Back to Patrick.
49	PE	Thanks. And yeah, we coming to the end and of all the topics we talked about today or even didn't consider what should we pay most attention to?
50	I5	Designing your work with AI and system social sustainability? I think to make it transparent that AI can most support us than hurts us. Because I think this is always in the news in the media. First of all, AI is shown as it can everything. No, we're in the very, very beginning. So, if Google can have a face recognition, yes, he has a face recognition but we all know in our iPhone, how often it goes wrong and everything. And of course, and this is an in the media is in the news that say hey, AI can everything. But maybe this is something where I often say: No, it doesn't go like this. When it comes to hardware AI is in a really research stage and not in a public stage. This is very, from my perspective, very important. And also, these discussions about job killer. It reminds every 15 years I had made there and it's really so with automation digital every 15 years, it comes up with job killers. I think this is also very important that like everything, which is new coming in social and industry is not killing jobs. It's changing jobs. And of course, nice old jobs are not existing today. Everybody thinks Hey, that's cool, like a basket maker for example. I don't know, this is not be done anymore. And of course, for the for the last, it's hard. But it's, I think, a kind of evolution. We are all in, like in the social, biological side. Also in the social side, is this evolution.
51	PE	Thanks for the insights. And what should we think about when we read your interview?
52	I5	When you re-do the interview?
53	PE	Yes.
54	I5	Good questions. This is a very good interview. And you made questions where I could talk for hours. I really have no clue right now what you could do in another way? Because you did it very well. I think the topic is maybe, but I'm not so deep in your research to have this. AI and sustainability. Also, the background which AI and what AI because the topic is for myself, the definition of AI is... A colleague of mine, he's told me this, the definition of AI is, is based on the time which you are using the AI. So, 10 years ago, the AI was a programming TV, for example. And I think this, what is meant as AI, because also we say yes, we make AI based calculation. And when you really look into it, yes, of course, we do have the first neural networks algorithms in it. But these are a lot of machine learnings. And when others when I see others are doing AI, I often see okay, these aren't normal

		machine learning algorithms, which is fully okay. And agreeable. But I think this is the definition of AI is sometimes always forgotten.
55	PE	Thanks. So now to the last question. Is there anything in particular, you would like to add before we finish?
56	I5	I'm curious about your research. So, when you made these finished, if it's possible, or if it's allowed to get the information that's would be very kind of you.
57	PE	We will can send you our thesis, I guess, in June or sometime. Yeah, we will send it to you.
58	I5	Cool, thank you.
59	PE	In case you forgot something or wants to add something, feel free to contact us, we will be happy to get more information, because I guess I can talk for both of us. We got a lot of rich information and knowledge about your company and the software that you produced and use. So, I just can say thanks again.
60	I5	Yeah, you're very welcome. It's always a pleasure for me to support students about this because I also know it makes such a thesis, to get the interviews to get the people up and running. It's always a really challenge and yes, it would be kind of you to get your LinkedIn or XING. Let's connect and stay in touch. It would be very interesting for me.
61	SR	We will. Thanks for your time and we will send you, our thesis. Have a nice weekend.
62	I5	Yes, you too both have a nice weekend. Take care.

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