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Ethical Issues in the Industrial Metaverse

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Abstract

The interest in the industrial metaverse is currently growing. The metaverse, a blend of physical and virtual environments, will be used in many different settings and could have a big effect on society, organisations, and work life. One potential use for the metaverse is in industrial settings. However, the ethical questions related to the industrial metaverse are under-researched, although they are important to ensure safe usage of the industrial metaverse.

This thesis aims to add to the discussion about ethics in the industrial metaverse by researching what ethical questions are related to the industrial metaverse. These questions were investigated with qualitative methods by interviewing 15 industry professionals about their views on the ethical questions in the industrial metaverse. The data was analysed with the Gioia method and grounded theory.

The results of this study show that there are many ethical questions related to the industrial metaverse, that require attention. The ethical questions were divided into three aggregate dimensions: technological challenges, the impact of the metaverse on an employee, and societal impacts. The results showed that the industrial metaverse will affect employees in many ways, such as impacting job satisfaction and safety. The informants saw that the industrial metaverse will also affect society by impacting the future labour market by meeting the needs of the future workforce and making processes more efficient.

To further add to the ethical conversation, this research underlines the ethical considerations organisations have when adopting the industrial metaverse. The considerations are from five themes: data safety, employee engagement, safety, information bias, and societal efforts.

This study has a valuable contribution both scientifically and practically. Scientifically, this research adds to the discussion about the ethics of the industrial metaverse. In addition, this study gathers the ethical impact of the industrial metaverse into one research. Practically, this study proposes guidelines on what employers should consider ethically when adopting the industrial metaverse, which can lead to positive impacts on individuals, organisations, and society.

Keywords Industrial metaverse, digital ethics, ethics, technology adoption

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Tiivistelmä

Kiinnostus teollista metaversumia kohtaan on viime aikoina ollut kasvussa. Metaversumia, eli fyysisen ja virtuaalisen todellisuuden yhdistelmää, voidaan käyttää monessa eri kontekstissa, ja sillä voi olla suuria vaikutuksia sekä yhteiskuntaan, organisaatioihin että yksilöön. Yksi konteksti metaversumin käyttöön on teollisuus. Teolliseen metaversumiin liittyviä eettisiä kysymyksiä ei kuitenkaan ole tutkittu kovin paljoa, vaikka ne ovat tärkeitä teollisen metaversumin turvallisen käytön varmistamisessa.

Tämän diplomityön tavoitteena on osallistua tieteelliseen keskusteluun teollisen metaversumin etiikasta. Tässä työssä tutkitaan, mitä eettisiä seikkoja teolliseen metaversumiin liittyy. Tätä tutkittiin laadullisin menetelmin haastattelemalla 15 ammattilaista heidän näkemyksistään teollisen metaversumin eettisistä kysymyksistä. Haastatteluista saatu aineisto analysoitiin Gioia-menetelmällä.

Tutkimuksen tulokset osoittavat, että teolliseen metaversumiin liittyy paljon eettisiä kysymyksiä. Tässä tutkimuksessa eettiset kysymykset jaettiin kolmeen kategoriaan: teknologiset haasteet, metaversumin vaikutus työntekijään, sekä yhteiskunnalliset vaikutukset. Tulokset osoittavat, että teollinen metaversumi vaikuttaa työntekijöihin monin tavoin, esimerkiksi työn mielekkyyteen sekä turvallisuuteen. Lisäksi teollinen metaversumi vaikuttaa yhteiskuntaan esimerkiksi vastaamalla tulevaisuuden työvoiman tarpeisiin.

Eettisten kysymysten tunnistamisen lisäksi tämä diplomityö pohtii mitä eettisiä kysymyksiä täytyy ottaa huomioon, kun yritykset ottavat käyttöön teollista metaversumia. Pohdintaa on viidestä eri teemasta: dataturvallisuus, työntekijöiden sitouttaminen, turvallisuus, informaatiovääristymät, sekä yhteiskunnalliset vaikutukset.

Tällä tutkimuksella on arvokkaita vaikutuksia sekä tieteellisesti että käytännössä. Tieteellisesti tämä tutkimus osallistuu keskusteluun teollisen metaversumin eettisyydestä. Tämä diplomityö kokoaa teollisen metaversumin eettisiä vaikutuksia yhteen. Käytännössä tämä tutkimus auttaa työnantajia tunnistamaan, mitä eettisiä kysymyksiä heidän täytyy pohtia teollisen metaversumin käyttöönotossa. Tällä voi olla positiivisia vaikutuksia sekä yksilöön, organisaatioihin että yhteiskuntaan.

Avainsanat Teollinen metaversumi, etiikka, digitaalinen etiikka, teknologian käyttöönotto

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Preface and Acknowledgements

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Marja Tiainen

1 Introduction

The development of novel technologies brings new ethical issues that should be considered (Moor, 2005). Technologies affect the world around us, changing the way people interact with technology and can have massive effects on society (Moor, 2005). Currently, we are in the midst of an adoption process of a new technology – the metaverse. The metaverse, a blend of virtual and physical environments, will be used in many different areas and industries. Currently, there is a growing interest in the metaverse (Kumar et al., 2023), but the ethical questions related to it are under-researched, especially in the industrial setting.

The need for ethical considerations in the metaverse scene has been discussed by researchers. Previously, Park and Kim (2022) have recognised ethics and security as one of the open challenges for the metaverse. They claim that it is necessary to build a metaverse with an ethical consciousness. Jaimini et al. (2022) recognised that there is room for improvement in the safe usage of the metaverse. De Giovanni (2023) has also argued for a sustainable and socially responsible metaverse. In his study, he discussed how the metaverse is related to a responsible digital transformation and found that the metaverse is related to all 17 Sustainable Development Goals (SDGs). De Giovanni writes that several negative side effects and negative consequences can happen if the impact of this digital technology adoption is underestimated. He emphasises the importance of making a responsible digital transformation. In their study, Ritterbusch and Teichmann (2023) recommend that the overall ethical boundaries of the metaverse should be researched more.

Although there has been some research on the ethical questions in the metaverse, these questions, for the most part, remain unexplored in the industrial metaverse domain. The industrial metaverse is becoming more common in industrial settings (Alpala et al., 2022), and to avoid possible negative consequences, it is important to study the ethical questions in the industrial metaverse. De Giovanni (2023) states that as the metaverse is still in the early stages of development and adoption, the implementation of the metaverse can still be guided in a responsible direction.

This thesis aims to add to the discussion about ethics in the metaverse, by researching the ethical questions in the industrial metaverse. In addition, this study researches what ethical issues are considered when adopting the industrial metaverse to an organisation and gives suggestions for ethical questions to consider.

1.1 Background

The term *metaverse* was first coined by Neal Stephenson in his novel "Snow Crash", which was published in 1992 (Gursoy et al., 2022). The word is a combination of the terms "meta", meaning transcending, and "verse", meaning universe (Cheng et al., 2022). Even though the interest in the metaverse has been rising, there is no definite consensus on the definition of the term metaverse (Ritterbusch & Teichmann, 2023). This is because the metaverse is still in the early developmental phase (Duan et al., 2021). According to Ritterbusch and Teichmann (2023, p. 12372) the term metaverse *"describes a three-dimensional online environment in which users represented by avatars interact with each other in virtual spaces decoupled from the real physical world."*

The interest in the metaverse has grown in recent years, and it has reached audiences both in and out of the scientific community (Ritterbusch & Teichmann, 2023). One of the reasons for this rising interest is that the metaverse brings with it new business possibilities. Currently, one of the most common uses for the metaverse is for gaming and some office applications, but there are many possibilities of how the metaverse could be used in other settings, such as education, offices, social media, marketing, and simulation (Park & Kim, 2022). One potential setting for the metaverse is in industrial settings, such as smart factories (Alpala et al., 2022).

However, new revolutionary technologies always come with ethical issues (Moor, 2005). With the metaverse, the challenges include issues with sustainability, ethics, and the limitations of technology from both the hardware and software perspectives (Park & Kim, 2022). Some of the ethical concerns in the metaverse include issues with usability, privacy concerns, and network security (Kaddoura & Al Husseiny, 2023).

1.2 Research Questions

The ethical aspects of the industrial metaverse have not been researched largely. Moor (2005) argues that new technologies can have major social impacts and that all technology, especially revolutionary technology, generates ethical problems. He argues that we need to be more proactive about the ethics of new technologies and work towards more sophisticated ethical analyses. The arguments by Moor highlight how important it is to analyse the ethics of developing and possibly revolutionary technologies, such as the metaverse.

In this thesis, the ethical issues in the industrial metaverse are studied. In addition, this study investigates what considerations organisations have when adopting the metaverse. The research questions through which these topics are studied are:

1. What ethical issues do metaverse professionals identify in the industrial metaverse?

2. What ethical considerations do organisations have when adopting the industrial metaverse?

The purpose of this study is, first of all, to bring ethics into the conversation within the industrial metaverse scene. Secondly, the aim is to identify what ethical issues are related to the industrial metaverse. Finally, this study aims to recognise what ethical considerations are present in the adoption process of the industrial metaverse. By investigating the two research questions above, this thesis aims to discover how ethics should be implemented in an industrial metaverse setting.

1.3 Scope and Limitations

This study focuses on the organisations using the metaverse in their business. This chapter explains what was scoped out of the thesis and why. Certain scopes and limitations were necessary to create a coherent study suitable for the extent of a thesis.

Firstly, this research will not focus on the developers of the metaverse, although they also have a lot of agency in creating an ethical metaverse. Developers have the power to steer the development of the metaverse in the direction they want, but for this research, the chosen angle was from the organisational perspective.

Secondly, this study is strictly from the perspective of the industrial metaverse. The metaverse is a large concept and can be used in many other settings than the industrial setting. However, the ethical questions have been discussed more in these other areas, such as the social media metaverse. This research adds to the discussion surrounding the ethics of the industrial metaverse.

Thirdly, broader discussion about the legislation surrounding the industrial metaverse is not part of this thesis. Legislative actions and standardisation can be a big part of how the metaverse is created and what its future looks like. However, due to the skillset of the author, a broader discussion of the

legislation and its effects on the industrial metaverse scene are not part of the scope of this thesis.

The setting for this study is Finland, and the research focuses on the views of Finnish metaverse professionals. Other cultures may have differing views of ethical issues and how they should be addressed.

1.4 Structure of the Thesis

The structure of the thesis is as follows: after this introduction, a state-of-the-art literature review will explain the relevant concepts to this research, such as the industrial metaverse and ethics.

In Chapter 3, the methodology used in this research is explained. This thesis is conducted as qualitative research. The method used for this research is qualitative, themed semi-structured interviews. During the research process, 15 informants from Finnish industrial companies and research institutes were interviewed. The methodology used to analyse the data was grounded theory by Gioia et al. (2013). In this method, the transcribed interviews are coded with first-order codes, which are sorted into second-order codes and finally aggregate dimensions (Gioia et al., 2013).

The findings of the research are provided in Chapters 4 and 5. Chapter 4 answers the first research question, answering what ethical issues were identified in the industrial metaverse. The second research question is addressed in Chapter 5, where ethical themes on what organisations consider when adopting the industrial metaverse are introduced.

Finally, in Chapter 6 the results are analysed in a broader context, and both the scientific and managerial implications of the results are discussed. Additionally, future research topics are proposed, and the limitations of this study are discussed. Chapter 6 also includes the conclusion. Appendices and references are provided at the end.

2 Literature Review

This chapter will summarise relevant literature regarding the metaverse, the industrial metaverse, ethics and adopting the industrial metaverse. The chapter defines the industrial metaverse and explains central technologies related to it. In addition, this chapter gives an overview of what ethical viewpoints can be used to discuss the industrial metaverse. The literature mostly includes scientific literature written in English and found through Google Scholar and other articles.

2.1 Metaverse

In this chapter, different definitions of the metaverse are discussed. At first, this chapter defines the metaverse, first from a more general perspective and following with an explanation of the industrial metaverse. This chapter also summarises how the metaverse has evolved through history. Finally, this chapter explains some of the most relevant technologies related to the industrial metaverse to give the reader a better understanding of the concept.

2.1.1 Definition

The word *metaverse* is a combination of the terms "meta", meaning transcending and "verse", meaning universe (Cheng et al., 2022). According to Cheng et al. (2022), there is no consensus on the definition of the metaverse. In their research, Ritterbusch and Teichmann (2023) performed a systematic literature review of scientific articles from 25 years between the years 1997 and 2022 and found that there were 28 definitions of the word *metaverse*. They found that the most used definition was the one by Davis et al. (2009, p. 91): *"Metaverses are immersive three-dimensional virtual worlds (VWs) in which people interact as avatars with each other and with software agents, using the metaphor of the real world but without its physical limitations."*

The most common words used to describe the metaverse are "world", "virtual" and "three-dimensional" (Ritterbusch & Teichmann, 2023). In their paper, Ritterbusch and Teichmann (2023, p.12372) established a definition that combines the findings of their research: *"Metaverse, a crossword of 'meta' (meaning transcendency) and 'universe', describes a (decentralized) three-dimensional online environment that is persistent and immersive, in which users represented by avatars can participate socially and economically with each other in a creative and collaborative manner in virtual spaces decoupled from the real physical world."* Another example of the definition

of the metaverse is by Park and Kim (2022, p. 4211): *"Metaverse is a compound word of transcendence meta and universe and refers to a three-dimensional virtual world where avatars engage in political, economic, social, and cultural activities."* Lee et al. (2021) discuss the metaverse as a virtual environment that blends the physical and the digital worlds.

Many of the definitions of the metaverse include the word *virtual world*. For example, Davis et al. (2009) argue that an instantiation of a metaverse is a virtual world, which can also be called virtual spaces or virtual world environments. According to Nevelsteen (2015), there are many descriptions and definitions for a virtual world. Dionisio et al. (2013, Chapter 1) describe virtual worlds as *"computer-generated simulations of three-dimensional objects or environments with seemingly real, direct, or physical user interaction."* For example, a virtual world can be a tool used by team members around the world to work together and interact virtually face-to-face (Davis et al., 2009).

Dionisio et al. (2013) argue that the metaverse is an integrated network of 3-dimensional virtual worlds with four central features: realism, ubiquity, interoperability, and scalability. However, Jaimini et al. (2022) argue that there are only three characteristics of the metaverse: interoperability, scalability, and accessibility. This characterisation of the metaverse is presented below in Figure 1. The common characteristics between Dionisio et al. and Jaimini et al. are interoperability and scalability. Interoperability means that virtual items and users can be easily moved between virtual environments without disrupting the immersive experience (Dionisio et al., 2013; Jaimini et al., 2022). Interoperability is mentioned as one of the key components of the metaverse in many definitions.

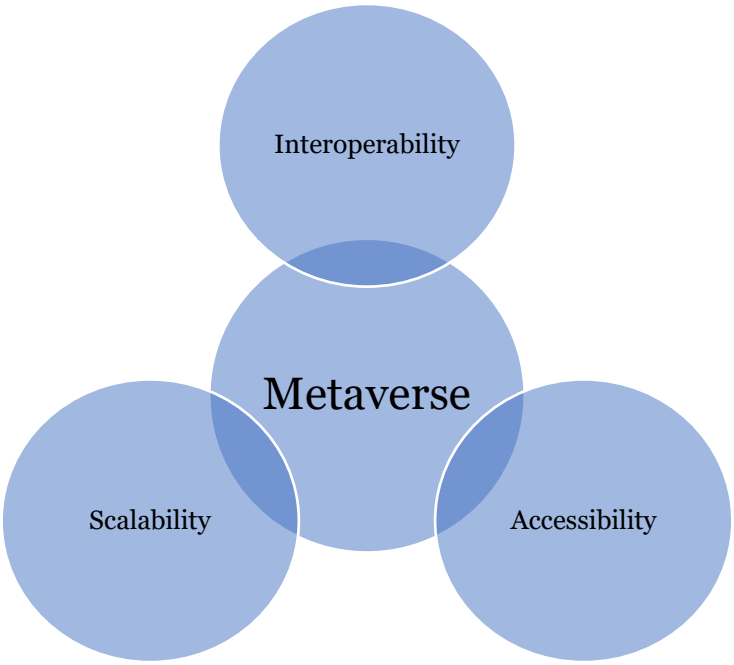

Figure 1: Characteristics of the Metaverse
Adapted from Jaimini et al. (2022).

As the focus of this research is on the industrial metaverse, the concept of the industrial metaverse is now explained.

2.1.2 The Industrial Metaverse

The metaverse can be used in different areas of business. The characteristics of the metaverses used in different areas have some differences. For example, Kshetri (2023) argues that the industrial metaverse is characterised by large data flows. Similarly to the regular metaverses, the industrial metaverse is also based on virtual spaces. However, the industrial metaverse focuses on just industrial uses, such as operating industrial processes, workshops, devices, and activities in virtual spaces (Jiang et al., 2022). Additionally, whereas in other metaverses, the definitions included avatars, avatars are not a prominent feature in the industrial metaverse. As the industrial metaverse is rapidly evolving, it does not yet have a widely recognised definition (Kshetri, 2023). The industrial metaverse can also be called the enterprise metaverse (Kumar et al., 2023).

According to Jaimini et al. (2022, p.61), the aim of the industrial metaverse is to promote "*the development of manufacturing and services for the industry*". This can include simulations, such as simulating product cycles in the metaverse, or collaborative work, such as designing products in the metaverse or working with clients. Companies are interested in using the industrial metaverse to make their work more efficient and to promote

discovery and innovation. One of the aims is to lower production costs (Jaimini et al., 2022). The industrial metaverse will promote productivity by enabling a more flexible working environment because workers do not need to be in the same place simultaneously (Jiang et al., 2022).

In addition to the development of manufacturing and services, education and training can also be an important part of the industrial metaverse. In the metaverse, it can be possible to offer training cost-effectively to simulate real-world uses (Jiang et al., 2022). Furthermore, remote training can be organised with teachers and students on the other sides of the world, but virtually in the same classroom (Jiang et al., 2022). Kaddoura and Al Husseiny (2023) highlight some of the possibilities of using the metaverse for education purposes, which can also be applied to industrial metaverse applications. For example, the metaverse can provide skill-based learning or visualised learning in new ways (Kaddoura & Al Husseiny, 2023). Here, skill-based learning refers to the way of learning where skills are practised and repeated.

As the industrial metaverse is just one application of metaverse technology, it can be defined similarly to the regular metaverse. However, certain characteristics are inherent to the industrial metaverse. The key technologies behind the industrial metaverse include digital twin technology, augmented reality (AR), virtual reality (VR) and extended reality (XR), big data, artificial intelligence (AI), and industrial cyber-physical systems (CPS) (Jiang et al., 2022). Jaimini et al. (2022) argue that there are five key facets to the industrial metaverse: the dataset, the simulation engine, artificial intelligence, hardware, and collaboration. The dataset is all the information fed into the system, and it can come from, for example, the Internet, the enterprise, or Internet of Things devices. The simulation engine is what enables real-time interaction in the industrial metaverse. Artificial intelligence in this case refers to the AI and big data technologies that enable learning, creating, and optimisation. The hardware refers to the physical interactive devices used in the metaverse, such as robots and new materials. Collaboration is an important part of the metaverse, which includes e.g., interoperability, which was previously mentioned as one of the key factors in the metaverse. The interoperability can enable using the metaverse for many different parts of the process, like design and simulation (Jaimini et al., 2022).

Although the industrial metaverse is not yet widely available, industrial giants and big technology companies have already started pioneering the use of the industrial metaverse. In 2021, Nvidia announced their plan to create a platform called Omniverse, which is a virtual collaboration and simulation platform. It can be used to simulate real-world buildings and factories, with the three main components being a database engine, an animation and rendering engine, and the streaming of XR content to client devices (Cheng et

al., 2022). In 2022, Siemens and NVIDIA announced a cooperation initiative, in which they are building an industrial metaverse combining Siemens's digital models and NVIDIA's Omniverse. BMW has made a trial version of a simulated, immersive digital version of a car factory (Jiang et al., 2022).

The industrial metaverse market is expected to reach a market value of over $100 billion, or in some predictions, over $200 billion, by 2030 (Kumar et al., 2023). Many analysts believe that the metaverse has more potential on the industrial side, rather than the consumer side because consumer metaverse platforms will have problems attracting users to their platforms (Kshetri, 2023).

In this thesis, the definition used for the industrial metaverse is one that was first presented by Thierry Klein, the president of Bell Labs Solutions Research at Nokia in the MIT Technology Review 2022: *"The industrial metaverse combines physical-digital fusion and human augmentation for industrial applications and contains digital representations of physical industrial environments, systems, assets and spaces that people can control, communicate and interact with.*" (MIT Technology Review, 2022, para. 2). This definition was chosen, because it encompasses the comprehensive nature of the metaverse, and considers the differences between the metaverse and the industrial metaverse. Many definitions limit the industrial metaverse to people working in virtual environments, but this definition allows for a broader understanding of the physical-digital interaction.

2.1.3 Evolution

As previously stated, the term *metaverse* was first coined by Neal Stephenson in his novel "Snow Crash", which was published in 1992 (Gursoy et al., 2022). However, the meaning of the term has changed, and the visions of a metaverse have started to move into reality (Ritterbusch & Teichmann, 2023).

Dionisio et al. (2013) divide the evolution of virtual worlds into five phases. They discuss that the development of virtual worlds started in the late 1970s when text-based virtual worlds started to emerge in role-playing games. The second phase in the 1980s introduced the first graphical interface. The third phase, in the 1990s, was big in terms of technological development, and in 1995 the first publicly available world with 3D graphics was published. The fourth phase included the popularisation of commercial virtual worlds, such as Second Life. Second Life was launched in 2003, and it was an immersive, 3-dimensional virtual world with avatars reflecting oneself (Berge, 2008). In 2013, the fifth development phase was ongoing, which is characterised by decentralised development (Dionisio et al., 2013).

Currently, many companies are developing metaverse platforms in different areas. According to Cheng et al. (2022), one of the most well-known companies in the metaverse industry is Meta, previously known as Facebook. Facebook changed its name to Meta in 2021 and announced its transition to a metaverse company. In addition to social media platforms, the metaverse is also used for gaming purposes, from which Fortnite by Epic Games, and Roblox are amongst the most popular (Cheng et al., 2022).

In addition to these uses of the metaverse, which are targeted to customers, the industrial metaverse is also being developed. According to Jaimini et al. (2022), the industrial metaverse is still in its initial stages and there are unsolved challenges in its development, especially concerning the interoperability of the metaverse platforms.

Although technology is unpredictable, it is the visions of the metaverse that push its development. According to Gursoy et al. (2022), the proponents of the metaverse expect the metaverse's products and services to be fully available in the next decade. There are still problems that the metaverse ecosystems need to overcome before the metaverse will be widely available. Cheng et al. (2022) identified technical requirements, such as scalability, accessibility, security, privacy, and legal issues, that need to be addressed.

2.1.4 Central Concepts of the Metaverse

As said before, the metaverse is a combination of other technologies. Jiang et al., (2022) argue, that the pillar technologies of the industrial metaverse include digital twin technology, AR, VR, XR, AI, and industrial cyber-physical systems. In this chapter, these pillar technologies are briefly explained to give a better understanding of what the industrial metaverse is. It is important to remember that the metaverse is not limited to these technologies.

Digital Twin. According to Madni et al. (2019, p. 1), "a digital twin is a dynamic virtual model of a system, process or service." Lv et al. (2022) argue that digital twins have the power to make big changes in all industries. Madni et al. claim that digital twins can enable real-time monitoring of systems and processes and that by analysing data at the right time, problems can be avoided. In addition, they explain digital twins can be used to predict the need for maintenance, upgrades, and developments. Additionally, Singh et al. (2021) describe that digital twins can be used for optimisation, safety, and remote access. Digital twins are an integral part of the industrial metaverse, as they are a link between the physical world and the virtual world. Singh et al. show that digital twins always have data flows between the physical object

and the digital objects. The data flows can be either manual or automatic, depending on the level of integration.

Digital twins can work together with artificial intelligence and machine learning to analyse and compare data (Aloqaily et al., 2022). Digital twins can come in different levels of maturity and sophistication. For example, some digital twins are virtual systems models of the physical twin, but some integrate machine learning and acquire more data from the physical twin, resulting in adaptive user interfaces and reinforcement learning (Madni et al., 2019).

Extended Reality. Extended reality (XR) is an umbrella term encompassing all of VR, AR, and MR (Andrews et al., 2019). According to Çöltekin et al. (2020), there has recently been growing interest in everything included in XR because many possible uses can be seen for XR. In addition, the technology has evolved to be more powerful and the price of XR devices has been decreasing, which further excites the scientific and industrial communities (Çöltekin et al., 2020). Next, this chapter explains what VR, AR, and MR mean.

Virtual Reality. According to Alpala et al. (2022, p. 4), *"Virtual reality (VR) is a non-real digital environment artificially designed and generated in a virtual interactive context."* The basic aspects of VR are the virtual environment, sensory feedback, interactivity, and immersion (Sekaran et al., 2021). Virtual environments are accessed through wearable devices such as VR glasses and motion controllers.

VR is an essential part of the metaverse due to its immersive nature. VR allows people to virtually interact with objects as they would in the real world. The development of the metaverse and VR technologies are closely linked to each other Alpala et al., 2022). In factory settings, VR can be used to plan factory layouts or robot paths or to help with planning, modelling, and simulating different manufacturing strategies. VR can also be used for training purposes (Sekaran et al., 2021.)

Augmented Reality. According to Van Krevelen and Poelman Ronal (2010, p. 1), *"AR supplements the real world with virtual (computer-generated) objects that appear to coexist in the same space as the real world."* In an industrial setting, this can mean a mechanic using AR to assist with assembling machines. Usually, AR includes visual displays, although haptic and aural displays also exist. There are many ways to present augmented realities. One way is to display a video feed of reality and overlay the augmentation upon that. Another way is to use transparent mirrors and lenses to create an AR overlay. AR can be used through different displays, such as

head-worn visual displays or hand-held displays (Van Krevelen & Poelman Ronald, 2010).

Mixed Reality. Mixed reality (MR) refers to a space where physical and virtual elements co-exist in a way that allows easy interaction between them. (Honig et al., 2015). The distinction between MR and AR is not always straightforward, as both are a mix of the virtual and the physical (Andrews et al., 2019). Perhaps the most distinctive difference between the two is that MR includes real-time spatial computing, where virtual and physical objects co-exist in the same space, but AR can augment physical reality by displaying information anywhere, such as in menus or heads-up displays (Çöltekin et al., 2020).

Artificial Intelligence. Artificial intelligence (AI) consists of different algorithms, and it tries to mimic intelligence in machines, that can function autonomously in environments, that they can sometimes partially observe. In many ways, AI mimics human intelligence, portraying decision-making, problem-solving, learning from the environment, and adapting (Khamis et al., 2019). AI is an important part of the metaverse. Especially using it together with other technologies, such as XR can create necessary parts of the metaverse (Huynh-The et al., 2022). In the metaverse, AI can be used in many different ways and through different types of algorithms, such as conventional AI and machine learning (ML) algorithms, but also through advanced techniques such as convolutional neural networks (Huynh-The et al., 2022). The use of AI in industrial settings can include applications such as process planning, predictive maintenance, quality control, assistance and learning systems, and process control and optimisation (Vyhmeister & Castane, 2024).

Industrial Cyber-Physical Systems. Industrial cyber-physical systems (CPS) are systems, that integrate hardware functions with cyber-representations, which are virtual representations of their physical counterparts (Leitão et al., 2016). Leitão et al. (2016) explain that CPS is not just one technology, but a combination of many. Kayan et al. (2021) view that factories using CPS are called smart factories. CPS are also used in other contexts, which is why the CPS existing in industrial domains, such as manufacturing and energy are called industrial CPS, also known as ICPS (Kayan et al., 2022).

2.2 Metaverse Ethics in the Organisational Context

In this chapter, an overview of the theory of ethics is presented. This chapter also discusses ethics from an organisational perspective and the metaverse perspective.

2.2.1 Theory of Ethics

Ethics is the study of *"morality and the application of reason which sheds light on rules and principle"* (Abdullah & Valentine, 2009, p. 93). There are many ways to view ethics, and there are many different ethical theories, such as virtue ethics theory, business ethics theory and postmodern ethics theory (Abdullah & Valentine, 2009). As this thesis studies the ethical issues of the metaverse in an organisational context, the most relevant ethical theories are digital ethics and business ethics.

According to Abdullah and Valentine (2009, p. 93), *"business ethics is a study of business activities, decisions and situations where the right and wrongs are addressed"*. They argue that businesses have power and influence over society, even more than ever before, as businesses are such an integral part of providing for society through products, services, and jobs.

Digital ethics, a branch of ethics, studies *"the normative principles for action and interaction in digital environments"* (Luke, 2018, p. 186). Digital ethics can be used to evaluate technology's effect on society and individuals (Teran et al., 2021). According to Moor (1985, p.266), computer ethics is *"the analysis of the nature and social impact of computer technology and the corresponding formulation and justification of policies for the ethical use of such technology."* Teran et al. (2021) argue that digital ethics is increasingly important since the internet and other digital services are integrating tightly into our everyday lives. New technologies, especially revolutionary technologies always come with ethical issues (Moor, 2005). Moor (2005, p. 117) proposes a law: "*As technological revolutions increase their social impact, ethical problems increase."* He argues that this is because the number of people affected by the technology increases and because the new technology will provide new use cases, where finessed ethical policies do not yet exist. The metaverse can be thought of as this kind of revolutionary technology that Moor is referring to, as it is likely to be used by and thus affect many people, and because it will be used in many ways.

2.2.2 Organisational Ethics

According to Koh and Boo (2001), ethical issues in business contexts have become more complex than before. They view that businesses face expectations from society and consider fair competition, legal issues, as well as social responsibilities. Moreover, the study by Vitell and Davis (1990) shows that the ethical actions of organisations have implications for employees, the business, and society. For example, their study showed that when professionals view their company as an ethical actor, they are more satisfied with their jobs. The importance of organisational ethics has grown due to the global

expansion of businesses. As cultures have different cultural and ethical environments, businesses have had to learn how to operate in these environments (Vitell & Hidalgo, 2006).

Lin et al. (2020) argue that organisations need to adopt a better understanding of ethical leadership when managing new technological innovations. They say that organisations need to balance both the stakeholders' wealth and organisational profitability while being ethically and socially responsible. Lin et al. state that there are several ways to conduct an ethical leadership style, such as respecting their followers, emphasising morality, and encouraging followers to innovate and put the followers' ideas into practice. Vitell and Hidalgo (2006) claim that organisational culture plays a big role in ethical decision-making.

There are a lot of benefits to ethical leadership. For stakeholders, ethical leadership is valuable, since ethical leaders build good relations with the stakeholders, and are respectful, sustainable, and responsible (Maak & Pless, 2006). Inside organisations, ethical leaders make good working environments for their workers and prioritise health, safety, and fairness. The products and services made through ethical leadership are safe, while possible risks are communicated to ensure customer safety (Lin et al., 2020). In addition, ethical leadership can foster the adoption of technological innovations, which improves firm performance (Lin et al., 2020). Vitell and Hidalgo (2006) note that exhibiting strong ethical values benefits from committed employees who prefer to work for ethical organisations.

Maak and Pless (2006) argue, that responsible leaders have commitments to many stakeholders: they ensure that employees throughout the supply chain have good working conditions, the products are safe for clients and customers, the business partners are respected, and the shareholders' investment capital is safeguarded. In addition, the social and natural environment around us is also a factor that ethical leaders consider.

2.2.3 Metaverse Ethics

Most of the research on the ethical questions in the metaverse is not from the industrial metaverse scene but from other applications of the metaverse. For example, Kaddoura and Al Husseiny (2023) discussed the ethical considerations of using metaverse in education and Bibri (2022) from a smart city's perspective. However, as there is no sufficient research on the ethics of the industrial metaverse, this chapter will use scientific literature from other fields of the metaverse. Some of these ethical issues can be applied to the industrial setting, but some can also depend on the area of use. The issues can be looked at from different perspectives. For example, one can assess the

ethical issues faced in the creation of the metaverse, which will be challenges faced by developers and designers (Fernandez & Hui, 2022). On the other hand, businesses that are part of the metaverse ecosystem also need to consider ethics in governing. This includes considering the privacy and security concerns or digital harassment and cyberbullying (Anshari et al., 2022).

The ethical aspects of individual technological components have been discussed before. For example, Mattioli et al. (2023) recognise that the concerns surrounding AI are receiving attention in industrial settings. These concerns include ethical topics such as liability, privacy, trust, and accountability. On the other hand, Honig et al., (2015) have discussed that MR technologies can improve safety and create a lower-risk experiment space for potentially dangerous interaction. Leitão et al. (2016) state that there are challenges in CPS technologies, including safety and security.

In their study, Bibri and Allam (2022) discuss the ethics of the metaverse in urban societies. The three areas that they emphasise are privacy, safety and integrity, and equity and inclusion. Overall, privacy is one of the main concerns that needs to be addressed in the metaverse (Bibri & Allam, 2022). In the metaverse, large amounts of data are collected, analysed, and classified (Bibri & Allam, 2022). This will be common within all metaverse applications. Kaddoura and Al Husseiny (2023) discuss that current privacy-enhancing mechanisms are not yet sufficient to address the problem.

One ethical implication of the metaverse is being environmentally sustainable. Kshetri (2023) argues, that the metaverse can promote sustainability because it can help lower energy consumption. In addition, De Giovanni (2023) explains that working in the metaverse can diminish CO_2 emissions since the amount of transportation needed will decrease, as workers will be able to work remotely in the metaverse. However, although the metaverse can lessen energy consumption in transport, other parts of the metaverse are heavy in energy consumption. Big data and other technologies require a lot of computing power, which requires significant amounts of energy (De Giovanni, 2023). Some social aspects of the metaverse are also discussed in the literature. For example, Kaddoura and Al Husseiny (2023) as well as Bibri and Allam (2022) discuss the physical and mental health issues of the metaverse.

Previous studies have found that the industrial metaverse can have an impact on the work life of employees. For example, Jiang et al. (2022) claim that the industrial metaverse brings benefits to the users. As discussed before from the sustainability perspective, the need for travelling will reduce. This will also impact the employee (Jiang et al., 2022). In addition, the industrial metaverse can work as a productivity tool, providing more flexibility to the work (Jiang et al., 2022).

Jiang et al. (2022) also discuss that the industrial metaverse will help with sustainable education. Metaverses can be used to educate about facilities and other subjects beforehand, which allows early recognition of weak points that need to be closely monitored. The metaverse can be used for training in conditions that could be difficult to mimic in the real world, such as the aviation industry (Jiang et al., 2022). Kaddoura and Al Husseiny (2023) discuss, that the metaverse can maximise learning when designed properly to high standards.

Table 1: Ethical issues of the metaverse in scientific literature.

Ethical issue	**Researcher**	**Context**
Privacy concerns	Anshari et al., (2022)	Metaverse business models
Privacy	Bibri and Allam (2022)	Urban societies
Security concerns	Anshari et al., (2022)	Metaverse business models
Safety and integrity	Bibri and Allam (2022)	Urban societies
MR improving safety	Honig et al., (2015)	Robotics
Safety and security of CPS	Leitão et al. (2016)	Industry
Liability and trust of AI	Mattioli et al. (2023)	Industry
Digital harassment and cyber-bullying	Anshari et al., (2022)	Metaverse business models
Promoting accessibility, diversity, and equality	Duan et al. (2021)	Infrastructure
Equity and inclusion	Bibri and Allam (2022)	Urban societies
Effect on health	Kaddoura and Al Husseiny (2023)	Education
Effect on health	Bibri and Allam (2022)	Urban societies
Benefitting employees	Jiang et al. (2022)	Industry
Learning benefits	Jiang et al. (2022)	Industry
Learning benefits	Kaddoura and Al Husseiny (2023)	Education
Environmental sustainability	Kshetri (2023)	Industry
Environmental sustainability and energy usage	De Giovanni (2023)	Industry

Although there are many ethical concerns about the metaverse, the metaverse also provides many positive ethical impacts on the real world. For example, the metaverse will promote accessibility, diversity, and equality (Duan et al., 2021). The ethical issues are not black and white but are complex matters and include trade-offs (De Giovanni, 2023). Ethical issues mentioned in the scientific literature are summarised in Table 1 above.

2.3 Adoption of the Metaverse

In this thesis, the processes and actions performed by the company to implement the metaverse into the everyday are referred to as adopting the metaverse. According to De Giovanni (2023), the metaverse is related to all 17 SDGs. For example, SDG number 7, affordable and clean energy, can be addressed by minimising the amount of energy consumed when using the metaverse, and SDG number 8, decent work and economic growth can be promoted through the metaverse. Therefore, companies should consider the effects of the metaverse when adopting it to their organisation. De Giovanni (2021) states that companies should make interdisciplinary evaluations incorporating economic, operational, and environmental aspects when they adopt new technologies.

In addition, the metaverse, like any new revolutionary technology, will have a great impact on organisations. Kumar et al. (2023) noticed, that the organisations intending to use the metaverse are likely to be agile and have good firm performance. It is also positively linked with innovation and adaptability, which are also parts of organisational agility. According to Kumar et al., there is a literature gap in the research on adopting the metaverse and how it affects the performance and agility of firms.

Adopting a new technology as part of everyday work can be challenging for organisations. Kumar et al. (2023) have multiple suggestions on how organisations should account for the adoption process of the industrial metaverse. For example, Kumar et al. suggest that companies should use small-scale pilot projects to better understand the use of the metaverse. In addition, they recommend that organisations allocate enough resources for building the required technological infrastructure. They also suggest that organisations should identify and encourage early adopters of the metaverse technology to socially influence other workers to use the new technology. Kumar et al. emphasise the importance of innovation by saying that organisations should promote a culture of innovation. An important part of this is that top management actively supports the innovation culture by participating in initiatives and allocating enough resources and budgets to it. Kumar et al. found

that those organisations with strong innovation cultures are likelier to adopt the industrial metaverse than others.

The metaverse will influence the working practices of an organisation. It can promote the efficiency and effectiveness of collaboration in teams (Kshetri, 2023). Additionally, in some cases, the metaverse will replace some workers with technology (Kshetri, 2023).

If the possible impacts of adopting the metaverse are underestimated and the digital transformation process is not done responsibly, several negative consequences can happen (De Giovanni, 2023). De Giovanni (2023, p.2) argues that *"the metaverse will consist of a disruptive technology wave"*, and thus requires good implementation and adoption of the metaverse, as well as fruitful management, for it to be responsible digitalisation. Responsible digitalisation can be defined as a company's ability to *"achieve corporate social responsibility (CSR) goals by adopting digital technologies"* (De Giovanni, 2023, p.3).

The successful implementation of adopting the metaverse is dependent on good change management and stakeholder alignment. In this context, stakeholders include different levels of the organisation, such as the administrators, employees, and project managers (Waqar et al., 2023). These stakeholders need to be aligned with the change because successful change requires all levels of employees to change (Luo et al., 2006). If everyone is not aligned with the change it may cause problems, such as some employees refusing to participate in the change (Luo et al., 2006).

It should be noted that although the metaverse is being developed around the world, the adoption process of the metaverse will differ regionally due to cultural differences, economic situations, and differing regulations (Waqar et al., 2023).

3 Methodology

This section will explain the methodological approach of this study, including the research approach, data collection, and analysis.

3.1 Research Approach

The goal of this thesis is to find out what ethical issues are related to the industrial metaverse and what ethical issues organisations as employers consider when adopting metaverse technologies to their business. As stated in section 1.2, the research questions are:

1. What ethical issues do metaverse professionals identify in the industrial metaverse?

2. What ethical considerations do organisations have when adopting the industrial metaverse?

For this research, a qualitative approach has been chosen, since this research studies metaverse as a phenomenon. In addition, since the industrial metaverse is a new phenomenon, a qualitative approach is best suited to study it.

As the adoption of the industrial metaverse is in its early stages, it is suitable to research it with grounded theory, as it does not limit the research to existing theories, but new theories can arise from it. The Gioia method is designed to generate inductive concepts (Gehman et al., 2018).

The Gioia method (2013) in enhancing grounded theory has four main features:

1. Research design

   In this stage, the research questions are framed, and the researcher initially overviews relevant existing literature.

2. Data collection

   Here, the data is collected from informants, who are knowledgeable agents. The interviews are designed to be flexible, and they should be changed to include questions that arise from previous interviews.

3. Data analysis

   The data collection and data analysis steps may overlap, as the collected data from the first interview should be analysed so that it can affect the design of the following interviews. In this stage, the data is initially coded. First, the data is grouped into first-order codes, which are informant-centric. This means that the words of the informant are used in the coding process. At this point, the number of codes may be large.

   After the first-order codes have been made into a compendium, they are organised into second-order codes. Whereas the first-order codes were informant-centric, the second-order codes are theory-centric.

   The final key feature of the data analysis step is combining the second-order codes into theoretical dimensions. These themes, dimensions and terms are assembled into a data structure, which is the base for the grounded theory.

4. Grounded theory articulation

   In this final step, the data structure is formulated into a more dynamic grounded theory model. The second-order concepts in the data structures are examined to find relationships between them. Existing literature is again consulted to refine the concepts and relationships that have emerged during the process. (Gioia et al., 2013.)

Next, this chapter will explain further how the data for this study was collected and analysed.

3.2 Data Collection

This research was implemented through semi-structured one-on-one thematic interviews.

3.2.1 Informants

In this study 15 interviews were conducted, each with one informant. The informants were all Finnish metaverse professionals working in Finland. In this context, a metaverse professional is someone whose work is related to the industrial metaverse. For example, a metaverse professional could be someone researching the industrial metaverse, or someone in an industrial company exploring how their business could utilise the industrial metaverse.

All the informants worked with the metaverse within their organisation. These informants were chosen for this interview to understand how Finnish industry professionals view the ethical issues in the industrial metaverse. In addition, they had current knowledge about how much their organisations had solutions from the industrial metaverse in use and what feedback the field workers using different metaverse technologies had given.

The informants were found through multiple different routes. Firstly, some informants were found through LinkedIn, a business-focused social media platform. In addition, the informants also suggested other possible people to interview. Additionally, the advisors for this thesis suggested some interviewees.

In LinkedIn, the informants were found through the search function, using search terms such as *"industrial metaverse", "metaverse",* and the Finnish translation for those terms. The results were sorted geographically to only include people working in Finland. From these results, suitable people were contacted either through email, or LinkedIn chat, if an email address was not available.

Because the industrial metaverse is not in wide use in Finnish organisations, finding suitable metaverse professionals was challenging. Overall, 28 metaverse professionals were contacted and asked for an interview. Of these people, 15 agreed to an interview. The other people either didn't think they were suitable informants, did not answer, or a suitable time for the interview was not found.

Twelve of the fifteen informants were professionals working in Finnish industrial companies, and three of the informants were from Finnish research centres. Some of the informants were from the same companies, but from different departments. Before the interviews, the informants were given information on how their data is processed and how data security and privacy were taken into consideration during the research process. The informants were informed, that they would stay anonymous, and that the interviews will be recorded and transcribed.

Below, Table 2 describes each informant, giving each informant a number used later to identify them. The table provides information about the informants' workplaces and a description of them. This information has been changed into a more general form to protect the privacy of the informants.

Table 2: Informant numbers and descriptions.

Informant number	Description	Workplace
1	Researcher	Research institute
2	Researcher	Research institute
3	Specialist	Large industry company
4	Senior Advisor	Large industry company
5	Director	Government agency
6	Director	Technology company
7	Director	Large industry company
8	Manager	Large industry company
9	Manager	Large industry company
10	Specialist	Large industry company
11	Researcher	Large industry company
12	Specialist	Large industry company
13	Consultant	Consulting company
14	Researcher	Research institute
15	Manager	Large technology company

3.2.2 Semi-Structured Interviews

Before the interviews, the informants were told that no preparation for the interviews was needed. The interviews were conducted remotely using Microsoft Teams as a platform. In terms of time, the interviews lasted from 40 minutes to 87 minutes. On average, the interviews lasted for 54 minutes.

The interviews were performed as thematic semi-structured one-on-one interviews. The themes and initial questions for the interviews were planned beforehand to ensure that necessary themes were covered during the interviews. The questions were designed to be open-ended questions to allow the informants to be able to discuss topics more freely. In addition, the interviews were designed to leave room for additional questions and clarifications.

The interviews started with a brief introduction to this study and the interviewer. Next, the informants were asked some background questions about their work background and their relationship to the metaverse. The two main

themes of the interviews were the ethics of the industrial metaverse and the industrial metaverse and organisations.

During the interview process, the interview data was initially coded. In this initial coding, certain themes emerged, and the interview questions were adjusted. Appendix A displays the final version of the interview guide. In addition to the interview questions displayed in the appendix, the informants were asked to elaborate and further questions were asked based on their answers. The interviewer aimed to be as neutral as possible during the interviews to not affect the answers given by the informants.

3.3 Analysis

The interviews were recorded with the Microsoft Teams software. Initial transcripts were made with the Microsoft Teams transcribing tool and they were checked and corrected by the researcher. These transcripts were then used for the analysis.

The data was analysed using the atlas.ti software. The data was initially coded during the interview process. The initial coding used both line-by-line coding and *in vivo* coding. During the initial coding, already coded transcripts were visited again as themes from other interviews became visible. When all of the interviews had been conducted, the data was further analysed using focused coding. The interviews were first gone through, coding the informants' sentences more selectively and conceptually than in the initial coding. After completing the focused coding, the data set hat 287 codes, including codes such as *"gathering audio data requires permission from the employees", "seeking better safety",* and *"physically straining processes can be replaced by digital ones."*

Next, the focused codes were sorted into second-order codes using theoretical coding. In this phase, second-order codes such as *"impact on job satisfaction"* and "*the role of artificial intelligence in decision-making"* were formed.

Finally, the second-order codes were formed into aggregate dimensions. In this study, there are three aggregate dimensions: technological challenges, the impact of the metaverse on an employee, and societal impacts. Below, Table 3 presents the data structure formed through this process, including first-order codes, second-order codes, and the aggregate dimensions. This table provides the basis for the results, which are discussed in the next chapter.

Table 3: First and second-order codes and aggregate dimensions formed through the Gioia (2013) method.

Aggregate dimension	**Second-order code**	**First-order code**
Technological challenges	Challenges in data security	Collection of biometric data
		Employee privacy issues
		Data collection from workers will increase
		Possibility of misuse of data
	The role of artificial intelligence in decision-making	Artificial intelligence involved in the decision-making process
		Can the information produced by AI be trusted?
The impact of the metaverse on employees	Improved safety	Technology can detect security risks
		Better access to information on the right policies
		Devices can be used to replace people in dangerous environments
	New safety risks	Using equipment in an industrial environment can be dangerous
		New safety risks have not been sufficiently researched
		Who is responsible if something goes wrong?
	Comfort of use of equipment	Unpleasant use of equipment
		Using equipment makes you feel sick
		Nausea is worse for women
	Impact on job satisfaction	Eliminating boring tasks from the job
		Work will become more varied
		Work will become more flexible
		Remote work will increase and expand
	Negative effects on work	Workload increases as technology removes an easy part of the job
		Fear of losing your job
Societal impacts	Impact on the future labour market	A solution to the labour shortage
		Meeting the needs of the future workforce
		Shorter training is enough to achieve the necessary skills
		Technology replaces part of the workforce
	Reducing carbon dioxide emissions	Reduced travel
		Logistics becomes more efficient

4 Results

This research aimed to find out what ethical issues are in the industrial metaverse, and how they could be taken into consideration when adopting the metaverse into the everyday of a company. This chapter focuses on answering research question 1, which was:

1. What ethical issues do metaverse professionals identify in the industrial metaverse?

The results presented in this chapter will follow the data structure presented in Table 3 above, first addressing the technological challenges, then the metaverse's effect on employees, and finally ending with the societal challenges. Since all the interviews were held in Finnish, the quotes used in this thesis have been translated into English. In addition, the quotes have been edited for readability and to protect the privacy of the informants. The original essence of the quotes has been kept as close to possible as the original quote stated in the interviews.

4.1 Technological Challenges

The aggregate dimension of technological challenges is formed from the second-order codes *challenges in data security* and *the role of artificial intelligence in decision-making*. This chapter explains the first-order codes behind these second-order codes and gives examples of what the informants said during the interviews.

4.1.1 Challenges in Data Security

One of the most common ethical questions that informants mentioned was the challenges in data security and privacy. Informants said that the data collected about employees will increase and that the data collected will also become more sensitive. For example, VR and AR glasses can read eye movements and activity, and certain tracking systems in factories will gather real-time data on the location of employees.

"People would be tracked more and more, and perhaps data will be collected of humans, so then of course you have to take into account GDPR issues."
- *Informant 14, researcher*

The informants said that although the biometric data can be used for good, the biometric data is still sensitive and should be ethically considered.

Informants also identified positive ethical impacts of using data. The gathered biometric data can be used to warn the employee when there are signals for increased safety risks.

"Employees will be measured to see how they are breathing, or eye movements, or things like that, whether they are terribly stressed, with the aim of ensuring that they don't cause any harm to others with their actions or things like that. If they are driving a car so that they do not drive a car accident."

- *Informant 2, researcher*

Some informants were worried about data safety. Some informants said that the employee should be able to permit the data gathering, and there should be openness from the employer regarding what data is collected and why, and how it is stored. The informants said that only necessary information should be collected. One informant said that in their company, they already have the capability to track the exact location of workers in their factory, but they do not want to use it, to protect the privacy of their employees. Multiple informants were worried about increased and detailed tracking of employees. The informants didn't want the tracking data to be used for evaluating the employees, but to increase safety and to better performance. The informants identified that there is a possibility of misuse of data and manipulation when gathering data.

"So, there you have it, basically, a dangerous manipulative recipe ready to go. Huge amounts of data collected of private data."

- *Informant 15, manager*

Overall, the informants agreed that the industrial metaverse has challenges in ensuring safe data gathering, storage, and usage.

4.1.2 The Role of Artificial Intelligence in Decision-Making

Artificial intelligence was mentioned in nearly all of the interviews. Many informants saw AI as an essential part of the industrial metaverse. For example, informant 15 said *"The metaverse and AI will develop hand in hand. We won't get the full potential out of the metaverse unless it is closely coupled with AI."* The informants identified that there are many ethical considerations related to the use of AI. For example, informant 2 stated that there are many ethical issues involved in the use of AI and that that is an integral part of the metaverse debate. AI was seen as a broad topic that included ethical questions such as what uses AI is used for, where it gets its information and how it decides its output.

Most of the ethical questions related to AI were about the role of AI in decision-making. The informants described situations, where AI is used as part of the working process and decision-making. For example, workers could use AI to guide them in putting together and constructing heavy machinery, or AI could be used to identify issues or possible risks in machinery. The informants emphasised that there are many possible uses for AI in industrial settings, which adds to the complexity of the subject.

"Who makes the decision and on what basis is, in my opinion, the essential question here. AI gathers information from a certain amount of sensor data and whatever is available of processes, people, and the environment. It brings decision proposals to people, and then a human is likely to make the final decision. So, on what basis does that person make that decision? How has the AI given those decision options? How correct are they?"

- *Informant 2, researcher*

Many informants commented on being able to trust the data on which the AI makes decisions.

However, not all the effects of the use of AI were seen as questionable or negative. The informants agreed that the use of AI will make better information available to workers and that it can allow workers to make better decisions. The informants described situations in which the AI has considerably more information than a worker can have and therefore could be used to help the worker.

"The advantage clearly is that the information and guidance is more available."

- *Informant 11, researcher*

"If we are talking about factory work, for example assembling a particular piece of equipment, then one advantage is that the employee has the right information available. He is given the right information at the right time in the right place, reasonable and easy instructions on what to do."

- *Informant 10, specialist*

The informants saw that although there are ethical questions related to AI, it can also make work easier, safer, and more efficient.

4.2 The Impact of the Metaverse on an Employee

The second aggregate dimension is *the impact of the metaverse on an employee,* which consists of the second-order codes *improved safety, new*

safety risks, comfort of use of equipment, impact on job satisfaction, and *negative effects on work.*

4.2.1 Improved Safety

Improved safety was seen as one of the most important benefits of the industrial metaverse. The informants identified many aspects of the industrial metaverse that will increase safety once it is in use. Increasing safety was also one of the benefits that companies are looking for in the industrial metaverse. Some informants saw that some industrial metaverse applications could save lives.

"There are definite safety benefits, especially related to the safety of employees."
- *Informant 3, specialist*

One way that the industrial metaverse will improve safety is that technology can detect safety risks better than humans can. Informants explained that technology can, for example, detect certain dangerous gases that humans cannot detect, and give warnings. In addition, technology can detect security risks in places that humans are not able to access. One informant gave an example, where the metaverse can improve safety by identifying that two machines or robots in a factory are on a course to collide, and they can be stopped.

"Technology can be used to automatically detect security risks."
- *Informant 14, researcher*

Safety can also be improved by technology by adding warnings and making them more noticeable. One informant described an example, where employees are wearing VR or AR glasses. When a warning comes on, the glasses can detect eye movements and can measure whether employees actually read the warning signs, or if they dismiss it.

Another way that informants saw that the industrial metaverse will increase safety was by giving workers better access to information and guidance. One informant explained that experienced senior workers might be too ashamed to ask questions about processes that they should know and giving them information through VR or AR glasses may give them more confidence that they are doing their work correctly and safely. Overall, the informants agreed that the metaverse will improve workers' access to information, which will allow them to do their job correctly and safely. However, as discussed in Chapter 4.1.2, informants also saw risks in AI being part of the decision-making process.

"Accessibility to different kinds of information for people has improved significantly and will improve significantly."

- *Informant 3, specialist*

Another way in which the metaverse can improve safety is by outsourcing dangerous jobs to machines and robots. Some informants used the words *down, dirty, dangerous* to describe what kinds of jobs could be outsourced to robots to improve the safety of workers. The informants explained, that the industrial metaverse could be used in safety-critical settings, such as in nuclear power plants or high up.

"When cameras can do real-time, we can reduce sending people to dangerous environments. There are concrete safety benefits of using extended reality.

- *Informant 8, manager*

Improving safety was seen as one positive ethical impact of the industrial metaverse. The informants viewed increasing safety as one reason for organizations to adopt the industrial metaverse. There are many possible ways that the safety could improve.

4.2.2 New Safety Risks

Although informants saw many possibilities in increasing safety, as discussed in Chapter 4.2.1., the informants also identified risks in safety. One of the possible safety risks was that the equipment, such as VR or AR glasses, or moving robots in factories, might cause trip hazards, because of the cables used in the glasses and the limited vision. In addition, wearable devices might limit the field of vision or affect the workers' other senses, thus making them more susceptible to accidents. One informant predicted that in the future there will be regulations that limit the use of headsets during safety-critical work tasks.

"If you're wearing AR or VR glasses, you're just at risk of tripping."

- *Informant 14, researcher*

"They have some safety issues. We can't deceive the field of vision if we have safety-critical work tasks. There are many concerns at the moment which prevent us from offering these kinds of products, but then again this is probably the right time to be active in research."

- *Informant 12, specialist*

The informants also saw that possible new safety risks have not been researched sufficiently. The informants said that the effect on safety should be

researched before adopting the industrial metaverse into the everyday so that no new safety risks are created.

The metaverse creates new dimensions to responsibility questions. As work becomes more complex and is divided for multiple workers and technology, it can be difficult to determine who is responsible for mistakes made. Multiple informants described a situation where two people were working on a work task together. One person was at the location and manually putting things together. The other person, the professional, was elsewhere and was instructing the worker through metaverse technology. The informants described that currently there are no answers to the responsibility questions if something goes wrong. In addition, the use of AI might add to the complexity of these situations.

"Of course, the question is, when the job is done, who is responsible, the guy here or the one who advises remotely from elsewhere?"

- *Informant 1, researcher*

In addition to these safety risks, one of the biggest new safety risks was data safety, which was discussed in chapter 4.1.1, challenges in data security.

4.2.3 Comfort of Use of Equipment

The informants claimed that one of the biggest hurdles in adopting the metaverse is that wearable devices are currently not comfortable enough for regular use. In this instance, wearable devices mean mostly VR and AR glasses.

Informants had experiences of the devices being too clumsy and uncomfortable, resulting in workers not wanting to use them. Currently, the glasses are big and heavy and not easy to use. Some informants reported that the use of the glasses may result in muscle pain. One worry related to the use of the glasses was hygiene. If everyone does not have their own pair of glasses, there can be questions about the hygiene of the glasses. One informant knew about a situation, where employees have refused to use VR glasses because of the worry of hygiene.

"The comfort of use of these smart glasses has been clumsy, so the ergonomics and other comfort of use has perhaps been a bit of a challenge."

- *Informant 3, specialist*

"And then there are all kinds of hygiene issues. We can't get 250 production workers their own equipment, and that would result in some feedback."

- *Informant 9, manager*

The biggest problem that the informants saw with the use of equipment is that they cause nausea. This phenomenon is sometimes known as cyber sickness or VR sickness. Almost all informants stated cyber sickness as one ethical problem related to the industrial metaverse. In addition, some informants said that the use of equipment can affect neurological issues and cause migraines.

"Some people get nausea and VR sickness."
- *Informant 4, senior advisor*

"Currently they can't be used for 8 hours, even after a few hours people say that they get a bit dizzy, or their neck starts to hurt."
- *Informant 11, researcher*

According to the informants, one problem with the VR sickness is that it is worse for women.

"VR nausea is a real phenomenon, and it is somewhat gendered."
- *Informant 4, senior advisor*

Overall, the informants saw that wearable devices are not comfortable to use for long periods of time, and can cause problems such as muscle pain, sickness, or nausea to employees. They agreed that the hardware requires development before they are used for long periods of time at work.

4.2.4 Impact on Job Satisfaction

Almost all informants identified metaverse effects on job satisfaction when asked about it. Effects that were mentioned included eliminating boring and unpleasant tasks from the job, making the work more varied and more flexible, making remote work more common and available to different groups of workers, and making work less physically straining and less dangerous. However, the informants emphasised that all the effects will not become reality at once and not in every situation. Some of the effects are currently hypothetical since the metaverse is not in full use and it is difficult to know what the metaverse will be like in the future.

"It will create more interesting professions, more productive work, general well-being, and well-being at work."
- *Informant 1, researcher*

The informants predicted that the metaverse will enable remote work for more people, as VR glasses will enable working remotely. The informants explained that currently, only knowledge workers can work remotely, but

through the industrial metaverse, factory workers could also be able to remote work. Some informants said that this will have a big effect on job satisfaction. The informants said that even if working from home is not becoming a reality for a while, remote working abilities will improve job satisfaction, as working trips away from home will decrease.

"I would see that the benefits come from, for example, from the remote possibility that a person can remotely from anywhere in the world interact with others."

- *Informant 14, researcher*

"In the future, factory workers could work from home."

- *Informant 1, researcher*

The informants believe that work will become more varied and flexible, and that will raise job satisfaction. Flexibility will come from being able to work from different places and automating different processes. It was seen that the work will become more interesting and varied, as people will be able to complete more differing tasks due to metaverse technologies helping them.

Metaverse technologies will automate some tasks that are currently seen as boring. One informant described a situation, where currently workers don't want to spend their time filling out reports, and in the future, those reports could be filled automatically using metaverse technology. This would free up time for more interesting and meaningful tasks. In addition, metaverse technologies could make tasks easier by assisting with decision-making or providing guidance.

"*Working time could be freed up for more important tasks for the worker."*

- *Informant 10, specialist*

Overall, it was seen that the metaverse will have positive effects on an individual's job satisfaction. This is due to the metaverse being able to eliminate boring work tasks and allow time for more interesting jobs and more flexibility.

4.2.5 Negative Effects on Work

Although the informants identified many positive effects on work and job satisfaction the informants also saw that the industrial metaverse also has negative effects on work. One problem that emerged during the interviews was that although metaverse technology can eliminate dull and uninteresting tasks from the job, the workload will probably not decrease, but the new time will be replaced with other work tasks.

In addition, the informants predicted that the workload will increase due to the amount of information that is available or presented to an employee. Some informants referred to this as an information overload. The employees also must learn new technologies so that they can use metaverse applications. Informants said that the load is increased also by the work being more varied and including many different types of work, that the employee needs to know how to do.

The informants also said, that as the metaverse is put into use, employees may be worried about losing their jobs. The metaverse technologies may replace humans in some situations, but the informants also said that it is more probable that the work will change rather than stop. However, many informants said that it is important to listen to feedback from employees and keep a human-centred attitude when adopting the industrial metaverse.

"I think that the employees will understand that these technological advancements are done not because we want to reduce the number of people, but because we want to be able to offer them more meaningful tasks and so on."

- *Informant 9, manager*

Some informants saw that the industrial metaverse will negatively affect the social side of work. They discussed, that if work and collaboration start being more virtual, the social aspect of working together will not feel the same or fulfil employees' social needs.

"I think that people still need that human contact. Putting on a wearable device does not satisfy most people's social needs. If we all isolate ourselves to our own homes for a week and just put the VR glasses on to join meetings, I think it's pretty badly suited to most of us."

- *Informant 11, researcher*

These results show that there are many possible negative impacts that the industrial metaverse can have on employees, such as negatively affecting the social aspect of work or increasing the workload. Additionally, employees may be worried about losing their jobs as the metaverse and technology might be able to replace them.

4.3 Societal Impacts

The third and final aggregate dimension, societal impacts, consists of the second-order codes *impact on the future labour market* and *reducing carbon*

dioxide emissions. The informants were able to identify societal impacts, but they said that there is a significant amount of uncertainty related to these impacts and that it is difficult to know how the industrial metaverse will affect society. The effects of these aggregate dimensions also depend on how the metaverse will develop and how much it will be in use.

4.3.1 Impact on the Future Labor Market

Many of the informants said that the industrial metaverse will affect the future labour market. The informants described that currently there is an increase in worker shortages in the market. One example was that no teenager dreams of being an escalator maintenance technician and that in the future there will be a shortage of workers if no action is taken. In addition, the informants identified that the future workforce has different wants and desires from their work than the current workforce. The informants saw that the industrial metaverse will make the situation better in many ways. Firstly, the industrial metaverse will allow less skilled workers to complete more complex tasks than before. This will allow education and training to be shorter. The reason for this phenomenon is that through the metaverse it will be easier to get assistance or instructions through either AI assistance or a remote connection to a professional elsewhere. These can be implemented through AR or VR glasses, for example.

"In these professions, the companies are competing for employees. They want to improve the employee experience, and this is one way to do it."

- *Informant 1, researcher*

Secondly, the industrial metaverse will make these professions more attractive to possible workers. As discussed in Chapter 4.2.4, the industrial metaverse will have a positive impact on job satisfaction, and as discussed in Chapter 4.2.1, the industrial metaverse will increase the safety of workers. These factors combined will make professions in the field more attractive to the future workforce. In addition, informants said that the use of equipment such as VR or AR glasses at work is also seen as a positive factor when choosing a workplace. However, the informants identified that as VR and AR technology becomes more common in workplaces, their charm of novelty will wear off. Despite these issues, the informants identified that each worker is different and has different expectations of work.

"As an exaggerated example, companies would be able to sell the idea that as a technician you can be a superman with all of these different technologies, AI, and all of the world's help in your hands and that it doesn't necessarily require extensive basic training."

- *Informant 4, senior advisor*

Finally, as the industrial metaverse will enable more efficient work, fewer workers may be needed. The informants also thought about other impacts on the labour market. One informant said that as remote work among factory workers increases, it could change the way that the whole job market works. The informant said that one possibility is that workers are not so tightly tied to one employer, but could offer their expertise through platforms, thus increasing the platform economy in this field. This would also change the role of trade unions. These changes would have a big impact on society.

4.3.2 Reducing Carbon Emissions

The informants also identified positive environmental impacts in the industrial metaverse. The informants said that travelling will decrease as remote support and other remote possibilities become more common through the metaverse. The informants described situations where experts could assist more junior workers through technology so that they do not have to go on a work trip to the other side of the world. This will reduce carbon dioxide emissions caused by travelling.

"In a way, this helps to reduce the need for travel."
- *Informant 8, manager*

"It can be seen as a driver of sustainable development from many perspectives, that is, to promote carbon neutrality through the reduced movement of people and goods."
- *Informant 5, director*

In addition to the reduced movement of people, the movement of goods will reduce. The informants saw that the metaverse will make logistics more efficient, thus reducing carbon emissions.

4.3.3 Other Societal Impacts

In addition to the effect on the future labour market and reducing carbon emissions, the informants were able to name other societal impacts as well. The informants agreed that the metaverse will bring new business possibilities to companies. Many companies are seeking to grow their business and are seeking financial profit. It was seen that the success of companies is also beneficial to the welfare society.

"But, of course, the movement of people is reduced, so then the processes are more efficient and thus produce a return on value. As the companies' return on value increases, the welfare society is maintained."
- *Informant 5, director*

One ethical question related to the industrial metaverse was that as remote working to factories becomes possible, will it result in outsourcing the labour to countries with worse working conditions or even exploitation? However, the informants were not too worried about this scenario. Some informants said, that as work to other countries will be possible, it could be a competitive advantage to Finnish companies, and a way to get foreigners to work in Finnish companies.

"Does it mean that Finnish buses are controlled from abroad? Who is being controlled? Well, maybe it's a certain kind of threat."

- *Informant 1, researcher*

Overall, the informants agreed that the industrial metaverse will have an impact on society as the availability of the industrial metaverse increases.

5 Ethical Considerations when Adopting the Metaverse

This chapter aims to answer research question 2, which is:

> What ethical considerations do organisations have when adopting the industrial metaverse?

The results presented in this chapter are a combination of data collected from the interviews and from existing literature. The chapter introduces five themes that organisations consider when adopting the industrial metaverse: *Handling data, employee engagement, safety, information bias,* and *societal efforts*. These themes were derived from the ethical issues identified and discussed in Chapter 4. Finally, this chapter presents a summary of all the findings of Chapters 4 and 5 in Figure 2.

5.1 Handling Data

As seen in Chapter 4.1.1, data security was identified as an ethical issue in the industrial metaverse. All the informants identified some questions related to gathering, storing, or using data. The informants suggested that when creating an ethical metaverse at the workplace, organisations will have to consider data handling. While many aspects of data security are controlled by laws and regulations, organisations need to be aware of their data usage and comply with the regulations. This is supported by many researchers. For instance, Kumar et al. (2023) argued that as the metaverse creates large amounts of data, organisations must have effective data management practices.

In the interviews, the informants emphasised that employers must be open and transparent to the employees about what information they collect and why, how the data is stored and what it is used for.

"The employer should openly and clearly explain why it collects this kind of information, and if it measures the employee, and why it is measured and what it is used for, and then give that information to the employees, so that they can see for themselves how they are measured and why. It must be very open and transparent, and in my opinion, it is the employer's obligation."

- *Informant 2, researcher*

Metaverse technologies can be used to collect significant amounts of data from factories and employees, but the main part of using it correctly is to not use it with malicious intent towards the employees. The informants described

that technologies could be used to detect the exact location of employees in the factory or to see how many breaks employees take. The data should not be used for micromanaging and punishing employees individually, but rather to increase safety and efficiency without invading the privacy of the employees. The literature supports this finding since previous literature has identified the huge amounts of data as one of the challenges in the industrial metaverse. For instance, Bibri and Allam (2022) recognised that the metaverse allows for surveillance, and De Giovanni (2023) also commented on the data processing issues related to the metaverse.

Overall, both the informants and previous literature suggest that companies should make sure that the data collected through the metaverse technologies is stored properly without the possibility of data breaches. Data safety is identified as a challenge in the industrial metaverse, and organisations have to take action to promote the safe usage and storage of data.

5.2 Employee Engagement

The informants emphasised how important it was to engage employees in the adoption process of the industrial metaverse. Many of the informants said that companies will not be able to adopt the industrial metaverse if the employees are not willing to use it, and if the employees do not have any power over their work.

"It's the engagement of employees that is perhaps the biggest challenge. How to get employees to be willing to, not forced to use these new solutions, and how to get them to understand that this will help them? How can we make their work more meaningful and communicate that to the employees? It is a really big challenge."

- *Informant 2, researcher*

The informants agreed that the use of metaverse technology should not be forced upon the employees and that it should be voluntary. However, employees should also benefit from using metaverse technology in their work to encourage them to use the technologies. Possible benefits include safer work, eliminating dull tasks or adding flexibility, as discussed in Chapters 4.2.1 and 4.2.4. Getting the employees to understand the benefits requires good communication and change management from the employer.

Motivating the employees goes hand in hand with the other topics, such as ensuring safety and data security.

"It should be from the person's own motivation. They should get a feeling that this makes their work more effective, and they get benefits from it. They should also feel safe in that the company does not collect information about me, or if it does, it anonymises it so that I cannot be identified."

- *Informant 11, researcher*

The data from the interviews suggests that employees should also be supported during the change. The industrial metaverse can bring many changes to the employee: the work will include new technologies, travelling to different places will decrease and remote work will increase, for example. In addition, these changes can affect the company structure and strategy. These changes require attention from the employer. These findings support the research by Gaimon (2008) who discussed the link between new technologies and organisational structures. She argues that technical developments aren't powerful enough by themselves, but that the workforce should be considered. Gaimon argues that the employees are an important part of the process, because, after all, they will be the ones implementing and using new technologies.

Some informants said that the industrial metaverse will challenge the professional identity of employees. The metaverse may take away parts of the job that result in pride and a sense of accomplishment for the employee. Employees may be worried that their work becomes dull, or that they lose their jobs. In addition, work may become more loading as easy tasks are outsourced to robots and machines. Companies should create a metaverse which is beneficial for the employees and take care of the employees' needs. Many informants talked about a human-centric perspective on the metaverse. The informants emphasised that employees should be part of the metaverse process from the beginning, so that they are heard, and their needs are met.

"In a certain way, people are deprived of their professional identity and a feeling that they know how to do it. They are just told what to do. It needs to be designed in a discreet way that allows them to use it when they want."

- *Informant 11, researcher*

Overall, the informants saw that employees are an integral part of the adoption process of the industrial metaverse. This finding supports existing literature. The informants argued that companies need to consider their employees when adopting the metaverse by, for example, supporting them and not forcing the metaverse onto them.

5.3 Safety

The informants of this study mostly saw, that the industrial metaverse will increase the level of safety because dangerous work tasks in dangerous places can be outsourced to robots and other technology. However, some informants stated that the safety effects of the industrial metaverse need to be examined further before adopting the technologies. Especially the need to protect and ensure the safety of the employees was very highly valued in the interviews.

To ensure a safe working environment for all, employers must explore how the industrial metaverse affects safety in their workplace. Potential safety issues must be addressed so no further safety issues become a reality. According to Bibri and Allam (2022), possible safety issues include injuries that VR and AR hardware, such as headsets can cause. In addition, one part of ensuring safety in the industrial metaverse is proper training. The informants saw that training can increase safety as work tasks are performed correctly.

"Safety is the key. It is the most important thing."
- *Informant 8, manager*

Overall, the industrial metaverse can increase safety in the workplace, but employers should understand the risks and possible safety issues and take proper action.

5.4 Information Bias

As many informants said, artificial intelligence is an integral part of the industrial metaverse. AI can be used in many ways: it can simulate factory flows or give real-time instructions on assembling machinery. Although AI in the industrial metaverse can be useful, it comes with ethical issues. As discussed in Chapter 4.1.2, there are ethical questions about the role of AI in decision-making, mostly about information bias. Companies should ensure that the way that AI is used in their facilities is used safely and ethically.

Firstly, the informants agreed that companies must consider what data is fed to the AI and how it affects the decisions. Companies should be aware of possible biases in the data and take precautions to ensure safe use of AI. Secondly, the informants wanted companies to make sure that the information generated by AI is correct and safe to use. This is important when AI is used in decision-making processes.

"Who makes the decision and on what basis is, in my opinion, the essential question here. AI gathers information from a certain amount of sensor data and whatever is available of processes, people and the environment. It brings decision proposals to people, and then a human is likely to make the final decision. So, on what basis does that person make that decision? How has the AI given those decision options? How correct are they?"

- *Informant 2, researcher*

Both the informants and the literature also identified benefits of using AI in decision-making. The informants said that AI can be used to create warnings and better decisions. In literature, Sekaran et al. (2021) illustrate that AI can be beneficial in the metaverse. They explain that AI can be better in decision-making than humans because AI can process significant amounts of data and consider more variables. Huynh-The et al. (2022) also second this, as according to them, AI can promote efficiency and reduce risks.

As there are both possibilities and risks related to AI, it is an important consideration for industrial companies. When used right, it can bring benefits to production in terms of efficiency and safety (Huynh-The et al., 2022), but the informants of this study emphasised the need for careful consideration.

5.5 Societal Efforts

Finally, the fifth theme, societal efforts, includes considerations from companies interacting with the surrounding society.

The informants saw that the industrial metaverse will have large effects on society. This view is shared with Kshetri (2023), as he recognises the potential of the industrial metaverse to enhance public welfare. One informant claimed that companies should actively participate in efforts to standardise the metaverse to create beneficial and ethical standards for the metaverse. The informant considered it important to keep values, such as reliability and transparency present when developing the metaverse. This is something that companies should remember when creating their strategies for the industrial metaverse. The informant saw that creating an ethical industrial metaverse would also benefit the companies and act as a competitive advantage.

"In a way, this kind of "fair-trade metaverse" could stand out from other metaverses."

- *Informant 4, senior advisor*

De Giovanni (2023) also endorses considering the social repercussions of the industrial metaverse. He argues that the social effects of the metaverse

should be considered. De Giovanni (2023) argues for a sustainable metaverse, and he says that the SDGs can also be used by businesses to evaluate their sustainability.

According to the informants, one ethical issue in the industrial metaverse was that it could allow companies to outsource work to countries with cheap labour and poor working conditions. Even though this could be possible with the industrial metaverse, companies should consider all workers in the value chain and ensure safe working conditions and a decent quality of life for all.

Companies should be actively involved in the societal discussion surrounding the industrial metaverse. Being socially responsible is not only beneficial to society, but also to the employees, and thus, the organisation (Vitell & Hidalgo, 2006). Vitell and Hidalgo (2006) suggest that when organisations are ethical and socially responsible, it can positively affect the employees.

The informants saw that now is a good time to be involved in the societal conversation, as the industrial metaverse is still developing, and there is time to affect the development and possible standards and regulations.

5.6 Summary

Overall, employers have agency in creating an ethical metaverse working environment in their company. Although employers are not the only instance responsible for an ethical metaverse, they have a considerable amount of power in creating an ethical workplace and good, safe, working conditions for their employees. This research identified five areas that employers must consider: data safety, employee engagement, safety, information bias, and societal efforts. The adoption process of the industrial metaverse is not simple, and organisations as employers must consider the ethical issues. Below, Figure 2 presents a summary of the results provided in Chapters 4 and 5.

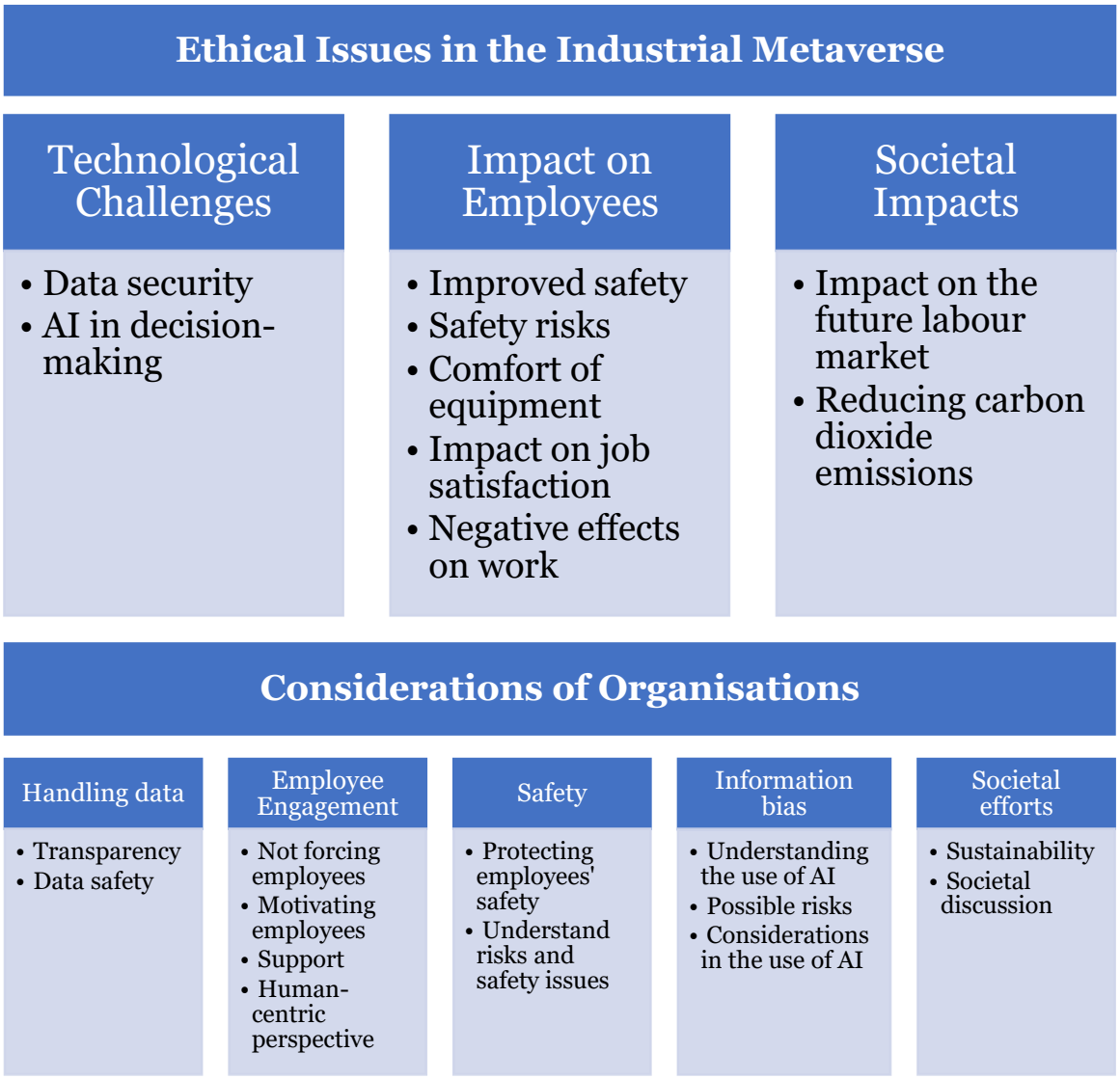

Figure 2: A summary of the results, including the ethical issues in the industrial metaverse and the considerations of organisations.

6 Discussion

The motivation for this thesis was to better understand the ethical questions related to the industrial metaverse. Moreover, this thesis aimed to identify the ethical questions and understand what ethical considerations should be had when adopting the metaverse.

In this chapter, the results presented in chapters 4 and 5 are critically analysed, and the impacts of the thesis are evaluated both scientifically and from a managerial perspective. In addition, the thesis is compared to previous research and possible future research topics are discussed. Finally, this chapter provides a conclusion for the thesis.

6.1 Analysis

This study successfully added to the scientific discussion about the ethical questions of the industrial metaverse. The study answered the research questions, and many ethical questions in the industrial metaverse were discovered. The ethical questions were from many different perspectives, and a broad view of the ethical questions was provided.

In this study, the informants identified many ethical questions related to the industrial metaverse. However, the results were not all-encompassing. What was surprising was that no informant mentioned the value chains of the hardware needed for the industrial metaverse. The implementation of the metaverse requires a lot of new equipment, such as cameras, headsets, batteries, tags, and radars, which need raw materials. The value chains of these raw materials and the production chains of these equipment can have ethical issues, that none of the informants mentioned during the interviews.

Additionally, although the informants identified that there are problems with the comfort of equipment, there are also possibilities of the equipment making work more comfortable or less physically straining. This positive effect did not come up in any of the interviews.

It is possible, that there are also other ethical aspects of the industrial metaverse that the informants and this research did not identify. However, the informants identified ethical aspects of the industrial metaverse from many different perspectives, such as safety, benefits to employees and society, and technological challenges. The informants saw that these ethical aspects can affect organisations, employees, and society.

This thesis was able to identify what ethical considerations are seen as important when adopting the industrial metaverse. However, for organisations to be able to create an ethical version of the industrial metaverse, more extensive and practical guidelines should be created. Creating such guidelines was out of the scope of this study. However, this thesis gives a broad overview of what ethical viewpoints employers must consider before adopting the industrial metaverse.

6.2 Theoretical Implications

As previously stated, there has been a research gap in the ethical questions in the industrial metaverse. However, some studies have found similar issues to this research.

Some studies have noted that privacy concerns are one ethical issue in the metaverse. For example, Kaddoura and Al Husseiny (2023) found, that in the context of education, the metaverse comes with network security and privacy concerns. Although the context differs from the industrial metaverse studied in this thesis, the findings are similar. For instance, Kaddoura and Al Husseiny discuss that the metaverse requires the gathering of big amounts of data and that data can be very personal to users. They state that *"datafication and privacy are at the foundation of the metaverse."* (Kaddoura & Al Husseiny, 2023, p. 21) This thesis supports these findings.

The sustainability factor has been discussed previously in scientific literature about the industrial metaverse. For example, Kshetri (2023) discussed that the industrial metaverse can promote environmentally sustainable actions. However, in this thesis, the results were mostly on decreasing emissions from travelling, whereas Kshetri argues that the industrial metaverse can help save energy in factories.

In their study Jiang et al., (2022) discuss similar effects on work that were discovered in this thesis. For example, they recognise that the metaverse will provide a more flexible working environment and that repetitive work tasks can be dismissed. They, too, recognise the advantages that the industrial metaverse can bring to education and training.

VR sickness is a phenomenon mentioned in previous literature as an issue in the metaverse, which supports the findings of this study. For example, Park and Kim (2022) recognise motion sickness and dizziness as a challenge in the metaverse.

As previous research has mostly focused on other metaverses, not the industrial metaverse, the results in this thesis and previous research also differ. For example, Kaddoura and Al Husseiny (2023) discuss the physical and mental health issues of the metaverse. These results do not apply to the industrial metaverse, as the use case is so different. For example, Kaddoura and Al Husseiny discuss the impact of shopping, playing, hanging out with friends, and learning in the metaverse, but this type of use differs from what the industrial metaverse will offer.

Previously, there has not been much research on the industrial metaverse's negative impact on work. However, in this thesis, the results were that the metaverse can result in more workload or a fear of losing jobs. In addition, previous research has focused more on the organisational perspective of the industrial metaverse, although this study found that the industrial metaverse has a huge impact on the employee.

Previous research on the industrial metaverse has mostly focused on the technologies and what can be achieved through the industrial metaverse. The ethical questions in the industrial metaverse have not been researched sufficiently, although some issues have been discussed more generally in the metaverse domain and can be extended to the industrial metaverse domain. Although some studies have discussed ethical issues, there has been a need for research focusing just on the ethical questions in the industrial metaverse. In addition, previously, the ethics of individual technologies such as AI or VR have been studied, but in this research, the scope was the entire industrial metaverse.

Overall, the scientific discussion surrounding the industrial metaverse requires more discussion and research about the ethical side of the industrial metaverse. This research provides a new type of view on the ethical side of the industrial metaverse and provides an overview of the ethical questions related to the industrial metaverse. This research also discusses the ethical effects of the industrial metaverse more broadly, addressing the intertwinement of technology and society. Additionally, this thesis provides topics and ideas for future research, further expanding the scientific impact of this thesis.

6.3 Managerial Implications

This research has a practical impact on industrial companies as employers that are planning on adopting the industrial metaverse. This study can help industrial companies in the metaverse adoption process, as it shows what perspectives need to be considered. This thesis highlights the important

ethical issues in the industrial metaverse and shows the employer's responsibility in adopting the metaverse in an ethical way. Based on the ethical considerations presented in Chapter 5, Figure 3 includes guidelines for employers, on what ethical considerations should be had to create an ethical metaverse in their workplace.

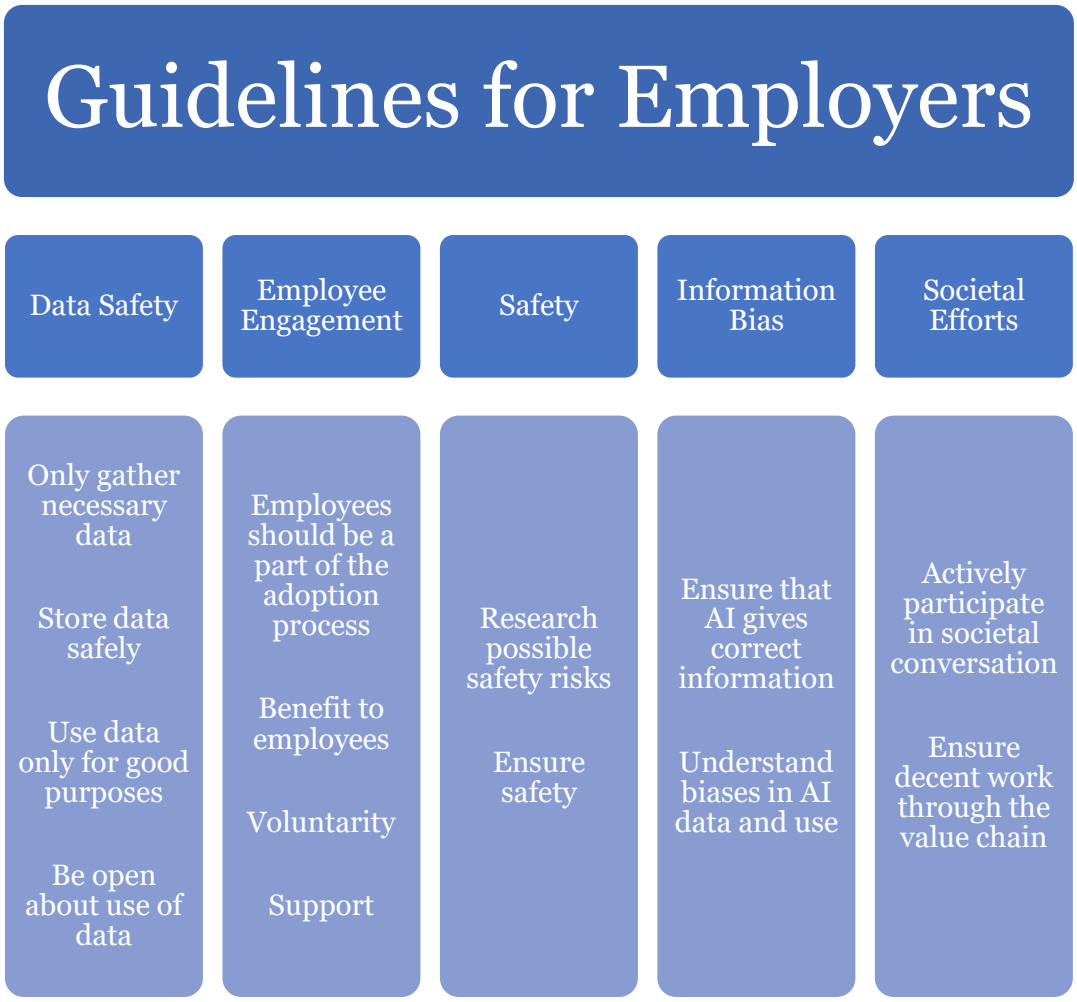

Figure 3: Guidelines for employers.

Although this thesis focused on the employers' perspective, the developers of the industrial metaverse can also benefit from the results of this research. As both developers and the user organisations of the industrial metaverse are responsible for the ethicality of the industrial metaverse, this thesis highlights the importance of ethical issues and gives developers new perspectives on what to consider when creating metaverse technologies. Furthermore, this can impact the employees in the industry as well as society at large. If the metaverse is adopted ethically, it will affect the well-being and safety of employees. Also, other ethically positive impacts can follow, such as positive effects on future work, the labour market, and society.

6.4 Limitations of the Study

There are three main limitations in the validity of this research. Firstly, the data set used in this study was small. Secondly, the geographical scope of the study is Finland, and all the informants were Finnish and worked in Finnish companies. Lastly, the informants were not specialists in ethics.

As the data set only included 15 informants, it is relatively small and is a major limitation for the validity of the research. With a greater number of informants, the results of the study would have been more valid. The topic should be further researched to confirm the validity of the results.

The geographical scope of the study was Finland, which had a certain effect on the results. The informants mostly spoke from a Finnish perspective. This affected the results of the study greatly, as views on ethics and work-life depend greatly on cultures. Some informants even pointed out, that there are cultural differences in views towards data privacy, for example. However, the results from this study could be applied to other European countries because they have culturally similar attitudes towards ethics and work. In addition, the results would be best applied in EU member countries, as the EU has common legislation for data protection, for example.

Finally, one of the main limitations of this study was that the informants were not specialists in ethics, but they were specialists in the metaverse. Even though the metaverse specialists identified ethical questions in the industrial metaverse, for some, the subject of ethics was unfamiliar, and they had not previously thought about the ethics of different technologies. More valid results on the ethical issues of the industrial metaverse would have been achieved by interviewing ethics professionals. However, there is also value in understanding how industry professionals see the value and implications of ethics, as they will be the ones pushing towards the adoption of the metaverse.

It is possible, that the researcher's background influenced the interpretation of the data. In addition, the informants' willingness to satisfy the interviewer might have shaped and influenced the responses provided by the informants. Furthermore, it is possible that although the interview questions were open-ended, the interviewer might have directed informants' answers. However, the researcher aimed to be as neutral as possible both in the interview situations and during the data analysis to ensure that the results were as valid as possible.

6.5 Future Research

As said before, the previous research on the industrial metaverse has mostly focused on the technologies and what can be achieved through the industrial metaverse. This thesis adds to the discussion about the ethical side of the industrial metaverse, but several other questions should be researched.

Firstly, this research focused on the organisational level of the industrial metaverse, and the companies that will be users of the metaverse. However, the developers of the industrial metaverse also have a responsibility to make the industrial metaverse ethical. Further research should be carried out about the ethical questions from the development perspective.

Secondly, since many of the ethical questions identified in this research affected the employee, it should be researched more. Possible research topics include how employees view the industrial metaverse, how it will affect their work and how the well-being of employees working in the industrial metaverse can be ensured.

Lastly, in this research, the effects of the industrial metaverse on society were touched upon. Many informants said that the industrial metaverse will influence society, including effects on the labour market or how the industry will change. These effects should be researched more. In addition, many of the informants talked about the legislation related to the industrial metaverse and how it will change. The informants predicted that globally there will be many different legislations that companies have to navigate in. These effects could be further researched.

6.6 Conclusion

This thesis investigated the ethical questions in the industrial metaverse, as that is an under-researched topic. In addition, this study aimed to understand the organisational perspective of what ethical issues to consider when adopting the industrial metaverse.

The study was conducted as qualitative research. 15 professionals from Finland were interviewed in thematic semi-structured interviews. The results were coded first into first-order codes, then grouped into second-order codes and lastly into aggregate dimensions, following the Gioia method (Gioia et al., 2013).

This study was able to identify several ethical issues in the industrial metaverse. The ethical issues were grouped into the following aggregate

dimensions: *technological challenges, the impacts of the metaverse on employees,* and *societal impacts*. The ethical issues included themes such as data safety, privacy, impact on job satisfaction, and societal impacts. This study also identified what themes organisations consider when adopting the industrial metaverse. The five themes were *data safety, employee engagement, safety, information bias,* and *societal efforts*.

This thesis has a valuable contribution both scientifically and practically. Scientifically, a new dimension and viewpoint to the scientific discussion about the industrial metaverse is introduced. This study identifies and gathers the ethical issues related to the industrial metaverse. In addition, several possible future research topics are suggested, which provides good grounds for further discussion about ethics in the industrial metaverse. The practical impact of this thesis is most prominent to employers planning on adopting the industrial metaverse to their organisations. This study highlights the importance of ethics in the adoption process and gives a broad view of what ethical issues employers must consider during the process.

Overall, this research found that the industrial metaverse has several ethical questions that can have big implications for employees, organisations, and society. Organisations have a considerable amount of power over how they implement and adopt the metaverse, and this thesis provides them with several guidelines on implementing an ethical metaverse working environment that is good and beneficial for both employees and society.

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Appendices

A. Interview Structure

The interviews were held in Finnish. The interview structure below is translated from the original interview structure.

Introduction

- Introduction of the interviewer
- Information about data processing

Background questions

- Describe shortly your current job (role, title, key tasks)
- Describe your work and educational background
- What is your understanding of the industrial metaverse?
- How long have you worked with the industrial metaverse?
- What interests you in the industrial metaverse?

Theme 1: Ethics

- What ethical issues do you identify in the industrial metaverse?
- Can you give me an example of how ethical issues could show up?
- What positive ethical effects does the industrial metaverse have?
- What effects can the industrial metaverse have on society?
- How would employees react to possible ethical questions?
- What effects could the industrial metaverse have on employees?

- is responsible for an ethical metaverse?
- What can happen if the industrial metaverse is unethical?
- Are the ethical implications of the industrial metaverse known in the industry?

Theme 2: Organisations

- Will the ethical questions hinder the adoption of the industrial metaverse?
- What kinds of things should be considered before the metaverse is in use?
- How should businesses lead the adoption process?
- What (ethical) challenges will the adoption of the industrial metaverse have?
- What feedback have employees given on the ideas of the industrial metaverse?
- What effects does the industrial metaverse have on organisations?
- How can organisations react to these ethical questions?
- How should organisations prepare for possible ethical issues?

Closing Questions

- Is there anything that you want to add that we have not yet discussed?
- Do you know any other metaverse professionals that I could contact and interview?