The impact of Industry 5.0 on the skillset and leadership style of middle managers within the manufacturing industry in the Netherlands

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ABSTRACT

In recent years the concept of Industry 5.0 has become a growing topic. Industry 5.0 can be considered as the fifth industrial revolution and improves on the current Industry 4.0, which was introduced in 2011 in Germany. Since 2021, the industry has been transitioning towards Industry 5.0, in which the importance of environmental and social aspects is highlighted. Furthermore, it is important to note that Industry 5.0 is not a technology-driven revolution. In the context of the manufacturing industry, Industry 5.0 intends to reshape the industry into a more human-centric, sustainable, and resilient industry. This study researches the impact of Industry 5.0 on the skillset and leadership style of middle managers within the manufacturing industry in the Netherlands. In order to reach this goal, this study has conducted qualitative research in the form of a multiple-case study. This study has conducted semi-structured interviews for gathering data from middle managers in manufacturing organizations in the Netherlands. This data has been analyzed using the Gioia methodology and forms the basis of the results of this study. Based on the gathered results, this study has found that Industry 5.0 requires middle managers to improve on several types of skills: technical skills, coaching skills, green thinking skills, and energy & waste management skills. Furthermore, this study has found that Industry 5.0 requires middle managers to adopt more empathetic and situational leadership because employees are all different and have different expectations of leadership. Therefore, the leadership style must be fitted toward employees instead of adopting one style of leadership for all employees.

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1. INTRODUCTION

In recent years the concept of Industry 5.0 has become a growing topic (Huang, 2022). Industry 5.0 can be considered as the fifth industrial revolution and improves on the current Industry 4.0, which was introduced in 2011 in Germany. The concept of Industry 4.0 revolves around technology-driven improvements to businesses, with the goal being improving the efficiency of production processes (Xu, 2021). With the developments within Industry 4.0, production organizations are able to predict machine maintenance, have further developed their supply chain management, and have automated repetitive tasks by using robots (Zizic, 2022). However, these improvements that Industry 4.0 has introduced are mostly focused on improving the efficiency and profitability of organizations, not on possible environmental and social benefits. However, it is important to state that these aspects are not completely ignored within Industry 4.0, but their importance is overlooked.

Since 2021, the industry has been transitioning from Industry 4.0 towards Industry 5.0, in which the importance of the environmental and social aspects is highlighted (Xu, 2021). Research from Huang gives the following description of Industry 5.0: "Industry 5.0 is understood to recognize the power of industry to achieve societal goals beyond jobs and growth, to become a resilient provider of prosperity by ensuring that production respects the boundaries of our planet and places the welfare of industry technicians at the center of the manufacturing process" (Huang, 2022, p. 425). Furthermore, it is important to note that Industry 5.0 is not a technology-driven revolution; it intends to reshape industries into a more human-centric, sustainable, and resilient industry (European Union, 2021). However, this form of transformation can have a disruptive impact on the production process and all layers of employees within organizations (Olssen, 2024). Middle managers of manufacturing organizations act as the link between top management and other hierarchical levels. Therefore, this study recognizes that middle managers of manufacturing organizations are likely to be affected disproportionately by this industrial revolution. (Van Doorn, 2023).

This study identifies two main challenges that the shift from Industry 4.0 towards Industry 5.0 introduces for middle managers in manufacturing organizations in Industry 5.0.

First, middle managers might not possess the necessary knowledge on how to implement innovations related to human-centricity, sustainability, and resilience of the production processes that Industry 5.0 introduces. They were tasked with optimizing production processes and had to be able to make data-driven decisions in order to improve efficiency and profitability (Olssen, 2024). Now, in Industry 5.0 middle managers of manufacturing organizations need to gain knowledge of how to change production processes into human-centric, sustainable and resilient processes that respect the boundaries of our planet (European Union, 2021). For example, in Industry 5.0 middle managers are required to gain knowledge of the environmental effects of the production process and how to improve the sustainability of their organization (Huang, 2022). Therefore, the first challenge this study identifies is that middle managers are now tasked with new tasks, for which they need to gain new skills and knowledge in order to perform their job in this new industry. These tasks include implementing human-centric innovations to the production process and the improvement of sustainability and resilience of the production organization.

Second, Industry 5.0 highlights the importance of well-being and meaningfulness of production employees and human strengths such as creativity, critical thinking, and innovation (Olssen, 2024). In Industry 5.0 new technologies need to assist the production employees and not replace them, making the industry more human-centric. (European Union, 2021). E.g., the integration of co-bots with human employees on the work floor intends to assist the production worker, not make his job obsolete (Xu, 2021). However, this requires middle managers to train the production employees in new skills such as data science and machine learning, combined with knowledge of how to use artificial intelligence in order to operate on this new work floor. (Zizic, 2022). Therefore, the second challenge this study has identified is that middle managers will need to gain skills in coaching, empathy, and applying situational leadership. By obtaining skills in coaching, employees can be more motivated, upskilled, and have more meaningful jobs. Middle managers need to be more empathetic and adapt their leadership style into a situational style of leadership towards production employees in which the way of communicating and leading is adapted to all employees; in doing so, employee well-being can be improved.

In light of the above, this study recognizes that it is important to research how the skillset of middle managers and their style of leadership are impacted by Industry 5.0. Furthermore, how middle managers can adapt to the new expectations of their skills and developments in leadership style in Industry 5.0. In order to reach this goal, the following research question has been developed:

How is Industry 5.0 impacting the skillset and the leadership style of middle managers in production organizations?

By conducting this research, this study has contributed to the existing literature on Industry 5.0 by providing new insights into the requirements that Industry 5.0 sets regarding the skills and leadership style of middle managers in production organizations. Furthermore, this research provides practical implications for middle managers in production organizations on which skills they need to obtain and which leadership style they should adopt in this new industry.

2. THEORETICAL FRAMEWORK

This chapter provides information from other papers regarding the key concepts that are relevant to this research and form the base of this study. This chapter is divided into three subchapters related to the key concepts of this study. These subchapters are then divided into sub-subchapters related to topics within these key concepts.

2.1 Manufacturing industry in Industry 5.0

It is important to state Industry 5.0 is a value-driven initiative that enables digital transformation with a particular purpose (Xu, 2021). In the context of the manufacturing industry, Industry 5.0 intends to reshape the industry into a more human-centric, sustainable, and resilient industry (European Union, 2021). These three elements are the core of Industry 5.0, and this subchapter is split into three sub-subchapters related to the key elements of Industry 5.0.

2.1.1 Towards human-centric production processes within the manufacturing industry

First, in order to achieve human centricity, the workplace must be made a safe environment. In Appendix 8.2, a figure from the European Union shows that in 2017, over 18% of non-fatal accidents at work happened within the manufacturing industry (European Union, 2021). Therefore, middle managers in Industry 5.0 have to prioritize automating dangerous, repetitive, or routine tasks in order to reduce accidents on the work floor. Furthermore, some skills are likely to become obsolete due to the automation of process steps. Therefore, middle managers are also tasked with reskilling the employees where needed. Furthermore, since new and more advanced jobs can be created from this process, it is also beneficial for middle managers to upskill employees. (Weritz, 2022). These new skills include data science and machine learning, combined with knowledge of how to use artificial intelligence, in order for them to operate more advanced machines in the future. (Zizic, 2022). Finally, technology must be adopted with the focus on serving the employees' needs and helping them perform their jobs. The focus of new technology should not lie on replacing human employees (European Union, 2021).

2.1.2 Towards sustainable production processes within the manufacturing industry

Second, sustainability is another key element of Industry 5.0. Industry 5.0 intends to respect the boundaries of the planet regarding material usage and emission output (Huang, 2022). In order for the manufacturing industry to respect planetary boundaries, it must adapt towards a circular economy. The circular economy is a theory revolving around a model of production and consumption, which involves using sustainable product designs. After consumption the products are either collected and recycled, reused, or repaired. This process is illustrated below in Figure 2. By doing this, the life cycle of products is extended, and waste is reduced to a minimum (European Parliament, 2023).

Furthermore, for middle managers in Industry 5.0 this means that they need to gain knowledge on how to implement the use of sustainable materials and reducing the environmental effects of the production process of their organization. IoT-enabled intelligent waste management systems help middle managers with realizing more efficient resource usage (Rame, 2024). Furthermore, by making use of blockchain technology in purchasing and supply management, middle managers can create transparency and traceability of the materials used in the production process and review the environmental impact of the purchased materials and products, ensuring sustainable practices throughout the supply chain (Rame, 2024). Additionally, middle management will be tasked with selecting reusable or recyclable resources for the production process (Huang, 2022). These practices contribute toward achieving a more sustainable industry.

2.1.3 Towards resilient production processes within the manufacturing industry

Third, resilience is the final key element of Industry 5.0. Resilience, in the context of Industry 5.0, refers to the need to develop a resistance within organizations against disruptions or crises through flexible business processes (Zizic, 2022). A significant role will be played by digital technologies. Even though digital innovations provide enormous benefits such as data gathering, automated risk analysis and mitigation, an increased dependence on digital technologies exposes organizations to disruptions, such as malfunctions and cyberattacks (Zizic, 2022). Furthermore, the literature states that nearly one-third of manufacturing organizations have not yet implemented a cyber risk assessment specifically targeting their factory floor technology. Additionally, there is an increase in the number of connected devices and systems in manufacturing. Both increasing the industries' susceptibility towards cyberattacks. (Alqudhaibi, 2024). Therefore, manufacturing organizations have to focus on improving their cybersecurity.

2.2 Tasks and required skillset of middle managers within the manufacturing industry

2.2.1 Skills of middle managers in Industry 4.0

This study recognizes three key middle manager skills within Industry 4.0. These skills are the ability to optimize production processes and perform lean manufacturing (Sanders, 2016), the ability to successfully perform change management (Lauer, 2021), and the ability to perform data-driven decision-making. These three skills are essential for middle managers in order for them to connect to both technical skills and leadership skills.

First, in Industry 4.0 middle managers are required to optimize production processes. Industry 4.0 requires middle managers to reach this goal by focusing on improving efficiency, quality, and cost reduction through the implementation of technological developments (Olssen, 2024). Developments in Industry 4.0 include the adoption of AI, big data analytics, and automation of repetitive tasks using robots (Zizic, 2022). By making use of big data and AI-driven analytics, middle managers are able to enhance their inventory management and recognize demand patterns in order to forecast future demands, thereby decreasing lead times and lowering costs (Emon, 2025). Additionally, with these developments, organizations are able to predict machine maintenance, resulting in reduced unexpected downtimes. Furthermore, automation through the adoption of robots has increased manufacturing speed and the quality of the products (Emon, 2025).

Second, middle managers are required to adopt change management. As stated above, Industry 4.0 focuses on improving efficiency, quality improvement, and cost reduction through technological improvements (Olssen, 2024). In order to successfully implement these improvements, middle managers need to be able to perform change management. The literature states that change management can be considered as changing a process or behavior from a current state into a desired state (Lauer, 2021). In the context of the manufacturing industry, this includes guiding the implementation of technological innovations into the production process as well as human behavior on the work floor. However, in Industry 4.0, the focus lies mostly on the performance aspects regarding changes. E.g., the automation of processes in Industry 4.0 intends to keep human interaction with the production to a minimum in order to be more cost efficient (Olssen, 2024).

Third, middle managers are required to perform data-driven decision-making. As stated above, change management is an important element of Industry 4.0. The innovations introduced within Industry 4.0 are related to digital transformation. (Xu, 2021). These innovations include the adoption of AI, IoT, and big data analytics. By using these technologies, lots of data are gathered, and middle managers are required to analyze these data sets, formulate conclusions on them, and make decisions based on the data (Xu, 2021). With these developments, middle managers are able to, e.g., identify hiccups in the production process, predict machine maintenance, and thereby also reduce machine downtimes (Zizic, 2022). Thereby, increasing efficiency and also increasing quality of products to a higher level (Huang, 2022).

2.2.2 Skills of middle managers in Industry 5.0

This study identifies changes in the required skills of middle managers in the manufacturing industry between Industry 4.0 and Industry 5.0. However, it is important to note that the skills that middle managers were required to possess in Industry 4.0 are not obsolete. As stated earlier, Industry 5.0 must be considered as an improvement on Industry 4.0, in which the focus lies not only on performance improvement but also on the three core elements of Industry 5.0 (Xu, 2021).

First, the literature recognizes that in Industry 5.0 middle managers gain the additional task of implementing human-centric innovations (Zizic, 2021). In Industry 5.0 middle managers are tasked with guiding the integration of cobots with human employees. Having the new technology serve the employees' needs and requirements, instead of replacing them (Xu, 2021). Furthermore, Industry 5.0 focuses on implementing technology that keeps operators involved in the production process (European Union, 2021). However, some skills will become obsolete due to the automation of process steps. Therefore, middle managers are also tasked with reskilling the employees where needed. Furthermore, since new and more advanced jobs can be created from this process, it is also beneficial for middle managers to upskill employees. (Weritz, 2022). This will be further discussed in chapter 2.3.

Second, the literature recognizes that in Industry 5.0 middle managers gain the additional task of implementing sustainability-related innovations (Xu, 2021). Industry 5.0 will require middle management to gain knowledge of the environmental effects of the production process and how to reduce the environmental impact of their organization. IoT-enabled intelligent waste management systems help middle managers with realizing more efficient resource usage (Rame, 2024). Furthermore, middle managers will be required to adopt practices from the concept of circular economy in order to reduce their resource consumption. Additionally, middle managers must assess the different options of materials and make use of sustainable variants (European Union, 2021). By making use of blockchain technology in purchasing and supply management, middle managers can create transparency and traceability of the environmental impact of the purchased materials and products, ensuring sustainable practices throughout the supply chain (Rame, 2024).

Third, the literature recognizes that in Industry 5.0 middle managers gain the additional task of implementing innovations that improve the organization's resilience. (Zizic, 2021). In their decision-making process, middle managers need to include risk management regarding their production process. The COVID-19 pandemic is the most recent example that shows how fragile the current production processes are (European Union, 2021).

2.3 Leadership style of middle managers

2.3.1 Leadership style of middle management in Industry 4.0

The leadership style that is mostly linked to Industry 4.0 is transformational leadership (Guzmán et al., 2020). Transformational leadership in the context of Industry 4.0

means that middle managers need to inspire their employees and promote technological innovations. Furthermore, middle managers in Industry 4.0 focus on data-driven decision-making and increasing performance through technological development. Additionally, middle managers are tasked with reviewing the performances of employees and are tasked with training employees to use new technologies in the production process. However, in Industry 4.0 production, employees are viewed as costs, and the automation of processes in Industry 4.0 intends to keep human interaction with the production to a minimum in order to be more cost-efficient (Olssen, 2024).

2.3.2 Leadership style of middle management in Industry 5.0

Leadership in Industry 5.0 consists of more than performance-related leadership. Leadership in Industry 5.0 has a coaching approach. Focusing on well-being and meaningfulness and highlighting human strengths such as creativity, critical thinking, and innovation (European Union, 2021; Olssen, 2024). As explained earlier, due to increased automation, some skills of production employees become obsolete. In Industry 5.0 smart factories will become highly complex work floors (Xu, 2021). Therefore, middle managers are required to train production employees in new skills such as data science and machine learning, combined with knowledge of how to use artificial intelligence, in order for them to operate devices in the future (Zizic, 2022). Furthermore, middle managers adopt a more inclusive approach where employees are included in the decision-making process by asking for their opinion on how they feel about production processes and how they should change. Additionally, the literature recognizes that empathy will become of increasing importance in Industry 5.0 (Alshaibani, 2025).

3. METHODOLOGY

This chapter discusses the type of research that this study has conducted. Second, this chapter motivates why it has chosen the instrument that is used for gathering data for this study. Third, this chapter gives information on how the data has been collected and analyzed to gather results. Fourth, this chapter will discuss how the gathered data has been analyzed.

3.1 Research Design

This study has had two research goals. The first goal has been to gain insights into how the skillset of middle managers in manufacturing organizations is being impacted by Industry 5.0. The second goal of this study has been how the adopted leadership style of middle managers in manufacturing organizations is being impacted by Industry 5.0. In order to answer these research questions, this study has made use of qualitative research in the form of a multiple-case study.

Qualitative research focuses on exploring how and why questions, whereas quantitative research focuses on measuring what and how many questions (Yin, 2018). The purpose of qualitative research is to gain a better understanding of a phenomenon or phenomena through, for example, opinions and experiences gathered from interviewees. On the other hand, there is quantitative research. Quantitative research uses statistics, percentages, and other numbers to compare or measure data gathered from, e.g., databases and surveys (Yin, 2018).

The goal of this study is to better understand the complex phenomena explained above and has drawn results based on the experiences and opinions from interviewed middle managers in order to gain insights into how the leadership role and required skillset of middle managers are changing in manufacturing organizations. Hence, we can conclude that qualitative research is more fitting for this study. In qualitative research, there are different options for gathering data; these include sending out surveys, gathering observations, conducting unstructured interviews, conducting semi-structured interviews, and conducting structured interviews.

First, sending out surveys was not a feasible option for this research, since the research topic is complex, and it is better to interview a middle manager to get the best quality of results (Yin, 2018). Furthermore, it would take a lot of time for middle managers to fill in properly, and this study assumes that participants will not feel as involved in the research compared to participating in an interview, thereby not giving the best answers and explanations. Second, gathering observations was not a feasible option either, since this study does not gather data from a large population in order to answer the research question (Yin, 2018).

3.2 Research Instrument

In light of the above, this study makes use of interviews as its research instruments. There are three types of interviews: unstructured, semi-structured, and structured interviews. This study makes use of semi-structured interviews because this type of interview allows for the following things: First, it provides a structure in the interviews with questions that are prepared before the interview, whereas unstructured interviews do not have structure and could cause the interviews to drift away from the topic and the research questions or vary significantly from each other (Yin, 2018). Second, semi-structured interviews have high flexibility of follow-up questions, whereas in structured interviews all questions are exactly the same; this could become a problem since the organizations produce products in different industries, and the follow-up questions can therefore slightly differ from each other (Yin, 2018).

This study has conducted seven interviews at five manufacturing organizations in the Netherlands. Multiple interviews have been conducted at some organizations

with different middle managers. The interviewees are all middle managers within the production department of manufacturing organizations. This includes the following functions: production manager, quality manager, and production team leader.

The interview protocol is focused on gathering the required information for the research questions. Additionally, they contribute to reaching the goal of this study of creating a framework that displays the changes in the skillset and leadership role of middle managers. It contains 10 open-ended questions that have a logical order and are structured in order to remain on topic during the interview. The length of the interviews is expected to be around 30 minutes. The interviews will be held in Dutch, because the middle managers are Dutch citizens, and this study expects to gather higher quality data when the interviewees can speak in their native language.

For the analysis of the data, the recordings of the interviews have first been transcribed verbatim. This has been done in Microsoft Word, by listening to the recordings and transcribing the interview. Transcribing by hand takes longer than doing it with a software program, but software can impact the quality of translation due to the quality of the recordings. This can cause texts to be translated improperly. After transcribing, the data has been translated into English in order for my research to not be restricted by a language barrier and reach a larger audience. For the translation process I have used the document translation function of Microsoft Word. In order to make sure the texts have been correctly translated, I have checked the texts manually afterwards for errors by listening to the recordings again and checking whether the sentences still have the same meaning. After completing the translation process, the interview data has been analyzed.

3.3 Data Collection

3.3.1 Selection of the organizations and interviewees

The three selected manufacturing organizations all have more than 50 employees and are SMEs or larger organizations. The industry of produced products varies among the interviewed organizations. Because of the short timeframe in which this study had to collect data, interviews were conducted at three manufacturing organizations. The interviews are held through physical meetings at the organizations and are all held in the exact same structure.

The interviewees have been approached by two methods. First, interviewees were approached by calling directly to organizations and explaining what this study attempts to do and whether they wanted to participate in an interview. Second, this study has reached out on the social media platform LinkedIn in order to approach middle managers and ask them whether they want to participate in an interview. Information regarding the interviewees, e.g., the industry they work in and their function, is visible in the table below.

Table 1: Interviewee information

Interviewee (Organization)	Gender	Industry	Function
I-1 (Org 1)	Male	Machines	Program Manager
I-2 (Org 1)	Male	Machines	Team leader Engineering
I-3 (Org 2)	Female	Medical	Production Trainer
I-4 (Org 2)	Male	Medical	Team leader engineering
I-5 (Org 3)	Male	Concrete	Production Manager
I-6 (Org 4)	Male	Drinks	Unit manager
I-7 (Org 5)	Male	Cement	Trainee Production Manager

3.3.2 Ethical considerations

Before conducting the interviews, approval was granted by the Ethical Committee of Behavioral, Management, and Social Sciences at the University of Twente. In order to gather the best possible data, anonymity has been guaranteed to the interviewees and their organizations. Before the interviews start, all participants are asked for permission to record the interview in order to properly transcribe and afterwards, analyze the results. The interview questions remove a large amount of bias because they are open questions that are objectively formulated; interviewees can give their experiences and opinions on the subject.

3.4 Data Analysis

3.4.1 Thematic Analysis

Thematic analysis can be chosen because it enables the identification of themes and patterns from data. There are six steps for thematic analysis (Braun & Clarke, 2006). The first step is to familiarize yourself with the data. The second step is to code the data. The third step is to search for themes among the coded data. The fourth step is to review the identified themes to determine whether they correctly represent the data or need to be corrected. The fifth step is to finalize the list of themes. The sixth step is to present the results (Braun & Clarke, 2006).

3.4.2 Gioia Method

The Gioia method is another option for the data analysis, since the interviewees are professionals that possess a large amount of industry knowledge and can use their own terms that may be different from terms used in other organizations (Gioia et al., 2012). The Gioia method has three steps. The first step is to create first-order concepts; this is coding the data gathered in the interviews using the words that the interviewees use. This study makes use of the software Atlas TI for completing the coding of the data. The second step is to interpret the first-order concepts and look for patterns, relationships, and broader meanings of the words and terms that the interviewees use and thereby create second-order themes. The third step is to take these second-order themes and group them into categories; these are overarching themes and are called aggregate dimensions. These three steps are then visualized within a diagram that shows the transformation of the data (Gioia et al., 2012).

This study makes use of the Gioia method for the data analysis. However, the first step of the thematic analysis is also included in the analysis, because thematic analysis provides deep insight into what participants think and feel by first familiarizing yourself with the data. After doing this, the Gioia method is used in order to perform the analysis.

4. RESULTS

This chapter displays the findings of this research. The chapter is divided into two subchapters, which relate to the research questions of this study. Additionally, on the next page a table is included showing the findings from the interviews. Table 2 shows the coded data from the interviews, the themes that have been identified from these codes, and the aggregate dimensions under which these themes can be placed.

Table 2: Data analysis of interviews

First-order concepts	Second-order themes	Aggregate Dimensions
I-1 Creating smart tools e.g. AI tools, a cobot and a human machine interface	New technical skills	Changes in required skills of middle managers in production organizations
I-2 Shared working environments, SharePoint and systems allowing easy coordination		
I-3 Usage of AI for writing documents and personal development plans of employees		
I-4 Creating AI tool to automize the documentation process.		
I-1 Attempting to lighten the human workload	Skills in human centric innovation	
I-2 Increasing importance of well being and inclusion		
I-3 Technical training courses to allow for personal development		
I-4 Improvements in workplace conditions		
I-7Automation not to replace people, but to decrease work load.		
I-1 Increasing importance of reducing CO2 emissions and using energy more efficiently	Green thinking skills Energy & waste management skills	
I-4 Stimulation to improve on sustainability where possible		
I-5 Increasing importance of sustainable innovations		
I-6 Increasing importance of CO_2 reduction and more efficient water usage		
I-7 Increasing importance of lowering the environmental cost indicator (ECI value). E.g. reducing CO2 emissions		
I-1 Increasing importance of encouraging critical thinking of employees	Coaching skills	
I-2 Importance of balance between personal development & ambition and not overburdening employees & patience in gaining additional responsibilities.		
I-3 Increasing importance of motivation and personal development.		
I-4 One employee wants to be coached, another just wants an answer to a concrete question.		
I-7 Coaching as a way to better understand employees, motivate them and improve inclusion and well-being.		

I-2 Increasing importance of empathetic leadership. Understanding what employees need.	Empathetic leadership	Changes in leadership style of middle managers in production organizations
I-4 Increasing importance of feelings and employee needs. Leadership was a lot more directive in the past.		
I-5 Importance of making employees feel comfortable at their work.		
I-6 Increasing importance of empathetic leadership. Employees want to work at an organization where they feel comfortable.		
I-6 Increasing importance of and maintaining strong connections with the employees.		
I-2 The younger generation values meaningfulness, involvement and personal development. The older generation values autonomous work.	Situational leadership	
I-3 Increasing importance of situational leadership, every employee requires a different approach		
I-4 Increasing importance of flexibility with employees.		
I-6 The younger generation has a higher need for personal attention, they want you to be more involved with their work and development		

4.1 Changes in the skillset of middle managers

4.1.1 New technical skills

The interviewees indicated that in their day-to-day tasks, middle managers work with technological innovations in recent years. First, for most of the interviewees, AI usage in their work is in the early stages. However, in some of the organizations the team members were starting to build AI tools to, e.g., automize repetitive office tasks. Interviewee 4 stated the following on this subject: "We can use AI to help us keep track of documentation. We have documents that keep the same information coming back, and we now do it all manually. We want to see how we can make that easier with AI so that the standard work happens automatically" (I-4). Second, the interviewees also talk about different new technologies, such as a cobot and human-machine interface, assisting technicians in their work by providing help in, e.g., the correct sequence of actions in their work. Other interviewees state that for development plans and visualization of new ideas, AI is a helpful tool, and it improves the efficiency of their work (I-1).

Therefore, this study has identified a change in skills of middle managers in Industry 5.0. Middle managers are now required to increase their knowledge in new technology and look into how new technologies can have an impact on their tasks. AI is a relatively new topic in the organizations, and interviewees believe that in the future there will be many ways of improving efficiency with AI; therefore, improving the ability to work with AI is becoming of increasing importance for middle managers.

4.1.2 Skills in human centric innovation

The interviewees recognize an increasing importance of human centricity in their work. First, most of the interviewees state that in recent years they started to more actively try to reduce the workload of production employees, e.g., by automating certain processes that would require heavy lifting (I-1 and I-7). However, most of the interviewees also talk about automation as very expensive; they consider the investment very carefully, and this can sometimes not happen due to the high investment cost. Second, some interviewees carry out workplace inspections with the assistance of an external party that specializes in improving workplaces in order to improve employee well-being on the work floor (I-4). Third, some of the interviewees stated they actively upskill their employees on technical skills in order for them to better understand and keep them up to date with the advanced production (I-3).

Therefore, this study has identified a change in skills of middle managers in Industry 5.0. Middle managers are now required to improve on their skills of how to improve the well-being of employees with a human-centered process design. Allowing for improvements in safety, workload reduction, and improved worker knowledge on operating advanced machines.

4.1.3 Green thinking skills and energy & waste management skills

The interviewees recognize an increasing importance of sustainability in their work in recent years. First, some of the interviewees work in contract manufacturing organizations, meaning that their product designs are coming from the customer. This means that they cannot make sustainability-related changes to the products; however, they are actively trying to reduce the emissions coming from production and manage energy consumption more efficiently (I-1). Interviewee 4 stated the following on this: "We are stimulated to improve on sustainability where possible, but we are a contract manufacturer, so the design of a product comes from the customer, and we cannot change that" (I-4). Second, interviewee 6 is

working at an organization that produces drinks, where the focus has been a topic of importance for a longer time, but they state that the topic has become of increasing importance over the last years; they focus on further reducing emissions output and water usage reduction. Third, interviewee 7 works in construction material production and actively tries to reduce their ECI value, environmental cost indicator. They state that this reduces emissions on one side and increases their marketing because this attracts more customers (I-7).

Therefore, this study has identified a change in skills of middle managers in Industry 5.0. Middle managers are required to improve their knowledge on how to improve sustainability in their organization and on change management in order to better guide the organization in adopting these sustainable practices.

4.1.4 Coaching skills

The interviewees recognize an increasing importance of coaching when leading their team members. First, most of the interviewees stated that the younger generation has a lot of ambition and wants to make steps in their careers more quickly than the older generation (I-1 and I-2). Interviewee 1 stated the following on this: “In recent years I have started to more actively try to encourage my team to think for themselves before they do something. My starting point is: "You don't have to ask me, but take action. Come up with a proposal or a solution, and then I can give feedback or give tips for adjustment." This helps people to take responsibility and to think critically about their work.” (I-1). Interviewees 1 and 2 state that this is a good thing, and they try to facilitate personal development by guiding them and giving them more responsibilities and growth opportunities. However, interviewee 2 also states that going too fast can result in stress, overburdening, and in some cases, burning out. Therefore, interviewee 2 advises maintaining a balance between giving additional responsibilities and patience to ensure employee well-being (I-2). Furthermore, interviewees 3 and 7 state that coaching can also motivate employees.

Therefore, this study has identified a change in skills of middle managers in Industry 5.0. Middle managers should improve their coaching skills and stimulate the development of their colleagues' abilities, like creativity and critical thinking.

4.2 Changes in leadership style of middle managers

4.2.1 Increasing importance of empathy

The interviewees recognize an increasing importance of empathy when leading their team members. All interviewees have stated that when leading their teams, it has become much more important to understand their employees' needs. First, interviewees state that understanding how employees feel has become much more important in recent years. It is important to increase interactions with colleagues and listen to your colleagues; by doing so, you can find out how your colleagues feel and what they need, on which they can take action to increase their well-being and productivity (I-2 and I-4). Interviewee 6 states the following: “When I look at people today, they are increasingly choosing an employer where they feel good. People now expect to feel good about their work, their colleagues, and their manager.” (I-6). Second, the interviewees also state that when adopting empathetic leadership, colleagues feel more comfortable and motivated as a result (I-7). Third, interviewee 6 states that as a byproduct of generating a better connection to the organization, employees are less likely to pursue a job at another organization. “People job hop much more easily and have less connection with their employer. So that makes it extra important to show empathy and create a bond with the employees.” (I-6).

Therefore, this study has identified a change in leadership style of middle managers in Industry 5.0. Middle managers are now required to adopt a more empathetic approach in their leadership style in order to better understand their employees' needs, better motivate employees, and generate a better connection with employees.

4.2.2 Increasing importance of situational leadership

The interviewees recognize an increasing importance of situational leadership when leading their team members. First, interviewees state that when it comes to leading people, it has become more important to adapt your way of instructing and communicating to every person, because everyone perceives this in a different way (I-2, I-3, and I-6). Interviewee 2 states the following on this: “The younger generation wants their work to be meaningful and to feel involved. They want their ideas to be heard and developed. Whereas the older generation may be more used to doing what is asked.” (I-2). This requires managers to be more flexible and emotionally intelligent than before. The interviewees give examples of this in which two factors predominantly come forward: generational differences and personality differences. For example, they state that the younger generation finds it important that their work is meaningful, that they are heard, and that they can develop themselves in an organization. On the other hand, the older generation is perceived to be less in need of this involvement, preferring more autonomous work and to be more mentally stable. Additionally, interviewee 3 stated the following: “I adapt it very much to the person; every employee is different and also requires a different approach.” (I-3).

Therefore, this study has identified a change in leadership style of middle managers in Industry 5.0. Middle managers should aim to adopt situational leadership in their leadership style and become more flexible and emotionally intelligent in order to better lead their teams and improve on facilitating employee needs.

5. DISCUSSION

This chapter displays the theoretical contributions of this research, the practical implications for middle managers in practice, the limitations of this research, and lastly, what researchers could focus on in future research.

5.1 Theoretical contribution of this research

By conducting this research, this study has provided a theoretical contribution to the existing literature on Industry 5.0 by providing new insights into this subject. Where previous studies highlighted other aspects of Industry 5.0, this study has filled a gap by researching the impact that Industry 5.0 has on the skillset and leadership role of middle managers in the manufacturing industry. Furthermore, the results of this research have added to a better understanding of how current and future middle managers in production organizations should operate in their function. This aspect is explained further in the practical implications of this research.

Furthermore, at the start of this research, this study identified two challenges for middle management of production organizations regarding Industry 5.0. The first challenge this study identified was that middle managers are now tasked with new tasks, for which they need to gain new skills and knowledge in order to perform their job in this new industry. The second challenge this study identified was that middle managers will need to gain skills in coaching, empathy, and applying situational leadership in this new industry. Based on the existing literature displayed in the theoretical framework and the results of this study, this study has found that Industry 5.0 has a significant impact on the skills and leadership role of middle managers in production organizations. Additionally, the results of this study show that the skills and leadership styles that are displayed in the results chapter are becoming of increasing importance in this new industry.

5.2 Practical implications of this research

The goal of this study was to research the impact Industry 5.0 has on the skills and leadership style of middle managers in production organizations. In order to reach this goal, interviews were held, and these results have generated insights on how middle managers perceive their skills and leadership style to have changed over recent years. The results indicate that in many different aspects, the skills and leadership styles of middle managers are impacted. The results of this study should be interpreted as a shift in focus, meaning that the skills and leadership style that have been adopted in Industry 4.0 are not replaced; these still are useful and are present in the new industry.

This study has found that instead of focusing on profit-driven automation and efficiency improvements, like in Industry 4.0, Industry 5.0 wants middle managers to adopt a more holistic view in their job by focusing on human centricity, sustainability, and resilience in their production processes. Additionally, this study has found that Industry 5.0 requires middle managers to adopt coaching, empathy, and situational leadership into their leadership style. The practical implications of these elements are displayed below.

First, in their organizational role, middle managers are still required to have skills in process optimization, but with the rise of smart technologies like artificial intelligence, middle managers are now required to gain skills in how to work with and implement these smart technologies into their organization's processes; this can have significant benefits for the organization (Xu, 2021).

Second, in the decision-making process, middle managers still need to have skills in improving efficiency and cost-effectiveness, since these aspects remain to play an important role in the decision-making within production organizations; however, instead of solely focusing on improving efficiency, middle managers now need additional skills in how to increase sustainability and make this an equally important factor in the decision-making process in comparison to efficiency and cost-effectiveness (Rame, 2024).

Third, in the innovation of production processes, middle managers are still required to have skills in creating automated production processes; however, with the focus shifting toward the implementation of human-centric production, middle managers require additional skills in creating a human-centric approach in innovation initiatives. E.g., improving employee well-being and safety by reducing the workload of employees (Zizic, 2022).

Fourth, regarding the relation with the employees, task-oriented leadership remains to be a part of the middle managers' tasks in Industry 5.0, since deadlines must be set and production must keep going. However, by adopting coaching skills in their leadership style, middle managers can stimulate the development of their colleagues' abilities, like creativity and critical thinking. Resulting in increased motivation and development of employees (Olssen, 2024).

Fifth, in Industry 4.0, when reviewing and assessing performance, metrics were mostly data-driven and focused on, e.g., the production output of employees. In Industry 5.0, these metrics of assessing performance are still present; however, by adopting a more empathetic leadership approach, middle managers can make employees feel more comfortable and motivated in their work by actively trying to understand how employees feel and facilitating their needs. In doing so, motivation and productivity can be increased (Alshaibani, 2025).

Lastly, in their communication style, middle managers in Industry 5.0 should aim to adopt situational leadership. This style of leadership also includes directive leadership;

however, it expands this by adding additional styles. Additionally, this style of leadership adapts to different types of team members, which is fitting because everyone perceives this in a different way and has different expectations of leadership (Tortorella, 2017).

5.3 Limitations and possibilities for future research

While this study has generated valuable insights, this research has several limitations that need to be taken into consideration. Furthermore, there are possibilities for future research to build upon this study.

5.3.1 Limitations of this research

First, this research is limited by being subject to interpretation bias, because this study is conducted by a single researcher. This can cause the interpretation of the collected data to become subjective (Yin, 2018). Second, this research is limited by being resource intensive; the data collection process is time-consuming by having to schedule interviews, code the gathered data, and analyze and interpret the coded data. This has limited this study because this study has had a limited timeframe. Third, this study is limited by having limited generalizability; this is due to the relatively small sample size. This restricts the extent to which the findings of this research could apply to a larger population. Lastly, this research is limited by being hard to replicate, since the findings of this study are based on the answers of interviewees. Therefore, another research with a different group of participants can result in differing findings.

5.3.2 Possibilities of future research

First, because this study has a relatively small population for its research, future research could attempt to conduct its research with a larger population. In doing so, future research can increase the extent to which the findings could be generalized and applied to a larger population. Second, the literature states that Industry 5.0 intends to make production organizations more resilient. However, this study was not able to gather information on how resilient organizations currently are and how they are improving this. The interviewees stated that the task of improving the resilience of the organization is not in their day-to-day tasks but that they know this is becoming a more important topic inside their organizations. Therefore, future research can build on this research by researching how organizations can become more resilient, identifying how this benefits organizations, and how organizations can implement these practices. Lastly, future research could build on this research by conducting research into how the workload of middle managers is changing due to the changes in tasks, skills, and adopted leadership style that are presented in this research.

6. CONCLUSION

The goal of this study has been to research the impact Industry 5.0 has on the skills and leadership style of middle managers in production organizations. In order to reach this goal, this study started by identifying key challenges. The first challenge this study identifies is that middle managers need to gain knowledge of how to change production processes into human-centric, sustainable, and resilient processes. The second challenge this study has identified is that middle managers need to adapt the current productivity-focused leadership style into a more empathetic and situational leadership style towards the production employees, where employees are upskilled and have more meaningful jobs.

In order to give answers to these challenges, this study has created the following research question. How is Industry 5.0 impacting the skills and leadership style of middle managers in manufacturing organizations? To answer the research questions, this study has built a theoretical framework and completed data collection in the form of interviews. This data has been analyzed, and in doing so, this study has been able to generate new insights that have practical implications for middle managers in production organizations. These insights imply that in many different aspects, the skills and leadership style of middle managers are impacted.

By conducting this research, this study has provided a theoretical contribution to the existing literature on Industry 5.0 by providing new insights into this subject. Where previous studies highlighted other aspects of Industry 5.0, this study has filled a gap by researching the impact that Industry 5.0 has on the skillset and leadership role of middle managers in the manufacturing industry. The results of this study should be interpreted as a shift in focus, meaning that the skills and leadership style that have been adopted in Industry 4.0 are not replaced; these still are useful and are present in the new industry. This study has found that instead of focusing on profit-driven automation and efficiency improvements, like in Industry 4.0, Industry 5.0 wants middle managers to adopt a more holistic view in their job by focusing on human centricity, sustainability, and resilience in their production processes. Additionally, this study has found that Industry 5.0 requires middle managers to adopt coaching, empathy, and situational leadership into their leadership style.

Therefore, based on the existing literature displayed in the theoretical framework and the results of this study, this study has found that Industry 5.0 has a significant impact on the skills and leadership role of middle managers in production organizations.

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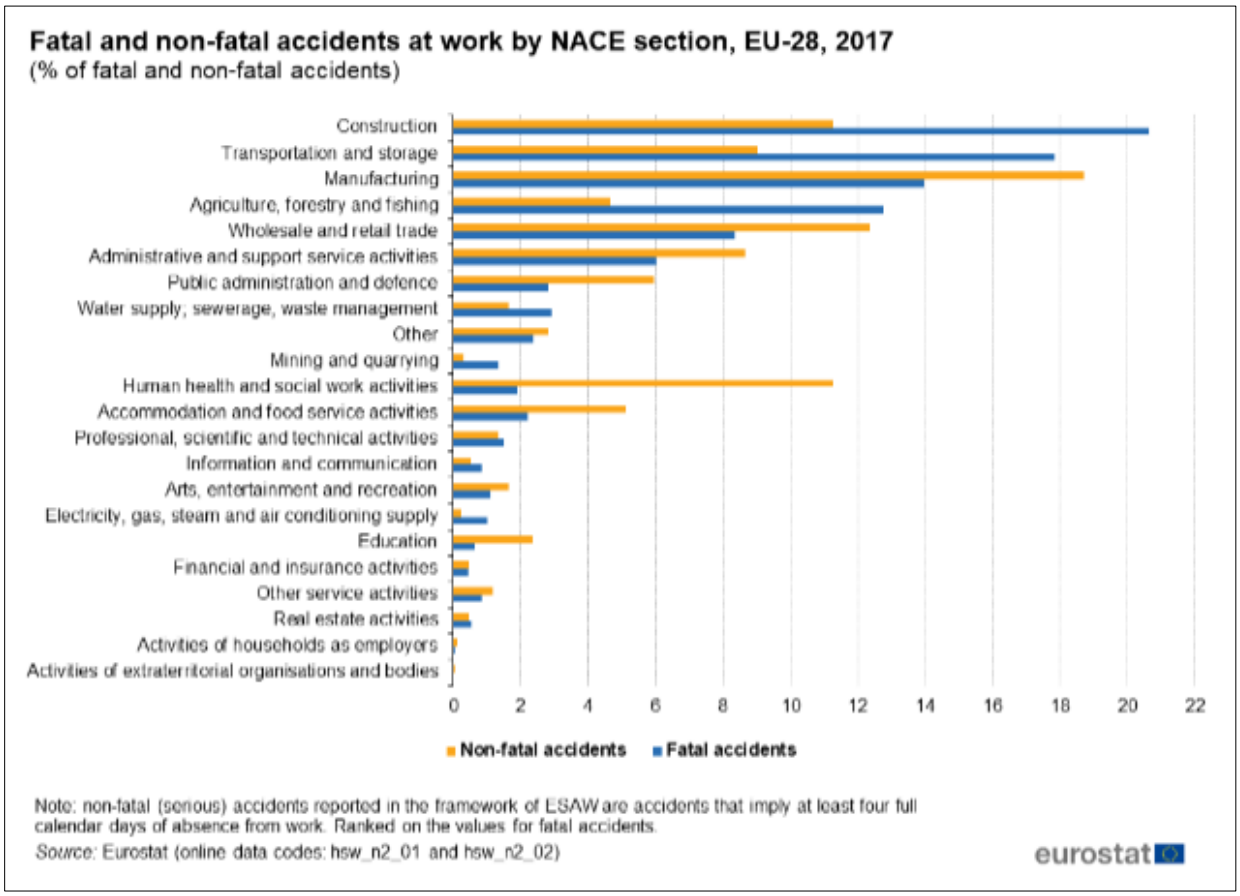
8. APPENDIX

8.1 Accidents at work listed per sector



Source: Report from European Union, 2021