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**TALENT MANAGEMENT IN THE
LOGISTICS SECTOR ACCORDING TO THE
INDUSTRY 5.0 APPROACH**

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JURY APPROVAL PAGE

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ABSTRACT

TALENT MANAGEMENT IN THE LOGISTICS SECTOR ACCORDING TO THE INDUSTRY 5.0 APPROACH

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This thesis investigates the essential skills and competencies required for effective talent management in the logistics sector within the framework of Industry 5.0. As the industrial landscape evolves, driven by advancements from Industry 1.0 to Industry 5.0, the skills needed by the workforce have undergone significant transformation. Industry 5.0 emphasizes a human-centric approach, balancing technological advancements with human well-being, sustainability, and resilience. Through a comprehensive literature review and the application of the Best-Worst Method (BWM), this study identifies and prioritizes the critical skills necessary for the logistics sector as it transitions to Industry 5.0.

The findings reveal that both Technical Skills, such as Data Analysis and Technology-Based Skills, and Soft Skills, including Critical Thinking and Problem-Solving, are important. While Workforce Readiness and Entrepreneurship also play supportive roles, the study highlights the need for a balanced approach that integrates technical expertise with human-centric abilities. These insights offer valuable guidance for organizations and managers in the logistics sector, helping them to navigate the challenges of Industry 5.0 and ensure workforce readiness and adaptability. The thesis concludes by emphasizing the importance of these skills in achieving a sustainable and resilient industrial future, aligning with contemporary research on the topic.

Keywords: Industry 5.0, Talent Management, Needed Skills in Industry 5.0, Best-Worst Method (BWM), Skills and Competencies

ÖZ

ENDÜSTRİ 5.0 YAKLAŞIMINA GÖRE LOJİSTİK SEKTÖRÜNDE YETENEK YÖNETİMİ

Kılıç, Hazal Öykü

Yüksek Lisans Tezi, Uluslararası Lojistik Yönetimi

Danışman: Prof. Dr. Yücel Öztürkoğlu

Ağustos 2024

Bu tez, Endüstri 5.0 çerçevesinde lojistik sektöründe etkili yetenek yönetimi için gerekli olan temel beceri ve yetkinlikleri araştırmaktadır. Endüstri 1.0'dan Endüstri 5.0'a kadar olan süreçte, sanayide yaşanan gelişmelerle birlikte iş gücünün ihtiyaç duyduğu beceriler önemli ölçüde değişmiştir. Endüstri 5.0, teknolojik ilerlemeleri insan refahı, sürdürülebilirlik ve dayanıklılıkla dengeleyen insan odaklı bir yaklaşımı ön plana çıkarmaktadır. Kapsamlı bir literatür taraması ve En İyi-En Kötü Yöntemi'nin (BWM) uygulanması ile bu çalışma, lojistik sektörünün Endüstri 5.0'a geçişi sırasında ihtiyaç duyulan kritik becerileri belirleyip önceliklendirmektedir.

Bulgular, Veri Analizi ve Teknoloji Tabanlı Yetkinlikler gibi Teknik Beceriler ile Eleştirel Düşünme ve Problem Çözme gibi Yumuşak Becerilerin önemli olduğunu göstermektedir. İş Gücünün Hazır Bulunuşluğu ve Girişimcilik de destekleyici roller oynasa da, çalışma teknik uzmanlık ile insan odaklı yeteneklerin entegre edildiği dengeli bir yaklaşıma duyulan ihtiyacı vurgulamaktadır. Bu bulgular, lojistik sektöründeki kuruluşlar ve yöneticilere, Endüstri 5.0'ın getirdiği zorlukları aşmaları ve iş gücünün hazır bulunuşluğunu ve uyum yeteneğini sağlamaları konusunda değerli rehberlik sunmaktadır. Tez, sürdürülebilir ve dayanıklı bir sanayi geleceği için bu becerilerin önemini vurgulayarak, güncel araştırmalarla uyumlu sonuçlara ulaşmaktadır.

Anahtar Kelimeler: Endüstri 5.0, Yetenek Yönetimi, Endüstri 5.0'da Gerekli Beceriler, En İyi-En Kötü Yöntemi (BWM), Beceri ve Yetkinlikler

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Hazal Öykü Kılıç

İzmir, 2024

TEXT OF OATH

I declare and honestly confirm that my study, titled “TALENT MANAGEMENT IN THE LOGISTICS SECTOR ACCORDING TO THE INDUSTRY 5.0 APPROACH” and presented as a Master’s in Art Thesis, has been written without applying any assistance inconsistent with scientific ethics and traditions. I declare, to the best of my knowledge and belief, that all content and ideas drawn directly or indirectly from external sources are indicated in the text and listed in the list of references.

Hazal Öykü Kılıç

22.08.2024



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SYMBOLS AND ABBREVIATIONS

ABBREVIATIONS:

AHP	Analytical Hierarchy Process
AI	Artificial Intelligence
ANP	Analytic Network Process
BWM	Best-Worst Method
ICT	Information and Communication Technology
IoT	Internet of Things
MADM	Multi-Attribute Decision-Making
MCDM	Multi-Criteria Decision-Making
MODM	Multi-Objective Decision-Making
TOPSIS	Technique for Order of Preference by Similarity to Ideal Solution

1. CHAPTER: INTRODUCTION

The evolution of industrial revolutions has significantly transformed the skills required in the workforce, from the mechanized processes of the 18th century to the technologically advanced systems of today. Each industrial revolution brought about profound changes in how work was performed, and the skills needed to meet these new demands. The First Industrial Revolution in the 18th century, marked by the invention of the steam engine, led to a shift from manual labor to mechanized production, resulting in the decline of certain traditional crafts but also the emergence of new occupations. As steam power became central to industrial processes, the demand for labor adapted, leading to the creation of new job opportunities and an overall increase in employment capacity. The subsequent industrial revolutions continued this trend, with each new technological advancement leading to similar transformations in both the economy and the nature of work (Çağlak, 2017).

The Fourth Industrial Revolution, or Industry 4.0, publicly introduced at the 2011 Hannover Fair in Germany, represented a further leap in this trajectory by integrating advanced technologies such as artificial intelligence (AI), big data, cloud computing, and cyber-physical systems into manufacturing and organizational processes (Demir et al., 2019). These innovations promised unprecedented levels of efficiency and productivity but also raised concerns about the potential displacement of human workers by smart machines and AI-driven systems (Horváth & Szabó, 2019). The transition to Industry 4.0 was expected to lead to significant structural changes across all sectors, with some occupations becoming obsolete while others would need to evolve substantially to remain relevant (Çağlak, 2017).

Despite the technological advancements of Industry 4.0, its approach often lacked consideration for the human element in industrial processes, focusing predominantly on optimization and efficiency. This has led to criticisms about the neglect of environmental consciousness and the human costs associated with process automation (Nahavandi, 2019). The role of human resources became a central issue, as the digital revolution demanded not only technological competencies but also a profound

reconsideration of human resource management in an increasingly automated world (Sivathanu & Pillai, 2018; Hecklau et al., 2016).

In response to these challenges, the concept of Industry 5.0 has emerged as an evolution of Industry 4.0, aiming to reintegrate the human factor into industrial processes. Unlike its predecessor, Industry 5.0 emphasizes a human-centric approach, where the focus is not solely on what technology can achieve, but on how technology can be used to enhance human well-being and social prosperity (Xu et al., 2021). According to this new framework, humans and machines will work together to develop more resilient and sustainable industrial systems by utilizing human creativity, emotional intelligence, and intuition in addition to machine precision and efficiency (Carayannis et al., 2022).

Industry 5.0 thus calls for a reevaluation of the skills required in the modern workforce. The importance of technical skills is still present, but soft skills—like emotional intelligence, creativity, critical thinking, and resilience—are becoming more and more valued since they are essential for negotiating the challenges of human-machine collaboration (Mingaleva & Vukovic, 2020; Pölönen, 2021). These skills are not only necessary for effective communication and decision-making in a hybrid work environment but also for ensuring that technology is harnessed in a way that benefits society as a whole.

As organizations transition towards Industry 5.0, they face the challenge of redefining job roles and developing educational programs that equip workers with the necessary competencies for this new industrial landscape. The European Commission's vision for Industry 5.0 highlights the importance of sustainable production, human-centricity, and resilience, emphasizing that the future of the industry lies in creating systems that are adaptable to change and focused on the well-being of workers (European Commission et al., 2021). In order to create a more inclusive and fair industrial future, it is important that as we advance, the integration of cutting-edge technologies in the workplace is balanced with a dedication to human values and social responsibility.

This thesis is structured to provide a thorough exploration of the skills and competencies essential for effective talent management in the logistics sector within the context of Industry 5.0. Chapter 2 begins by offering a historical overview, tracing the progression of industrial revolutions from Industry 1.0 to Industry 5.0. This chapter

emphasizes the impact of these transformations on the skills demanded by the workforce, with a particular focus on the distinct characteristics of Industry 5.0, such as its emphasis on human-centricity, resilience, and sustainability. The chapter sets the stage for understanding how Industry 5.0 differentiates itself from previous industrial eras, particularly in terms of the evolving skill requirements.

Chapter 3 explores a comprehensive literature review, identifying the key skills and competencies relevant to Industry 4.0 and 5.0. Through the synthesis of various empirical studies and theoretical frameworks, this chapter provides a broad understanding of the critical skills necessary in the modern industrial landscape. The literature review forms the foundation for identifying the skills that are increasingly vital in the transition to Industry 5.0.

Chapter 4 details the methodology used to identify and prioritize the essential skills for talent management in the logistics sector. The Best-Worst Method (BWM) is employed to systematically assess the significance of various skills based on expert input and a structured decision-making process. This chapter outlines how the BWM is applied to ensure a rigorous evaluation of the skills most relevant to Industry 5.0.

Chapter 5 explains the practical implications of the BWM findings, drawing on insights from 10 experts within the logistics sector. This chapter discusses how these experts evaluated the relevance and importance of different skills, offering a real-world perspective on the evolving demands within the logistics industry as it adapts to Industry 5.0.

In the 6th and the last chapter, the study's findings are discussed and analyzed, with an emphasis on the key skills prioritized for Industry 5.0 and their implications for talent management. The focus is on how workforce readiness and adaptability can be optimized to meet Industry 5.0's challenges. The conclusion synthesizes the importance of technical and soft skills, advocating for a balanced approach that integrates both. As companies make the shift to Industry 5.0, they must also consider the larger implications for people management in the logistics industry.

2. CHAPTER: INDUSTRIAL REVOLUTIONS

The term “Industrial Revolution” was initially introduced by the French historian Louis-Gabriel Michaud. In his publication “The Biographical Dictionary of Modern France” in 1837, Michaud utilized the term “Révolution Industrielle” (Industrial Revolution). Subsequently, this term was translated into English and gained broader usage. Some sources state that Arnold Toynbee first used the term for Britain's economic development (Mathur et al., 2022; Wilson, 2014).

Arnold Toynbee integrated the term “Industrial Revolution” into his scholarly work, “The Industrial Revolution”, in 1884. One of the first books about the Industrial Revolution, this one helped to popularize the phrase. With the advancement of technology, new methods emerged in production aimed at reducing human labor. These significant changes in production techniques and technologies are recognized as the Industrial Revolution (Mathur et al., 2022).

The evolution of industrial history, industrial revolutions, and the path that led to modern production methods must all be studied in order to fully comprehend the idea of Industry 5.0. This chapter explores the development of manufacturing processes during the course of the five Industrial Revolutions, focusing on historical and contemporary developments.

2.1. First Industrial Revolution (Industry 1.0)

For numerous years, a multitude of commodities have been produced or utilized through the labor of both animals and humans. The First Industrial Revolution (Industry 1.0), which began in the 18th century, was characterized by significant advancements in manufacturing processes driven by steam power and mechanization. This era saw the transition from traditional hand production methods to the use of machines, new chemical manufacturing techniques, and the increasing utilization of steam and waterpower (Weightman, 2010). Steam engines were employed to drive weaving looms, changing the shift in reliance on manual labor (Antony et al., 2005).

The introduction of steam-powered transportation, such as steamships and locomotives, enabled rapid movement of people and goods over long distances, contributing to urbanization and the transformation of society from agrarian to industrial (Landes, 2003).

In Britain, where the First Industrial Revolution originated, technological innovations fueled economic growth and commercial dominance, setting the stage for modern capitalism and sustained per-capita economic growth (Ashton, 1998). The emergence of factories and the development of mechanical processes resulted in higher average salaries, higher productivity, and unheard-of population growth. (Weightman, 2010).

The impact of the First Industrial Revolution extended beyond manufacturing to fundamentally reshape daily life, sparking societal changes, urbanization, and the emergence of new forms of labor and business organization (Sharma & Singh, 2020). This period laid the groundwork for subsequent industrial revolutions and marked a pivotal moment in human history, comparable in significance to the domestication of animals and plants in terms of its transformative impact (Weightman, 2010).

Overall, the First Industrial Revolution epitomized a shift towards modern industrial economies, driven by technological innovations like the steam engine. These innovations not only increased productivity but also laid the foundation for the expansion of global trade and the development of modern capitalist societies (Stearns, 2012).

2.2. Second Industrial Revolution (Industry 2.0)

The Second Industrial Revolution (Industrial 2.0), which occurred in the late 19th and early 20th centuries, was marked by significant technological advancements in steel production, electricity, and petroleum refining, which revolutionized various industries (Iyer, 2018).

The broad use of electricity and the use of assembly-line industrial techniques were two important advancements during this era. These innovations, such as the internal combustion engine, facilitated the entry of electrical machines into industry and transportation, significantly reducing energy loss previously associated with steam engines (Saidy, 2021).

Assembly line production, pioneered by Henry Ford's implementation in automobile manufacturing, transformed production processes, enabling faster and more cost-effective mass production of goods (Donovan, 1997). This period, known as the Technological Revolution or Industry 2.0, witnessed a surge in standardization and industrialization, characterized by the introduction of key technologies like telegraph and railroad networks, gas and water supply, and sewage systems (Saidy, 2021).

The Second Industrial Revolution was characterized by rapid industrial growth, driven by new energy sources like coal, electricity, and petroleum, which powered the expansion of production processes, including the establishment of energy centers and the proliferation of electric motors (Günay, 2002). It also saw the advancements of transformative inventions like the gasoline engine and airplanes, which revolutionized transportation and industry, contributing to urbanization as workers migrated from rural areas to urban centers for factory jobs (Donovan, 1997). Urbanization was further accelerated by innovations such as electric lighting, radio, and telephones, which reshaped daily life and communication (Jensen, 1993).

The socio-cultural impact of the Second Industrial Revolution was profound, with improvements in education, healthcare, and transportation in countries adapting to industrialization (Özdoğan, 2019). Mass production and the development of interchangeable parts streamlined manufacturing, contributing to economies of scale and the rise of consumer culture (Görçün, 2020).

In summary, the Second Industrial Revolution was an era of rapid technological progress, mass production, and urbanization, significantly transforming society and paving the way for modern industrialized nations (Karabacak & Dilmaç, 2021). It was a period defined by innovative breakthroughs and the integration of new technologies into manufacturing, transportation, and communication systems, setting the stage for subsequent economic and social developments.

2.3. Third Industrial Revolution (Industry 3.0)

The Third Industrial Revolution (Industry 3.0) unfolded as a transformative period in the history of industrialization, beginning around the 1960s and extending into the early 21st century. This era was defined by the integration and widespread adoption of automation systems, computers, robots, and digital technologies into manufacturing

processes, marking a significant shift towards digitalization and automation (Xu et al., 2018).

Advancements such as the discovery of the transistor during the mid-20th century played a pivotal role in laying the groundwork for the Third Industrial Revolution (Özdoğan, 2019). The development of programmable machines and automation systems enabled the automation of manufacturing processes, leading to improved productivity, efficiency, and precision in industrial operations (Sharma et al., 2021).

A key hallmark of the Third Industrial Revolution was the rapid adoption of digital technologies, including computers, the internet, and mobile devices, which revolutionized industrial production and control systems (Ghobakhloo et al., 2021). This integration of digital technologies enabled machine control and automated production, enabling a significant departure from traditional manual processes (Garbie, 2016; Ghobakhloo et al., 2021).

The transition to digital technologies during the Third Industrial Revolution also had profound implications for global industries. Semiconductors, mainframe computing, and personal computing became instrumental in driving the shift from analog to digital technologies across various sectors (Rifkin, 2011). This shift facilitated the automation of tasks and processes previously reliant on human intervention (Fremdling, 1996; Lucas, 2004).

Moreover, the Third Industrial Revolution included both technological and socio-economic changes. Globalization trends, emerging during this period, contributed to the development of a unified global market, transforming business practices and supply chain management (Özsoylu, 2017). New business models emerged, driven by digital technologies, fostering the growth of e-commerce and social media platforms (Taş, 2018).

The impact of the Third Industrial Revolution extended beyond industrial sectors, reshaping societal interactions and consumer behavior. This era laid the groundwork for future technological innovations, including the Internet of Things (IoT), blockchain technology, and AI (Özdoğan, 2019). These innovations continue to redefine modern industrial processes and shape the trajectory of technological advancement.

It was characterized by the widespread adoption of digital technologies, automation, and globalization. This period represents a transformative chapter in industrial history,

showing a shift towards digitalization and setting the stage for subsequent technological revolutions.

2.4. Fourth Industrial Revolution (Industry 4.0)

The evolution of industrialization, shaped by different eras of transformation, represents a profound progression from the age of water and steam-powered machines post the initial industrial revolution, through the era of electrically driven systems, and ultimately to the age of digitally automated production and services. These transitions have led to increasingly intricate, automated, and sustainable production processes, culminating in what we now recognize as Industry 4.0.

The term “Industry 4.0” was first used by the German government in 2011 during the Hannover Fair to describe a plan to assist the German industry in meeting upcoming problems. It refers to the fourth Industrial Revolution, in which disruptive digital technologies are significantly impacting industrial output (Marzano & Martinovs, 2020).

Emerging from the foundational developments of previous industrial revolutions, Industry 4.0 embodies the blending of physical and virtual realms, characterized by highly interactive virtual information networks and the representation of physical objects within them. This revolution encompasses wireless network connectivity, cyber technologies, integrated automation, and cloud computing, all of which will pave the way for the establishment of smart factories over time (Dalenogare et al., 2018).

The core objectives of Industry 4.0 include minimizing waste, enhancing process flexibility, developing personalized solutions, maximizing energy efficiency, achieving high-quality production at low costs, optimizing underutilized production areas, accelerating operational speeds while mitigating risks, and establishing sustainable competitive advantages (Barreto et al., 2017; Gürpınar, 2022).

Similar to its predecessors, Industry 4.0 has triggered transformative shifts in human lifestyles and work patterns. Its development represents a significant shift in industrial processes, integrating advanced digital technologies to transform manufacturing and service sectors. This concept builds upon earlier industrial revolutions, incorporating information and communication technologies (ICT) to create “smart factories” and enhance production efficiency and flexibility (Culot et al., 2020; Qin et al., 2016;

Saidy, 2021), while leveraging advanced digital technologies like the IoT, AI, big data analytics, and robotics (Akgül & Ayer, 2020). This global phenomenon has significant economic implications, impacting every sector and facet of human life, building on the achievements of prior eras while introducing unprecedented speed, scope, and scale of change.

By leveraging intelligent equipment, robotics, IoT, and big data analytics, Industry 4.0 empowers manufacturing intelligence and enables predictive maintenance, self-organized logistics, and autonomous production systems. This technological convergence has the potential to revolutionize factory environments, enabling machines to predict failures and trigger maintenance processes autonomously while also facilitating self-organized logistics that adapt to changes in production (Sharma et al., 2021; Wang et al., 2020).

Moreover, the adoption of Industry 4.0 technologies transforms the nature of work, creating smarter networks and more efficient workflows. Digitalization enables the delivery of critical information to maintenance professionals in real time, reducing downtime and optimizing problem-solving activities (Lee et al., 2015).

In essence, Industry 4.0 represents a transformative era characterized by the integration of advanced digital technologies into manufacturing and service industries, paving the way for smarter, more efficient, and flexible production processes (Hermann et al., 2016; Xu et al., 2018). This paradigm shift not only impacts industrial environments but also influences job descriptions and the requisite skills sought for these positions.

2.5. Fifth Industrial Revolution (Industry 5.0)

Industry 5.0 signifies a progression beyond Industry 4.0, aimed at rectifying significant limitations and challenges posed by the Fourth Industrial Revolution. While Industry 4.0 centered on process automation and efficiency using technologies like edge computing, it inadvertently neglected the human impact of these optimizations. This oversight is expected to become more apparent in the future as the consequences of Industry 4.0 unfold, leading to opposition from labor unions and policymakers concerned about employment implications. In response, Industry 5.0 proposes a collaborative model where humans and machines work together to enhance process efficiency, utilizing human creativity and intelligence alongside autonomous systems (Nahavandi, 2019).

The idea of Industry 5.0 stemmed from the European Commission's acknowledgment of the pressing requirement to integrate social and environmental concerns into technological advancement. This initiative targets significant societal problems, including transitioning to a circular economy and strengthening industrial resilience in the face of global disruptions like the COVID-19 pandemic (European Commission et al., 2021). By moving towards a holistic, systematic strategy than singular technologies, Industry 5.0 aims to enable industries to pursue broader societal objectives beyond mere economic expansion (Xu et al., 2018).

Moreover, Industry 5.0 includes and is defined by a set of core values: Human-centricity, sustainability, and resilience. Human-centricity emphasizes placing fundamental human needs and interests at the center of production processes, transforming industry workers from mere “costs” to valuable investments. Sustainability promotes the adoption of circular processes that reduce waste and environmental impact, fostering resource efficiency and a circular economy. Resilience highlights the need for industrial production to be robust and adaptable, capable of navigating geopolitical shifts and crises effectively (European Commission et al., 2021; Xu et al., 2018).

It can be said that Industry 5.0 represents a fundamental departure from the technology-driven focus of Industry 4.0 towards a value-driven industrial revolution that aligns with broader societal aspirations and environmental imperatives. This evolution highlights a transformative shift in how industries perceive their role in society, emphasizing not only economic prosperity but also the wellbeing of workers and the responsible stewardship of planetary resources.

As we transition from Industry 4.0 to Industry 5.0, the emphasis shifts from the automation and digitalization of manufacturing processes to a more human-centric, sustainable, and resilient approach. Industry 5.0 aspires to a symbiotic link between human creativity and cutting-edge technologies, with a focus on worker welfare and the sustainability of industrial processes. The shift in the role of human workers to augment and improve technical capabilities necessitates a new set of abilities and competencies. Understanding the specific competencies needed for Industry 5.0 is crucial for preparing the workforce of the future and ensuring that technological progress aligns with human and environmental well-being. In the next chapter, the literature review explores the transition from Industry 4.0 to Industry 5.0, emphasizing

the evolving skills and competencies required, the integration of advanced technologies, and the importance of human-centric, sustainable, and resilient industrial practices.

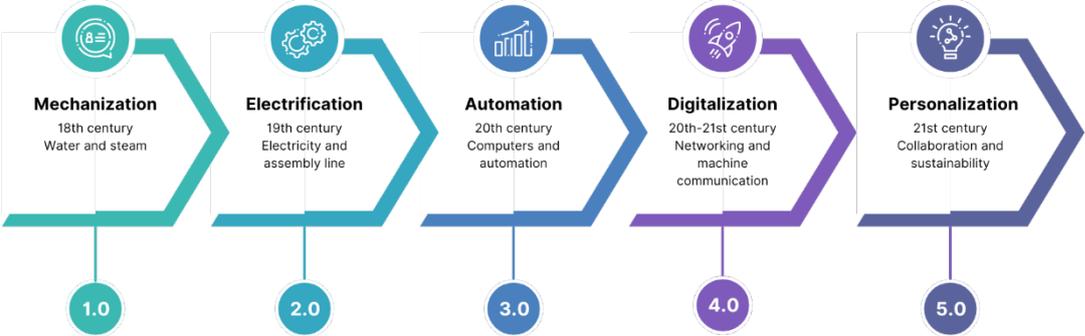


Figure 2.1. Industry 1.0 to Industry 5.0
Source: Adapted from Mathur et al. (2022)

In this chapter, the historical evolution of industrial revolutions was examined, from the steam powered First Industrial Revolution through the digital advancements of the Fourth Industrial Revolution, resulting in the emerging concept of Industry 5.0. Figure 2.1 represents the historical development of Industry 1.0 to 5.0. This progression highlights the shift from technology-driven advancements to a value-driven industrial paradigm focusing on human-centricity, sustainability, and resilience. The exploration of these transformations sets the stage for understanding Industry 5.0, where collaboration between humans and machines addresses broader societal and environmental goals.

In the next chapter, an in-depth literature review will be conducted to identify and analyze the evolving skills and competencies required for Industry 5.0. This review will emphasize the integration of advanced technologies and the importance of fostering a human-centric, sustainable, and resilient industrial environment.

3. CHAPTER: SKILLS AND COMPETENCIES FOR INDUSTRY

5.0

Rapid technological advancements have continuously transformed the industrial landscape. Industry 4.0 and the emerging Industry 5.0 represent significant shifts in how industries operate, emphasizing technological integration and human-centric approaches, respectively. This literature review aims to provide an in-depth analysis of the skills and competencies required for professionals to thrive in both Industry 4.0 and Industry 5.0, drawing on recent research findings and exploring the evolution of these skills.

Industry 4.0 involves the incorporation of digital technologies like the IoT, AI, and robotics into manufacturing systems, as explained in previous chapters. This digital transformation necessitates a new set of skills and competencies from the workforce. Proficiency in ICT, including cybersecurity and software development, is essential for managing digital manufacturing systems (Kipper et al., 2021). The ability to analyze and interpret large datasets, or big data analytics, is crucial for optimizing production processes and making data-driven decisions (Saniuk et al., 2021). Knowledge of automation technologies and robotics is fundamental for implementing smart manufacturing systems (Bongomin et al., 2020). Understanding how different components of a manufacturing system interact, known as systems thinking, is necessary for designing efficient and effective processes (Gaikwad & Pandey, 2022).

As Industry 5.0 continues to take shape, the core goal remains clear: Placing human well-being at the heart of production. This is a contrast to Industry 4.0's preoccupation with technology, as Industry 5.0 advocates for the enhancement of soft skills, particularly emotional intelligence, which is vital for boosting workforce performance. Suan Chin (2021) emphasizes Industry 5.0's focus on enhancing soft skills, revealing that emotional intelligence plays a crucial role in cognitive processes, significantly enhancing workforce performance. Their study involving executives has shown that emotional intelligence is crucial for workforce performance, with key roles for emotional recognition and expression. This focus on emotional skills highlights the

importance of fostering these attributes, reflecting a broader understanding of the human factors that drive productivity and innovation. Nousala et al. (2024) further explore the need for soft skills, addressing misconceptions and challenges in supporting their acquisition and highlighting their critical role in enhancing individual and societal well-being.

3.1. Skills and Competencies for Industry 4.0 and Industry 5.0

The emphasis on human-centric values extends to skill development, where a comprehensive realignment of competencies is underway. Engineers and professionals in Industry 5.0 are now required to possess a blend of technical and soft skills, with a focus on interdisciplinary knowledge and systemic competence development. Pacher et al. (2023) explore the requisite skills for engineers, developing a competence profile for industrial logistics engineering education, grounding it in systematic competence development, and examining the impact on job performance and satisfaction. This work informs new educational concepts, elucidating causal relationships between competence orientation and performance. Meanwhile, Leon (2023) introduces a multi-criteria decision-making methodology using the Analytic Network Process (ANP) to select professional development programs for reskilling employees in Industry 5.0, identifying teamwork, online communities, and enterprise social networks as effective options. This methodology bridges human resource management with operations management, linking employees' psychological profiles and human capital to development strategies.

Further exploration into the impacts of digital transformation reveals a complex interplay of socio-technical systems, skill-biased technological change, and the political economy of digital transformation. Kolade & Owoseni (2022) provide a systematic review of the disruptive impacts of digital transformation, identifying three theoretical perspectives: Socio-technical systems theory, skill-biased technological change, and the political economy of digital transformation. These perspectives explore technological unemployment, wage inequality, job polarization, and the evolving dynamics of technology ownership, highlighting the need for education reforms to equip the workforce with new skills and a mindset ready to tackle future challenges. The need for education reforms becomes evident as these changes demand a workforce equipped with new skills and a mindset ready to tackle future challenges.

As we navigate through these changes, the integration of human-machine collaboration emerges as a key area of focus. Kaasinen et al. (2022) discuss the design of human-machine teams, advocating for the joint cognitive systems approach supplemented by ethical considerations and human-centric design principles. This approach is crucial for developing resilient human-machine collaborations, ensuring that future factory systems are both smart and human-centered. Kemendi et al. (2022) highlight the impact of digitalization, AI, and robotization on human resources and job roles, noting the need for enterprises to adapt quickly to these trends. They stress the importance of digital and computer competencies and the security challenges in Industry 5.0, emphasizing the role of Small Medium Enterprises in this new era. Demir et al. (2019) discuss organizational and employee perspectives on human-robot co-working, identifying critical issues related to human-robot collaboration, and anticipating these challenges to be central to future research in organizational robotics.

The transition to Industry 5.0 aims to integrate advanced technologies such as AI, robotics, and IoT with human capabilities to create a more sustainable and human-centric industrial environment. Proficiency in AI, machine learning, and robotics is crucial for the development and implementation of intelligent systems that work collaboratively with humans (Brkovic et al., 2023). Understanding IoT and its applications in industrial settings is essential for connecting devices and systems to streamline operations (Iqbal et al., 2022). Skills in big data analytics are necessary for making data-driven decisions and optimizing industrial processes (Maddikunta et al., 2022). The ability to interpret complex data and derive actionable insights is critical (Pacher et al., 2023).

As Industry 5.0 focuses on human-machine collaboration, emotional intelligence and empathy are key for managing interactions between humans and intelligent systems (Takács & Pogátsnik, 2023). Workers must be adaptable to rapid technological changes and flexible in adopting new roles and responsibilities (Ghassoul & Messaadia, 2023). Innovative thinking and creative problem-solving are vital for developing new solutions and improving existing processes (Saniuk & Grabowska, 2022). Applying lean principles to eliminate waste and enhance productivity is important in a highly automated environment (Pacher et al., 2023).

To drive organizational change and negotiate the challenges of Industry 5.0, leaders require a strategic vision (Kaur et al., 2019). Effective team management skills are

essential for coordinating multidisciplinary teams and fostering collaboration (Knap-Stefaniuk, 2023). Knowledge of sustainable development practices and the ability to implement them in industrial processes are increasingly important (Iqbal et al., 2022). The capacity to make ethical decisions, particularly in the deployment of AI and robotics, is crucial for maintaining public trust and ensuring responsible innovation (Nahavandi, 2019).

3.2. Applications and Technologies in Industry 5.0

In parallel, the exploration of Industry 5.0's applications and technologies reveal a rich tapestry of possibilities, from intelligent healthcare and smart supply chains to the use of advanced technologies like edge computing, digital twins, and blockchain. Maddikunta et al. (2022) provide a survey-based tutorial on Industry 5.0, exploring its potential applications and supporting technologies. They discuss various applications such as intelligent healthcare, cloud manufacturing, and smart supply chain management, delving into technologies like edge computing, digital twins, collaborative robots, IoT, blockchain, and advanced networking technologies like 6G. The study highlights several research challenges and open issues critical for realizing Industry 5.0, laying the groundwork for future research and development in this domain. Gisi (2024) explores how automation, robotics, IoT, and advanced technologies are transforming manufacturing processes, emphasizing the integration of technologies like advanced analytics for optimizing production and predictive maintenance. The findings underscore the need for manufacturers to embrace these technologies to enhance efficiency, agility, and sustainability.

3.3. Sustainability and Socioeconomic Impacts

As the focus on human-centric and sustainable technologies gains momentum, the socioeconomic impacts of emerging technologies become increasingly significant. Fadziso et al. (2022) explore the integration of robotics, IoT, and additive manufacturing in the transition to Industry 5.0. Their study discusses the broader socioeconomic implications, such as job displacement and income inequality, and stresses the necessity of integrating human-centered technology and digital literacy into the core of technological advancements. They advocate for proactive strategies and collaborative efforts to build a sustainable digital future, ensuring that technological progress benefits society as a whole.

In a related vein, Leng et al. (2022) review the defining characteristics of Industry 5.0—human-centricity, sustainability, and resiliency (Figure 3.1.)—and propose a tridimensional system architecture for its implementation. They identify critical enablers, applications, and challenges, urging future research to address existing limitations and stimulating discussions toward a comprehensive Industry 5.0 framework. This approach aims to create a cohesive vision that aligns technological advancements with human and environmental well-being.

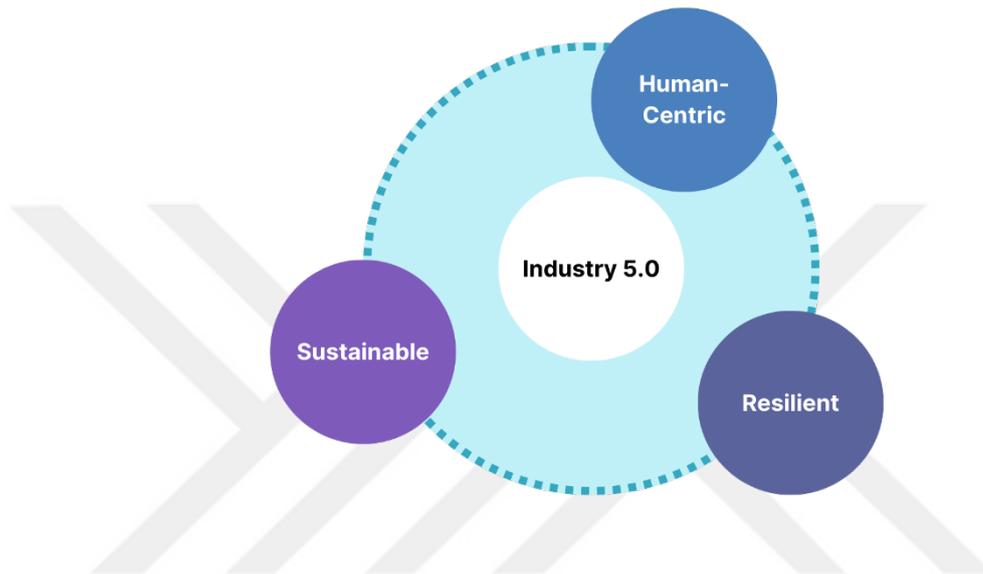


Figure 3.1. Industry 5.0 Characteristics

Source: Author

3.4. Educational and Training Models

Addressing the skills gap is pivotal for realizing Industry 5.0. Brkovic et al. (2023) explore this gap, emphasizing the integration of advanced technologies with human capabilities. They analyze strategies to bridge this gap, stressing the importance of digital literacy, continuous skill development, and the creation of a future-ready workforce. Their insights are invaluable for stakeholders aiming to establish a resilient workforce, supporting ongoing research in skill development and transformation.

Using text-mining algorithms on job adverts, Pejic-Bach et al. (2020) conducted a similar exploration and created a job model for Industry 4.0. The study identifies competencies related to cyber-physical systems, IoT, smart production, and areas like supply chain management. It reveals that job ads for Industry 4.0 roles focused on specific knowledge and competencies tailored to the industry's demands. This

practical profiling approach offers significant insights for educational institutions, human resources professionals, and industry experts, guiding them in aligning education and training with industry needs.

Fareri et al. (2020) investigate the impact of Industry 4.0 on job profiles, emphasizing the creation of new skills alongside existing ones. By analyzing job profiles at Whirlpool using text mining, they quantify employee readiness for Industry 4.0, identifying key technologies, techniques, and skills. Their study highlights the differences between profiles ready for Industry 4.0 and those that are not, offering a novel framework for assessing Industry 4.0 readiness and providing a valuable tool for organizations aiming to bridge the skills gap effectively.

Navigating the challenges of talent management in the era of Industry 5.0 reveals critical gaps between employee capabilities and the evolving demands of their roles. Whysall et al. (2019) explore these dynamics, emphasizing the pivotal role of middle managers in change management. They argue for dynamic, systems-thinking talent management practices that are essential for keeping pace with rapid technological advancements, ensuring that employee skills align with new industry requirements.

Kipper et al. (2021) contribute to this discussion by identifying essential competencies for Industry 4.0 through a systematic literature review and scientific mapping. Their findings highlight skills such as leadership, creativity, problem-solving, and interdisciplinary knowledge, alongside ICT, algorithms, and automation. They advocate for the development of “learning factories”, which provide hands-on experiences, thereby aligning education with the demands of Industry 4.0 and enhancing professional education.

The implications of policy and practical strategies for workforce development are further explored by Kazançoğlu & Özkan-Özen (2018) and García et al. (2022). Both studies emphasize the use of fuzzy multi-criteria decision-making (MCDM) methodologies and the integration of soft skills into workforce planning. Singh & Alhabbas (2024) extend this discussion by focusing on workforce development in Saudi Arabia, recommending technology-driven training and international collaboration to enhance local talent, aligning with the goals of Saudi Vision 2030.

Gagnidze (2022) demonstrates how clusters can address challenges associated with Industry 4.0 and 5.0, fostering local economic development. Through an analysis of

various reports and surveys, the study illustrates the development trajectory within clusters and underscores their role in driving digitalization, using innovative graphical imagery to highlight key points.

As Industry 5.0 continues to evolve, integrating technology with ethical considerations becomes increasingly vital. Kaasinen et al. (2022) discuss the design of human-machine teams, advocating for a human-centric approach enriched with ethical considerations. They identify significant challenges in developing resilient human-machine interactions. Fadziso et al. (2022) and Nousala et al. (2024) further explore the socio-economic implications of this integration, stressing the need for proactive policies in digital literacy, skill development, and ethical innovation to ensure a sustainable digital future.

Paschek et al. (2019) analyze the business impact of Industry 5.0, emphasizing the integration of human workers into automated supply chains. Their study identifies opportunities, threats, and strategic recommendations, highlighting the necessity for businesses to enhance their entrepreneurial capabilities to become Industry 5.0-ready. Demir et al. (2019) focus on the dynamics of human-robot collaboration, discussing organizational and employee challenges. They highlight advancements in robotics and AI, calling for further research into the organizational dynamics and employee perspectives in human-robot collaboration.

They look toward the future and identify critical gaps in competence development and the integration of soft skills. They propose research on decision-making methodologies and the impact of emotional intelligence on workforce performance. Gisi (2024) examines how automation, robotics, IoT, and other advanced technologies are transforming manufacturing. He stresses the need to embrace these technologies to enhance efficiency, agility, and sustainability, highlighting the transformative potential of these advancements.

In conclusion, the transition from Industry 4.0 to Industry 5.0 signifies a transformative shift towards a model that harmonizes technological advancements with human-centric values, sustainability, and resilience. This evolution underscores a fundamental change in focus—from a technology-driven paradigm to one that prioritizes human well-being and the synergy between humans, machines, and technology. The insights from various studies collectively highlight the critical need for integrating soft skills,

particularly emotional intelligence, into workforce development, while also enhancing technical skills and digital literacy. The emphasis on designing resilient human-machine collaborations and the adoption of ethical considerations further exemplifies Industry 5.0's commitment to creating systems that are both innovative and humane. As we navigate this new era, it is evident that continuous research, adaptive policies, and strategic workforce planning are essential to bridge the skills gap and ensure that the workforce is well-prepared for the challenges and opportunities of Industry 5.0. The journey towards this future is not merely about technological advancement but also about fostering balanced and sustainable growth that benefits society as a whole.

To conclude the literature review, it is evident that the transition to Industry 5.0 necessitates a thorough reassessment of the skills and competencies required for the workforce to thrive in this advanced industrial landscape. Building on the work by Ada et al. (2021), which identified essential skills for Industry 4.0—such as Project Management, Financial Management, Technology-based Skills, Digital Literacy, Literacy, Innovation, and Creativity—the scope of this study has been expanded to include the evolving needs of Industry 5.0. Table 3.1. and Table 3.2. synthesizes the findings from various empirical studies and theoretical frameworks related to skills in Industry 4.0 and Industry 5.0.

In addition to the skills identified by Ada et al. (2021), several additional competencies crucial for Industry 5.0 have been highlighted through the literature review, as can be seen in Table 3.3. For instance, Human-Machine Interaction (4.79%) has been included to address the growing importance of seamless collaboration between humans and advanced technologies, which is a core principle of Industry 5.0. Sustainability Awareness (2.97%) has been added in response to the heightened emphasis on sustainable practices within the industrial sector, which are increasingly becoming essential rather than optional. Similarly, Cybersecurity Awareness (2.28%) has been recognized as critical due to the need to secure digital infrastructure, a challenge that has intensified with the rise of Industry 5.0 technologies.

Furthermore, the necessity of Problem-solving (4.26%) and Lifelong Learning (3.95%) has been emphasized as vital for adaptability and continuous learning in a rapidly changing industrial environment. Competencies such as Analytical Thinking (3.42%), Ethical Awareness (2.36%), and Emotional Intelligence (2.13%) have also

been added to address the growing importance of cognitive and interpersonal skills, which are increasingly necessary as technology and human roles become more intertwined. In the technical domain, Robotics (3.88%) and Data Analysis (3.27%) have been included, reflecting the growing demand for specialized technical skills essential for operating and optimizing advanced systems central to Industry 5.0. These additions to the skill map are not merely enhancements but essential updates to ensure that the framework remains aligned with the future demands of Industry 5.0. By integrating these skills, it is ensured that the talent management strategies developed are robust, forward-thinking, and fully aligned with the evolving needs of this new industrial era. The frequency and percentage of these skills within the overall framework further validate their importance and provide a scientifically sound basis for their inclusion in the skill map.

Table 3.3. Skills found in the literature review

Skill Set	Freq.	in %	Skill Set	Freq.	in %
Workforce Readiness			Soft Skills		
Human-machine Interaction	63	4.98%	Adaptability	65	5.14%
Digital Literacy	55	4.35%	Collaboration/ Teamwork	63	4.98%
Sustainability Awareness	39	3.08%	Problem-solving	56	4.43%
Cybersecurity Awareness	30	2.37%	Lifelong Learning	52	4.11%
Time Management	21	1.66%	Communication	50	3.95%
Professionalism	17	1.34%	Critical & Analytical Thinking	45	3.56%
Social Norms	8	0.63%	Leadership	33	2.61%
Numeracy	5	0.40%	Ethical Awareness	31	2.45%
Etiquette	2	0.16%	Growth Mindset	29	2.29%
Self-Presentation	2	0.16%	Emotional Intelligence	28	2.21%
Resume Writing	1	0.08%	Cultural Awareness	16	1.26%
Subtotal	243	19.21%	Empathy	15	1.19%
			Self-Confidence	10	0.79%
			Social-Emotional Learning	10	0.79%
			Subtotal	503	39.76%

Skill Set	Freq.	in %	Skill Set	Freq.	in %
Technical Skills			Entrepreneurship		
Technology-based Skills	67	5.30%	Innovation	63	4.98%
Robotics	51	4.03%	Creativity	52	4.11%
Data Analysis	43	3.40%	Resilience	43	3.40%
Project Management	30	2.37%	Initiative	29	2.29%
Computer Programming	29	2.29%	Business Acumen	23	1.82%
Scientific Tasks	13	1.03%	Resourcefulness	14	1.11%
Mechanical Functions	11	0.87%	Business Execution	10	0.79%
Financial Management	5	0.40%	Ingenuity	9	0.71%
Subtotal	249	19.68%	Curiosity	7	0.55%
			Risk-Taking	7	0.55%
			Courage	6	0.47%
			Optimism	4	0.32%
			Industriousness	3	0.24%
			Subtotal	270	21.34%
			TOTAL	1265	100.00%

Source: Author

In this chapter, a comprehensive literature review was conducted to explore and analyze the skills required for Industry 4.0 and Industry 5.0. The review highlighted the evolution of these skills, the distinctions between the two industrial paradigms, and the challenges associated with the transition. This foundation sets the stage for the subsequent chapter, where the methodology employed in this thesis will be detailed, guiding the empirical investigation of the identified skills within the context of Industry 5.0.

4. CHAPTER: METHODOLOGY: BEST WORST METHOD

Multi-Criteria Decision-Making (MCDM) is a decision support tool designed to evaluate and compare various options or scenarios by considering multiple criteria. This approach helps decision-makers arrive at a well-rounded and fair decision. MCDM problems can be categorized into two types based on their solution space: Multi-Objective Decision-Making (MODM) for continuous problems with an infinite set of alternatives, and Multi-Attribute Decision-Making (MADM) for discrete problems with a finite number of alternatives (Nispeling, 2015). In practice, MCDM is often used synonymously with MADM, particularly in literature concerning discrete alternatives (Rezaei, 2015).

An MCDM problem is typically represented as a matrix, where alternatives are evaluated against a set of criteria. The goal is to select the best alternative based on these evaluations. A simple additive weighted value function can be used to obtain each alternative's overall value. Each alternative's score is computed by multiplying its corresponding alternative score by the product of the criteria weights (Keeney & Raiffa, 1993).

MCDM is applied to evaluate alternatives against various criteria, often represented as a matrix. The goal is to select the best alternative, i.e., the one with the highest overall score. This score is typically calculated using a weighted sum of criteria scores. The general form of the additive weighted value function is given by:

$$V_i = \sum_{j=1}^n w_j a_{ij} \quad (1)$$

where V_i is the overall value of alternative i , w_j is the weight of criterion j , and a_{ij} is the score of alternative i with respect to criterion j (Keeney & Raiffa, 1993).

Several MCDM methods have been developed to weigh multiple decision criteria and derive solutions, including Analytical Hierarchy Process (AHP) (Saaty, 1990), the ANP (Saaty, 2001), and the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) (Hwang & Yoon, 1981).

These techniques frequently assess choice alternatives based on expert opinions through pairwise comparisons. Nevertheless, methodological issues can arise because of things like complicated questions, ignorance, and respondent weariness, which can affect how consistently these comparisons are made (Rezaei, 2015).

The Best-Worst Method (BWM) is a relatively new and efficient MCDM method proposed by Rezaei (2015). It uses two sets of pairwise comparisons to determine the weights of criteria and the scores of alternatives. Compared to other methods like AHP, BWM requires fewer comparisons and tends to produce more consistent results.

Steps of BWM includes:

1. **Determine a set of decision criteria:** Define the criteria $\{C_1, C_2, \dots, C_n\}$ to be used in the evaluation process.
2. **Identify the best and worst criteria:** Select the most important (best) criterion and the least important (worst) criterion among the set.
3. **Perform best-to-others comparisons:** Evaluate the preference of the best criterion over all other criteria using a scale from 1 to 9. This results in a best-to-others vector $A_B = (a_{B1}, a_{B2}, \dots, a_{Bn})$ where a_{Bj} indicates the preference of the best criterion B over criterion j.
4. **Perform others-to-worst comparisons:** Evaluate the preference of all other criteria over the worst criterion, resulting in an others-to-worst vector $A_W = (a_{1W}, a_{2W}, \dots, a_{nW})$, where a_{jW} indicates the preference of criterion j over the worst criterion W.
5. **Calculate criteria weights:** Determine the optimal weights $(w_1^*, w_2^*, \dots, w_n^*)$ by solving the following linear optimization problem, which minimizes the maximum absolute differences between the calculated and observed preferences:

$$\min \xi \quad (2)$$

subject to:

$$|w_B - a_{Bj}w_j| \leq \xi, \quad \forall_j \quad (3)$$

$$|w_j - a_{jW}w_W| \leq \xi, \quad \forall_j \quad (4)$$

$$\sum_{j=1}^n w_j = 1 \quad (5)$$

$$w_j \geq 0, \quad \forall_j \quad (6)$$

The consistency of the comparisons in BWM is assessed using a consistency indicator, ξ . Lower values of ξ indicate higher consistency. The matrix of pairwise comparisons is fully consistent if for all j , $a_{Bj} \times a_{jW} = a_{BW}$ (Rezaei, 2015).

By applying MCDM and specifically BWM, decision-makers can systematically and objectively evaluate multiple criteria and make informed choices in complex decision-making scenarios. In the next chapter, the methodology applied for this thesis is explained.



5. CHAPTER: IMPLEMENTATION

The purpose of this study is to identify and prioritize the essential skills required for talent management in the logistics sector within the framework of Industry 5.0. In this research, BWM is applied to identify and prioritize the essential skills required for talent management in the logistics sector according to the Industry 5.0 approach. As it is comprehensively described in Chapter 2, Industry 5.0 emphasizes the collaboration between humans and machines, focusing on human-centricity, resilience, and sustainability.

In Chapter 3, a comprehensive literature review is conducted to identify relevant skills for Industry 4.0 and 5.0. The literature review involved analyzing empirical studies and theoretical frameworks, as summarized in Table 3.1 and Table 3.2.

Table 5.1. Criteria and Explanation

Expert	Sector	Area of Expertise	Experience	Location
1	Forwarder	Country Sales Manager	17 years	İstanbul, TR
2	Forwarder	General Manager	25 years	İstanbul, TR
3	Forwarder	Operation Manager	14 years	İzmir, TR
4	Manufacturing	Supply Chain Manager	15 years	İzmir, TR
5	Manufacturing	Logistics Manager	22 years	İstanbul, TR

Source: Author

Given the extensive list of 47 skills identified, a focused selection process was conducted to prioritize those with the highest frequency and those most relevant to Industry 5.0. These key skills, identified through a thorough literature review, were further evaluated by 5 experts to ensure their critical relevance in the context of Industry 5.0. Information on the experts, including their backgrounds and sectors, is detailed in Table 5.1. The skills are summarized in Table 5.2.

Table 5.2. Criteria and Explanation

Criteria	Explanation
Social Norms	Social norms are the established standards of acceptable behavior within a community, decisively shaping individuals' decisions by setting clear expectations of what is deemed acceptable or unacceptable (Lapinski & Rimal, 2005).
Professionalism	Demonstrating professionalism in behavior, interactions, and work ethic entails being reliable, responsible, and maintaining a positive attitude towards duties and colleagues (Gisi, 2024).
Time Management	Showing excellent time management abilities by setting priorities, creating plans, and efficiently allocating resources to fulfill project milestones and deadlines, hence guaranteeing timely work completion (Gisi, 2024).
Cybersecurity Awareness	Understanding and putting cybersecurity procedures into operation to guard against malicious activity, theft, damage, and illegal access to computer systems, networks, and sensitive data (Gisi, 2024).
Sustainability Awareness	Reusing, repurposing, and recycling natural resources is a key component of advocating for sustainability. Waste reduction and minimizing environmental effect are also important goals (Zizic, 2022).
Digital Literacy	Digital literacy involves an individual's awareness, mindset, and capability to efficiently use digital tools and resources for a range of purposes (Martin, 2006).
Human-Machine Interaction	Gaining new skills to enhance communication between humans, machines, and products, aiding in the integration of customers with digital technologies, and adapting to Industry 4.0, where mental tasks take precedence over physical labor (Fareri et al., 2020; Morgan et al., 2020; Beier et al., 2020).
Emotional Intelligence	According to Mayer & Salovey's (1993) definition, emotional intelligence is a subset of social intelligence that includes the ability to identify and control one's own emotions as well as those of others, differentiate between various emotions, and apply this knowledge to guide actions and ideas.
Leadership	Leadership is characterized as a nuanced blend of the leadership process, leadership techniques, the leader's personal attributes,

specific skills and traits, and the overall demands of the role (Gini, 1997).

Critical and Analytical Thinking	Employing critical and analytical thinking to proficiently evaluate information, conceptualize, collect data, communicate, resolve complex issues, and make well-informed decisions (Grzybowska & Łupicka, 2017).
Communication	Being proficient in collaboration, information sharing, and effective communication within a team. This includes active listening, giving feedback, and working cohesively to achieve common goals (Gisi, 2024).
Lifelong Learning	Adopting a mindset of continuous learning and skill development to stay abreast of the rapidly advancing manufacturing technologies and processes, while remaining informed about the latest industry trends and innovations (Gisi, 2024).
Problem-Solving	Exhibiting the capability to recognize and address intricate technical challenges that occur during equipment construction, utilizing robust analytical and troubleshooting skills to devise innovative solutions (Gisi, 2024; Grzybowska & Łupicka, 2017).
Collaboration/ Teamwork	Working as a team cohesively through excellent communication and information exchange. This entails paying attention, providing criticism, and cooperating to achieve a shared objective (Gisi, 2024).
Adaptability	Being flexible and adaptable in response to unforeseen challenges, changes, or evolving requirements in manufacturing projects, while maintaining productivity and quality (Gisi, 2024).
Computer Programming	Computer programming involves creating and developing instructions that guide a computer in executing specific tasks or operations (Fang et al., 2022).
Project Management	Project management is a recognized approach designed to plan, organize, and oversee projects to ensure their successful completion (Santos et al., 2023).
Data Analysis	The methodical process of reviewing, sanitizing, converting, and modeling data in order to draw conclusions, derive insights, and support decision-making is known as data analysis. The interpretation of data analysis can differ significantly, with some focusing on the application of statistical techniques for dataset cleaning, while others

adopt a more expansive view where the distinctions between data analysis and data science become less clear (Peng & Parker, 2022).

Robotics	Employing collaborative robots (cobots) that operate alongside humans to improve productivity and safety (Gisi, 2024).
Technology-Based Skills	Technology-based skills refer to a range of competencies required to effectively use and understand various technologies, which are crucial in today's digital world. These skills include proficiency in areas such as troubleshooting, digital literacy, project management, and ICT. Beyond technical expertise, these skills also encompass cognitive, behavioral, social, and emotional competencies needed to thrive in a technology-driven environment (Kang & Ritzhaupt, 2015).
Business Execution	Business execution as a talent refers to the capability of individuals within an organization to successfully carry out strategies and attain operational excellence, thereby propelling the business forward. In this context, talent signifies key employees who have the skills, characteristics, knowledge, ambitions, and behaviors essential for business success (Sohel-Uz-Zaman, 2018).
Resourcefulness	Applying an efficiency-oriented approach that emphasizes the optimal use of resources as a key determinant of decision-making and action (Grzybowska & Łupicka, 2017).
Initiative	Järvi & Khoreva (2020) highlight those talented employees, who take the initiative as change agents, can drive and organize strategic renewal within the organization.
Resilience	Displaying the competence to effectively react to and adjust to changes in the environment (Kaasinen et al., 2022).
Creativity	Demonstrating creativity by seeing things from different viewpoints, recognizing hidden patterns, linking unrelated ideas, and coming up with new solutions (Grzybowska & Łupicka, 2017).
Innovation	Baregheh et al. (2009) offer a broader definition, proposing that innovation includes the generation, adoption, and implementation of fresh concepts, methods, goods, or solutions.

Source: Author

The skills required for Industry 5.0 by consulting experts in the logistics sector to identify the best (most crucial) and worst (least crucial) skills among the selected criteria. The experts provide their input based on their experience and understanding

of the evolving requirements in the logistics sector. These experts were selected from various sectors, including academia and the private sector, all of whom have experience working in the logistics sector. Each expert contributed based on their extensive knowledge and experience in logistics, providing a comprehensive perspective on the evolving requirements of Industry 5.0. Information on the experts, including their backgrounds and sectors, is detailed in Table 5.3.

Table 5.3. Information on Experts

Expert	Sector	Area of Expertise	Experience	Location
1	Academia	Operations Management	9 years	İzmir, TR
2	Manufacturing	Supply Chain	6 years	İzmir, TR
3	Defense	Operations and Logistics	32 years	İzmir, TR
4	Academia	Supply Chain	11 years	İzmir, TR
5	Software	Programming	39 years	İzmir, TR
6	Manufacturing	Supply Chain and Logistics	7 years	İstanbul, TR
7	Automotive	Project Management	9 years	İstanbul, TR
8	Academia	Operations and Logistics	10 years	Antalya, TR
9	Manufacturing	Product Development	17 years	Woerden, NE
10	Academia	Sustainability	8 years	İzmir, TR

Source: Author

Implementation of BWM

In this section, the process of applying the BWM to identify and prioritize the essential skills required for talent management in the logistics sector within the framework of Industry 5.0 is described.

Step 1: Determine a set of decision criteria

We begin by identifying a set of criteria that, according to our literature review, serve as the foundation for analysis using the BWM. Initially, all criteria are considered under four main pillars: *Workforce Readiness*, *Soft Skills*, *Technical Skills*, and *Entrepreneurship*. Each of these pillars encompasses various sub-criteria that are essential for decision-making within the context of Industry 5.0 in the logistics sector, as can be seen in Table 5.4.

Table 5.4. Skill Sets and Subcriterias

Workforce Readiness	Soft Skills	Technical Skills	Entrepreneurship
Social Norms	Emotional Intelligence	Computer Programming	Business Execution
Professionalism	Leadership	Project Management	Resourcefulness
Time Management	Critical and Analytical Thinking	Data Analysis	Business Acumen
Cybersecurity Awareness	Communication	Robotics	Initiative
Sustainability Awareness	Lifelong Learning	Technology-based Skills	Resilience
Digital Literacy	Problem-solving		Creativity
Human-machine interaction	Collaboration/ Teamwork		Innovation
	Adaptability		

Source: Author

Step 2: Selection of the Best and Worst Criteria

Subsequently, 10 experts in the field were engaged to determine the best (most desirable) and worst (least desirable) criteria over a comparison scale of 9 (see Table 5.5) The selection was based on their extensive experience and understanding of the logistics sector's requirements within the context of Industry 5.0.

Table 5.5. Pairwise Comparison Scale

Intensity of Importance	Definition	Explanation
1	Equal Importance	Two activities contribute equally to the objective
2	Weak or slight	Experience and judgment slightly favor one activity over another
3	Moderate importance	Experience and judgment slightly favor one activity over another

4	Moderate plus	Experience and judgment strongly favor one activity over another
5	Strong importance	Experience and judgment strongly favor one activity over another
6	Strong plus	An activity is favored very strongly over another; its dominance demonstrated in practice
7	Very strong or demonstrated importance	An activity is favored very strongly over another; its dominance demonstrated in practice
8	Very, very strong	The evidence favoring one activity over another is of the highest possible order of affirmation
9	Extreme importance	The evidence favoring one activity over another is of the highest possible order of affirmation
Reciprocals of above	If activity i has one of the above non-zero numbers assigned to it when compared with activity j , then j has the reciprocal value when compared with i	A reasonable assumption
1.1–1.9	If the activities are very close	May be difficult to assign the best value but when compared with other contrasting activities the size of the small numbers would not be too noticeable, yet they can still indicate the relative importance of the activities.

Source: This table is used to describe the fundamental scale for pairwise comparisons, as proposed by Saaty (2008)

Step 3: Assessment of the Best Criterion Over Others

The experts were then asked to rate the importance of the best criterion relative to all other criteria on a scale of 1 to 9. This process generated a vector $A_B = (a_{B1}, a_{B2}, \dots, a_{Bn})$ where a_{Bj} represents the relative importance of the best criterion B over criterion j. The best criterion itself was assigned a value of 1. As an example, Table 5.6. shows the best criterion over others step of assessment of the skill sets.

Table 5.6. Best to Others Assessment of Skill Sets

Participant	Best to Others	Workforce Readiness	Soft Skills	Technical Skills	Entrepreneurship
P1	Technical Skills	3	4	1	8
P2	Technical Skills	3	2	1	7
P3	Soft Skills	3	1	2	7
P4	Technical Skills	2	4	1	8
P5	Technical Skills	4	2	1	7
P6	Soft Skills	8	1	2	4
P7	Soft Skills	7	1	3	5
P8	Technical Skills	4	2	1	8
P9	Soft Skills	7	1	3	5
P10	Soft Skills	3	1	5	9

Source: Author

Step 4: Assessment of the Worst Criterion Over Others

Similarly, experts provided ratings on how much more important each criterion was compared to the worst criterion, using the same scale. This resulted in a vector $A_W = (a_{1W}, a_{2W}, \dots, a_{nW})$, where a_{jW} represents the relative importance of criterion j over the worst criterion W . As an example, Table 5.7. shows the worst criterion over others step of assessment of the skill sets.

Table 5.7. Worst to Others Assessment of Skill Sets

Participant	Worst to Others	Workforce Readiness	Soft Skills	Technical Skills	Entrepreneurship
P1	Entrepreneurship	6	4	8	1
P2	Entrepreneurship	3	7	8	1
P3	Entrepreneurship	5	8	5	1
P4	Entrepreneurship	6	5	9	1
P5	Entrepreneurship	3	6	8	1
P6	Workforce Readiness	1	8	7	5
P7	Workforce Readiness	2	8	2	3
P8	Entrepreneurship	2	6	7	1
P9	Workforce Readiness	1	7	5	3
P10	Entrepreneurship	7	9	5	1

Source: Author

Step 5: Aggregation of Weights and Prioritization

Following the calculation of optimal weights for each expert, the results were aggregated to determine the final prioritization of the skills. These aggregated weights were subsequently used to rank the skills from highest to lowest priority. The results of this analysis for the main skill sets are presented in Table 5.8., with the skills in the left column to the right column arranged according to their average weights.

Table 5.8. Aggregation of Weights – Skill Set

Criteria Weights	Technical Skills	Soft Skills	Workforce Readiness	Entrepreneurship	Input-Based CR
P1	0,55556	0,16667	0,22222	0,05556	0,17857
P2	0,47297	0,28378	0,18919	0,05405	0,16667
P3	0,28177	0,47514	0,18785	0,05525	0,19048
P4	0,50000	0,15000	0,30000	0,05000	0,21429
P5	0,50382	0,29008	0,14504	0,06107	0,11905
P6	0,30000	0,50000	0,05000	0,15000	0,21429
P7	0,28340	0,42510	0,12146	0,17004	0,19048
P8	0,50382	0,29008	0,14504	0,06107	0,07143
P9	0,27273	0,45455	0,09091	0,18182	0,19048
P10	0,13968	0,57692	0,23279	0,05061	0,22222
Average	0,38137	0,36123	0,16845	0,08895	0,17579

Source: Author

Table 5.9. presents the aggregated results of the analysis for workforce readiness arranged according to their average weights.

Table 5.9. Aggregation of Weights – Workforce Readiness

Criteria Weights	Human-machine interaction	Time Management	Professionalism	Cybersecurity Awareness	Digital Literacy	Social Norms	Sustainability Awareness	Input-Based CR
P1	0,34418	0,10662	0,07108	0,14216	0,21324	0,08530	0,03741	0,30952
P2	0,17288	0,17288	0,11525	0,02615	0,17288	0,29056	0,04939	0,26389
P3	0,12698	0,30476	0,19048	0,06349	0,09524	0,19048	0,02857	0,28571
P4	0,11268	0,06761	0,16901	0,27042	0,27042	0,08451	0,02535	0,20833
P5	0,13095	0,19643	0,31548	0,09821	0,09821	0,02976	0,13095	0,23214
P6	0,34722	0,13889	0,10417	0,08333	0,08333	0,03472	0,20833	0,21429
P7	0,34014	0,10204	0,13605	0,10204	0,03401	0,20408	0,08163	0,21429
P8	0,12060	0,18090	0,02513	0,18090	0,09045	0,12060	0,28141	0,28571
P9	0,08364	0,20910	0,35260	0,13940	0,10455	0,04100	0,06970	0,21429
P10	0,06303	0,16807	0,10084	0,40336	0,16807	0,03361	0,06303	0,31944

Average 0,18423 0,16473 0,15801 0,15095 0,13304 0,11146 0,09758 0,25476

Source: Author

Table 5.10. presents the aggregated results of the analysis for soft skills arranged according to their average weights.

Table 5.10. Aggregation of Weights – Soft Skills

Criteria Weights	Critical and Analytical Thinking	Problem Solving	Communication	Collaboration/ Teamwork	Emotional Intelligence	Adaptability	Lifelong Learning	Leadership	Input-Based CR
P1	0,16789	0,27099	0,11193	0,11193	0,02946	0,08395	0,16789	0,05596	0,26190
P2	0,18028	0,11556	0,21726	0,11556	0,07704	0,19877	0,07704	0,01849	0,26190
P3	0,17433	0,17433	0,11622	0,11622	0,26983	0,05811	0,02122	0,06973	0,36111
P4	0,29266	0,18092	0,09046	0,07237	0,09046	0,12061	0,03193	0,12061	0,21429
P5	0,30864	0,18519	0,12346	0,12346	0,07407	0,09259	0,03086	0,06173	0,21429
P6	0,29940	0,17964	0,11976	0,08982	0,02994	0,08982	0,11976	0,07186	0,21429
P7	0,09554	0,19108	0,09554	0,31847	0,03185	0,07643	0,12739	0,06369	0,21429
P8	0,16713	0,26741	0,11142	0,08357	0,06685	0,16713	0,11142	0,02507	0,30357
P9	0,10148	0,08119	0,13531	0,05799	0,31997	0,03343	0,06766	0,20297	0,35714
P10	0,17358	0,24858	0,27001	0,06943	0,11572	0,05786	0,02143	0,04339	0,31944
Average	0,19609	0,18949	0,13914	0,11588	0,11052	0,09787	0,07766	0,07335	0,27222

Source: Author

Table 5.11. presents the aggregated results of the analysis for technical skills arranged according to their average weights.

Table 5.11. Aggregation of Weights – Technical Skills

Criteria Weights	Data Analysis	Technology-based Skills	Computer Programing	Project Management	Robotics	Input-Based CR
P1	0,38372	0,20930	0,20930	0,13953	0,05814	0,10000
P2	0,11475	0,38251	0,22951	0,22951	0,04372	0,21429
P3	0,25532	0,17021	0,12766	0,40851	0,03830	0,28571
P4	0,26415	0,44025	0,17610	0,07547	0,04403	0,17857
P5	0,17234	0,41723	0,23583	0,12925	0,04535	0,26190
P6	0,42735	0,10256	0,25641	0,04274	0,17094	0,21429
P7	0,44643	0,10714	0,26786	0,04464	0,13393	0,21429
P8	0,40858	0,12873	0,17164	0,25746	0,03358	0,26389
P9	0,26519	0,04972	0,13260	0,08840	0,46409	0,14286
P10	0,14082	0,44694	0,09388	0,28163	0,03673	0,29167
Average	0,28787	0,24546	0,19008	0,16971	0,10688	0,21675

Source: Author

Table 5.12. presents the aggregated results of the analysis for entrepreneurship skills arranged according to their average weights.

Table 5.12. Aggregation of Weights – Entrepreneurship

Criteria Weights	Business Acumen	Resource-fulness	Initiative	Innovation	Resilience	Business Execution	Creativity	Input-Based CR
P1	0,17143	0,11429	0,11429	0,30000	0,08571	0,04286	0,17143	0,20000
P2	0,31430	0,19570	0,19570	0,02965	0,13046	0,05591	0,07828	0,23214
P3	0,32134	0,19909	0,13273	0,07964	0,03493	0,13273	0,09955	0,30952
P4	0,28448	0,03026	0,16342	0,08171	0,28448	0,10895	0,04669	0,14286
P5	0,10376	0,06917	0,20752	0,13835	0,03008	0,31278	0,13835	0,28571
P6	0,34722	0,13889	0,08333	0,20833	0,03472	0,08333	0,10417	0,21429
P7	0,35211	0,14085	0,07042	0,10563	0,03521	0,21127	0,08451	0,21429
P8	0,07042	0,14085	0,08451	0,21127	0,35211	0,10563	0,03521	0,21429
P9	0,08364	0,06970	0,13940	0,20910	0,35260	0,10455	0,04100	0,26190
P10	0,15616	0,36438	0,23424	0,05205	0,06693	0,09370	0,03253	0,22222
Average	0,22049	0,14632	0,14256	0,14157	0,14072	0,12517	0,08317	0,22972

Source: Author

In the next chapter, the analysis and the implications of this study are discussed.

6. CHAPTER: DISCUSSION AND CONCLUSION

This chapter presents a comprehensive discussion of the results obtained from the analysis conducted in the previous chapters. The findings are contextualized within the broader scope of Industry 5.0, with particular emphasis on the logistics sector. This discussion also explores the implications of these findings for talent management, highlighting how the identified skills can be prioritized to optimize workforce readiness and adaptability to Industry 5.0 challenges. The BWM was used to systematically identify and rank these skills, providing a robust foundation for the conclusions drawn.

6.1. Industry 5.0 and Prioritization of Key Skill Pillars

Industry 5.0, characterized by the collaboration between humans and machines, places a significant emphasis on human-centricity, resilience, and sustainability (European Commission et al., 2021; Xu et al., 2018). Unlike its predecessor, Industry 4.0, which focused heavily on automation and digitization, Industry 5.0 aims to restore the human touch in manufacturing and logistics by fostering a symbiotic relationship between technology and human capabilities.

The findings of this study highlight the importance of developing a diverse set of skills that cater to both the technical and human-centric demands of Industry 5.0. As in line with Ada et al. (2021)'s findings, in this study *Technical Skills* emerged as the most critical pillar with an average weight of 0.38137. This high prioritization shows the logistics sector's heavy reliance on *Technical Skills* to drive efficiency, optimize operations, and support the digital transformation integral to Industry 5.0. Technical skills are highly valued, which means that in order to preserve and improve operational capabilities, firms need to keep spending money on technical training and development.

Soft Skills were identified as the second most critical pillar, with an average weight of 0.36123. This close ranking to *Technical Skills* highlights the increasing importance of cognitive and interpersonal abilities in the logistics sector. In Industry 5.0, where

human-machine collaboration is essential, skills such as *critical and analytical thinking, problem-solving, communication, and teamwork* are indispensable. These skills enable workers to navigate complex environments, interact effectively with technology, and collaborate with colleagues to achieve organizational goals. The prioritization of *Soft Skills* suggests that while technical expertise is crucial, organizations must also cultivate these human-centric skills to leverage the benefits of Industry 5.0 fully.

Workforce Readiness was ranked third, with an average weight of 0.16845. This pillar encompasses skills necessary for preparing employees to meet the demands of Industry 5.0, such as human-machine interaction, time management, and digital literacy. The relatively lower prioritization of *Workforce Readiness* compared to *Technical* and *Soft Skills* suggests that while these skills are important, they may be seen as more foundational or baseline competencies. However, their importance should not be underestimated, as they are critical for ensuring that the workforce can adapt to new technologies and maintain productivity in a rapidly changing industry.

Entrepreneurship was the least prioritized pillar, with an average weight of 0.08895, unlike Ada et al. (2021)'s study. While still important, the lower ranking indicates that entrepreneurial skills such as *business acumen, resourcefulness, and initiative* are viewed as less critical than *technical* or *soft skills* in the logistics sector under Industry 5.0. This may reflect the sector's current focus on operational efficiency and the practical application of technology rather than on *innovation* and entrepreneurial thinking. However, as Industry 5.0 continues to evolve, the role of *entrepreneurial skills* could become more prominent, particularly as organizations seek to innovate and stay competitive in a rapidly changing market.

6.2. The Role of Technical Skills in Industry 5.0

In the context of Industry 5.0, technical skills were identified as the most critical category, with a strong emphasis on *Data Analysis* (0.28787) and *Technology-based Skills* (0.24546) aligning with Suci et al. (2023). These skills are foundational for the ongoing digital transformation in logistics, where the ability to analyze and interpret vast amounts of data is essential for optimizing operations, making informed decisions, and anticipating industry trends. The high prioritization of these skills underscores

their importance in maintaining the efficiency and competitiveness of logistics operations.

Computer Programming (0.19008) and *Project Management* (0.16971) were also highlighted as vital technical skills. As logistics systems become increasingly automated and reliant on software-driven processes, programming skills are crucial for developing and managing these systems. Project management, on the other hand, is essential for successfully implementing new technologies and ensuring that projects are completed on time and within budget. The sector's requirement for technical know-how to negotiate the intricacies of Industry 5.0 is reflected in the relative relevance of these talents.

Robotics (0.10688), while still important, was assigned a lower priority compared to other technical skills. This may reflect the current stage of robotics adoption in the logistics sector, where the technology is evolving and not yet universally essential. However, as robotics becomes more integrated into logistics operations, its significance is expected to increase.

6.3. Critical Soft Skills for Industry 5.0

The analysis revealed that *Critical & Analytical Thinking* (0.19609) and *Problem-Solving* (0.18949) are important among *soft skills*, indicating their essential role in addressing the complex challenges characteristic of Industry 5.0. These skills enable workers to think critically, analyze situations, and develop innovative solutions, which are crucial in an environment where traditional problem-solving approaches may no longer suffice (Poláková et al., 2023). The prioritization of these skills reflects the logistics sector's need for cognitive abilities that complement technical expertise.

Communication (0.13914) and *Collaboration/Teamwork* (0.11588) were also prioritized, highlighting their importance in ensuring effective information sharing and teamwork in an increasingly interconnected and collaborative work environment. These skills are vital for fostering a cohesive workforce that can work efficiently with both human colleagues and advanced technological systems.

6.4. Workforce Readiness in Industry 5.0

The analysis of workforce readiness identified *Human-Machine Interaction* (0.18423) as the most critical sub-criterion within this pillar, aligning with the core objectives of

Industry 5.0. Effective human-machine interaction is crucial for ensuring that technology enhances rather than replaces human effort. The high priority assigned to this skill suggests that organizations must focus on developing employees' abilities to interact seamlessly with advanced systems.

Time Management (0.16473) was also identified as a key competency, reflecting the logistics sector's demand for efficiency in operations. The ability to prioritize tasks and manage schedules effectively is indispensable in a fast-paced environment where meeting deadlines is critical. The importance of these skills reflects the need for workers who can manage their time efficiently in a rapidly changing industry.

Other sub-criteria such as *Digital Literacy* (0.13304), while essential, were ranked slightly lower but still play a significant role in preparing the workforce to navigate and leverage the digital tools that are increasingly integrated into logistics operations.

Sustainability Awareness (0.09758) and *Social Norms* (0.11146) received the lowest prioritization within workforce readiness. While these factors are crucial for long-term success and alignment with global sustainability goals, their lower ranking suggests that immediate operational concerns, such as technological integration and efficiency, currently take precedence in the logistics sector. However, as sustainability becomes more embedded in corporate strategies, the importance of these skills is expected to rise.

6.5. Entrepreneurship in Industry 5.0

Within the *Entrepreneurship* pillar, *Business Acumen* (0.22049) was identified as the most critical sub-criterion, reflecting its importance in driving strategic decision-making and maintaining a competitive edge in the logistics sector. Business acumen is crucial for ensuring that logistics companies can effectively execute strategies, optimize operations, and achieve long-term goals.

Resourcefulness (0.14632) and *Initiative* (0.14256) were also highly valued, underscoring the need for employees who can think creatively and proactively address challenges. The emphasis on these skills indicates the importance of a proactive approach to problem-solving and innovation in maintaining operational excellence in Industry 5.0.

Interestingly, *Innovation* (0.14157) was also recognized as an important skill, but it was ranked slightly lower than business acumen and resourcefulness. This suggests that while innovation is valued, it may be considered slightly less critical compared to other entrepreneurial skills in the logistics sector. The lower weight assigned to *Creativity* (0.08317) further reflects this trend, indicating that while creativity is important, it may not be the primary focus in an industry that prioritizes operational efficiency and practical solutions.

6.6. Implications for Talent Management in Logistics

The findings of this study have several important implications for talent management in the logistics sector within the framework of Industry 5.0:

Balanced Skill Development: Organizations should focus on developing a balanced skill set that includes both *technical* and *soft skills*. Technical skills remain critical, but soft skills such as *critical thinking*, *problem-solving*, and *communication* are increasingly important for managing human-machine interactions and guiding teams.

Customized Training Programs: Training programs should be tailored to address the specific needs of Industry 5.0, with an emphasis on enhancing *human-machine interaction*, *data analysis*, and *critical thinking*. These programs should be designed to prepare workers for the complex and dynamic environments characteristic of Industry 5.0. Initiatives for continuous learning will be crucial to ensuring that the staff is knowledgeable about the most recent developments in technology and logistical best practices.

Strategic Recruitment: Recruitment strategies should prioritize candidates with a strong foundation in *technical skills*, particularly in *data analysis* and *technology-based* skills. However, equal attention should be given to soft skills, ensuring that new hires are equipped to navigate the human-centric aspects of Industry 5.0.

Leadership Development: Organizations should invest in leadership development programs that equip managers with the skills needed to guide teams through technological transitions and foster a culture of continuous improvement.

Optimizing Workforce Readiness: *Workforce readiness*, particularly in areas like *human-machine interaction* and *time management*, is critical for maintaining efficiency and productivity in the logistics sector. Managers should ensure that

employees are not only equipped with the necessary *technical skills* but are also adept at managing their time and adapting to new tools and processes.

Sustainability and Social Responsibility: While *sustainability awareness* was not the top priority in the analysis, its importance is expected to grow as organizations increasingly align with global sustainability goals. Managers should start integrating sustainability into their talent management strategies to ensure long-term viability and compliance with emerging regulations.

6.7. Conclusion

In conclusion, the prioritization of skills identified in this study provides valuable insights for organizations and managers operating in the logistics sector as they transition to Industry 5.0. By applying BWM, the findings of this study highlight the critical importance of *Technical Skills* and *Soft Skills* in the logistics sector as it transitions to Industry 5.0, as aligning with Takács & Pogátsnik (2023) and Suciú et al. (2023). *Technical Skills*, particularly in areas such as *Data Analysis* and *Technology-Based Skills*, are important for driving efficiency and supporting the digital transformation essential to Industry 5.0. *Soft Skills*, including *Critical & Analytical Thinking* and *Problem-Solving*, are nearly as crucial, emphasizing the need for a workforce that can navigate complex challenges and collaborate effectively with both technology and colleagues. While *Workforce Readiness* and *Entrepreneurship* are also important, their roles are more supportive, ensuring that the workforce can adapt to new technologies and maintain operational effectiveness. To succeed in the rapidly evolving landscape of Industry 5.0, organizations must prioritize the development of these key skills, focusing on a balanced approach that integrates both technical expertise and human-centric abilities.

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