Industry 5.0 Skills: A Hierarchical Categorization

Seda Güğerçin
D.Sc., Prof.,
Assistant Professor,
Department of Management Information Systems,
Iskenderun Technical University,
seda.gugercin@iste.edu.tr, Hatay/Türkiye

Utku Güğerçin
Associate Professor,
Department of Management Information Systems,
Adana Alparslan TürkeşScience and Technology University,
ugugercin@atu.edu.tr, Adana/Türkiye

Abstract

Despite the increased focus on the skills required in the Industry 5.0 (I5.0) era, there remains a significant gap in the literature regarding the categorization of these skills, particularly in relation to the organizational levels at which employees operate. To bridge this gap, this study aims to develop a hierarchical categorization of in-demand I5.0 skills according to organizational levels. By synthesizing insights from three key frameworks, 1) the World Economic Forum's "Future of Jobs Reports", 2) Maslow's hierarchy of needs, and 3) Katz's managerial skills, this study offers a structured framework for understanding and categorizing I5.0 skills. A systematic literature review was conducted to outline the in-demand skills in I5.0, the target audience expected to possess these skills, and the categorization of I5.0 skills at various organizational levels. The findings from the systematic literature review were utilized to establish a hierarchical categorization of in-demand I5.0 skills.The analysis highlights the importance of human-centered approaches, advanced digital literacy, and sustainable practices in the workplace, as well as the need for upskilling and reskilling to bridge the skills gap in the I5.0 era.The results are anticipated to provide valuable guidance for human resources management in recruitment, reskilling, and upskilling strategies, ultimately enhancing organizational effectiveness and reducing long-term costs.

Keywords: Industry 5.0, Skills, Skill Categorization, Skill Hierarchy, Systematic Literature Review, Skill Schema

Introduction

The era of Industry 4.0 (I4.0)ushered ina paradigm shift towards the creation of integrated information systems through the deployment of big data, the internet of things, artificial intelligence, cyber-physical systems, and cloud computing. While the flexibility and modularity of I4.0 systems are designed to adapt to dynamic market changes, their full potential cannot be realized without individuals who possess the necessary skills and knowledge to implement and operate these advanced systems (Trstenjak et al., 2023). Based on this progression, the transition to I5.0 shifts the focus towards cultivating a human-centered, sustainable, and resilient industry (Braun et al., 2024; Brequeet al., 2021; Choi et al., 2022).

I5.0 can be characterized as the human-centered evolution of I4.0 (Güğerçin & Güğerçin, 2021), with a specific focus on the collaboration between humans and machines (Kolade &Owoseni, 2022). Given this fact, I5.0 comes with a pronounced emphasis on employee[1] skills, surpassing the focus observed in prior industrial eras. In the I5.0 era, "a worker for a company is no longer a cost but an investment" (Kralj and Aralica, 2023, p. 320). Understanding the evolving skill requirements and making recruitment decisions accordingly can be seen as a value-enhancing effort for organizations, and bridging the gap between the current workforce competencies and the skills needed for I5.0 is essential for organizational success in this new industrial paradigm.

As the importance of these skillsrequired in I5.0 has come to the forefront, there has been a corresponding increase in academic studies addressing this concept.The concept of I5.0 skills has been investigated across various disciplines. Within the existing literature, a number of studies have been undertaken with a focus on I5.0 skills (e.g.,Braun et al., 2024; Dhaliwal & Misra, 2020; Kolade &Owoseni, 2022; Poláková et al., 2023; Saniuk et al., 2024).These studies offer valuable contributions to the broader discussion on skills, revealing crucial insights into the necessary skills in navigating the complexities of I5.0, the skills gap, and the necessity for upskilling and reskilling, thereby increasing the importance of human-machine collaboration, the need for advanced digital literacy, and the emphasis on sustainable practices in the workplace.Collectively, the synthesis of these studieshighlights the evolving nature of skills required in I5.0, where technological advancements are integrated with human-centric approaches to foster innovation and productivity.

Specifically, the literature offers a particular perspective on sector-specific skill demands (e.g.,Akyazı et al., 2020; Branca et al., 2022), or the impact of these demands on employee development and technology training initiatives (Haputhanthrige et al., 2024). However, the body of knowledge is limited regarding the multifaceted landscape of I5.0 skills. The new skills required in the I5.0 era are expected not only to differ across industries but also to correspond to the level at which an employee is working. Nonetheless, to the best of the authors' knowledge, no study has categorized the skills in terms of the employees at different levels. From this point on, this study will examine whether any categorization of I5.0 skills has been made and whether the categorized I5.0 skills have been associated with employees at different organizational levels. In order to accomplish this goal, the multifaceted nature of I5.0 skills should also be defined. Additionally, the target audience expected to possess these skills should be identified from a human resources management (HRM) perspective. Accordingly, a systematic literature review was decided to be conducted to answer the research questions, which are as follows:

RQ1. What are the in-demand skills in the I5.0 era?

RQ2. Who is the target audience expected to possess these skills?

RQ3a.Have the in-demand I5.0 skills been categorized?

RQ3b. (If the answer toRQ3a. is "Yes", then) Have these skill categories been associated with employees at different organizational levels?

By engaging in this effort, the purpose of this study is to develop a hierarchical categorization of in-demand I5.0 skills according to organizational levels. The conceptual framework of this study is tripartite, consisting of three main components. First, the study grounds the skill classifications outlined in the World Economic Forum's (WEF) "Future of Jobs Reports (FoJR)" (2016, 2020, 2023). Second, it presents a hierarchy of skills inspired by Maslow's need hierarchy pyramid, incorporating the flexibility of Alderfer's ERG Theory, which acknowledges that multiple needs can be active simultaneously, allowing individuals to pursue different needs at various levels concurrently. Third, the hierarchy of categorized in-demand skills for I5.0 has been developed following the traces of Katz's managerial skills (1955) framework.

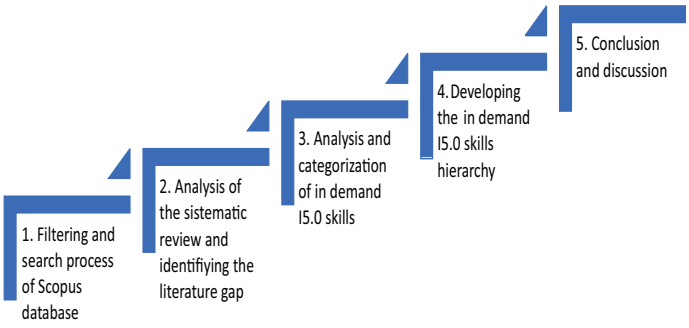
This study contributes both to the practicians and researchers.Firstly, on the practical side, it offers a new perspective on essential skills from an HR standpoint. It is anticipated that the study will benefit particularly HRM departments and also employees, managers, and job candidates across various fields. Given that employees are

recruited and developed based on their skills, decision-makers within organizations, particularly in HR departments, require a well-defined skill hierarchy. This hierarchy is crucial for effectively recruiting entry-level, middle-level, and top-level employees, in alignment with organizational needs. Consequently, the significance of this study lies in its potential to enhance efforts to reduce erroneous hires, optimize the recruitment process, develop effective reskilling and upskilling strategies, and ultimately reduce long-term costs for companies. Secondly, this study is expected to serve as a guide and reference for researchers, offering valuable insights for further exploration in the field of human resource management and organizational development. By integrating Maslow's Hierarchy and Katz's managerial skills classification, this study aims to provide a comprehensive framework for understanding and categorizing the skills required in the I5.0 era. This contribution is expected to enrich the academic discourse and provide a foundation for future research on the evolving skill requirements in this new industrial paradigm.

Methodology

In order to answer the research questions and eventually to hierarchically present the categorization of I5.0 skills according to organizational levels, a five-step research design has been defined, beginning with a systematic literature review(see Figure 1).

Figure 1. The five-step research process



Filtering and Search Process

The systematic literature review began with an analysis of the papers extracted from the Scopus database, employing the filter and search criteria presented in Table 1. Relevant articles published between 2020 and 2024 were included in the review since the terms ((“INDUSTRY 5.0”) AND (“SKILL” or “SKILLS”)) began appearing in titles, abstracts, and keywords from the year 2020 onwards in Scopus. To avoid inconsistencies related to the language, only articles written in English were considered. The document types chosen were "Articles".

Table 1. Filtering and Search Criteria

Database: Scopus
Search date: 13/08/2024
TITLE-ABS-KEY ((“INDUSTRY 5.0”) AND (“SKILL” or “SKILLS”))
Year: 2020-2024 (No date selection was made; the first study in Scopus appears to have been conducted in 2020)
Document type: “Articles”
Keyword is limited: Industry 5.0, Skill, Skills
Language: English
Relevance screening: Articles selected for inclusion only where “Titles-abstract-keywords” are relevant to the research questions
Number of items returned by query: 45
Number of items returned by review: 14

The application of the criteria outlined in Table 1 initially yielded 45 articles. Among these, 42 were selected after reviewing the titles, abstracts, and keywords for relevance. Each of these 42 items was subsequently examined in detail to determine their alignment with the research questions. Although 28 of these articles were generally relevant to the topic of I5.0 skills,they fell outside the scope of this study as they did not address the specific research questions and therefore excluded based on the predefined inclusion criteria. Consequently, the final number of relevant papers was reduced to 14.

Analysis of Systematic Literature Review

As shown in Table 2, the first study examined within the scope of this research's findings was conducted in 2021 (Taverner et al., 2021), with no studies found for 2022. The number of studies has progressively increased in 2023 and 2024.

Regarding the 1st research question (What are the in-demand skills in the I5.0 era?), it is evident that soft skills are featured in almost all the research. Following this,

digital, technical, cognitive, and other skills are highlighted (see Table 2).

As for the second research question (Who is the target audience expected to possess these skills?), it is observed that the target audience most associated with I5.0 skills consists primarily of industry workers, employees, or personnel (see Table 2). Additionally, some studies specifically focused on engineers (Broo et al., 2024), or designers (Taverner et al., 2021), and others on leaders and managers (Bakir and Dahlan, 2023; Posillico and Edwards, 2024).

With regard to the first part of the third research question, RQ3a (Have the in-demand I5.0 skills been categorized?), several skill categories have been identified. These categories can be outlined as follows:

- Taverner et al. (2021): soft, technological, design, digital, and green skills
- Modgil et al. (2023): managerial, operational, and advanced-technical skills
- Poláková etal.(2023): soft and digital skills
- Posillico and Edwards (2024): interpersonal and technical skills

Given that scholars have categorized the I5.0 skills, the study explored RQ3b(Have these skill categories been associated with employees at different organizational levels?). However, to the best of authors 'knowledge, no prior research links these categories to organizational levels. Therefore, in the systematic literature review, it was found that there was no hierarchical categorization of skills based on employees' positions.

Table 2. Research Articles Indexed in the Scopus

No	Year	Title	Author(s)	Sample	Emerging Skills
1	2021	Design Culture in the Era of Industry 5.0: A Review of Skills and Needs	Taverner et al.	the designers in the manufacturing sector	soft, technological, design, digital, and green skills
2	2023	The resurrection of digital triplet: A cognitive pillar of human-machine integration at the dawn of industry 5.0	Alimam et al.	workers/employee/ personnel	cognitive skills
3	2023	Higher education leadership and curricular design in industry 5.0 environment: a cursory glance	Bakir and Dahlan	leaders	being decisive, resilient, open to change and continuous learning, adaptable, the soft skills of human-centered IT communication, empathy, ability to work more online and less face-to-face.
4	2023	Collaborative or substitutive robots? Effects on workers' skills in manufacturing activities	Dornelles et al.	workers/employee/ personnel	cognitive skills, digital skills
5	2023	Employees' reskilling and upskilling for industry 5.0: Selecting the best professional development programmes	Leon	workers/employee/ personnel	soft skills like social skills (compassion, trust, empathy), human skills (communication, self-awareness, listening), creativity and problem solving

No	Year	Title	Author(s)	Sample	Emerging Skills
6	2023	Developing human capabilities for supply chains: an industry 5.0 perspective	Modgil et al.	supply chain professional	managerial skills, operational skills, advanced-technical skills
7	2023	Towards a New Paradigm for Digital Health Training and Education in Australia: Exploring the Implication of the Fifth Industrial Revolution	Pang et al.	healthcare sector workers/educator/ trainees	fundamental skills (big data usage and analytics, AI, and ML), technical skills, soft skills, critical thinking, leadership, ethical conduct, life-long learning
8	2023	Soft skills and their importance in the labour market under the conditions of Industry 5.0	Poláková et al.	workers/employee/ personnel	soft and digital skills
9	2023	Core Competence—As a Key Factor for a Sustainable, Innovative and Resilient Development Model Based on Industry 5.0	Suciu et al.	workers/employee/ personnel	technical skills, non-technical skills, soft skills, and other core competencies
10	2024	Transforming KSA's local workforce into global talent: An Industry 4.0 and5.0 initiative leading to vision 2030	Singh and Alhabbas	workers/employee/ personnel	digital skills & analytical thinking, technical skills with soft skills, collaboration, and problem-solving
11	2024	The Fifth Industrial Revolution as a Transformative Step towards Society 5.0	Ziatdinov et al.	workers/employee/ personnel	digital literacy and technology-related skills, lifelong learning, soft skills such as critical thinking, complex problem solving, and adaptability
12	2024	Rethinking engineering education at the age of industry 5.0	Broo et al.	engineers/ workers/employee/ personnel	technical skills, cognitive and non-cognitive skills, commonly referred to as soft skills (4Cs of twenty-first-century learning, critical thinking, creativity, collaboration, and communication)
13	2024	Developing a proof-of-concept curriculum foundation model for industry 5.0: A primary data survey of built environment academics	Posillico and Edwards	contemporary construction manager	interpersonal and technical skills
14	2024	Evolution of Social Competencies in Sustainable Supply Chains	Foltynowicz et al.	future managers/ workers/employee/ personnel	social competencies (foreign language skills, communication skills)

Analysis and Categorization of In-Demand I5.0 Skills

In studies within the scope of this systematic literature review, scholars have been categorizing I5.0 skills since 2021. These categorizations vary according to the conceptual framework employed. Along with invaluable efforts in academia, this topic has also been discussed as part of a long-term effort by the World Economic Forum (WEF) in the Future of Jobs Report (FoJR). Several reports by the WEF from 2016, 2020, and 2023 identified and categorized the required employee skills based on the dynamics at the time each report was prepared. These reports are considered fine-grained, as they rely on holistic survey data instead of limited samples and are continuously updated to reflect evolving trends.

Since the WEF – FoJR reports draw on data that outline the current expectations of a diverse group of the world's largest employers concerning the impact of socioeconomic and technological trends on the future workplace, the results of these reports are more generalizable and can provide valuable insights for organizations across various industries. Accordingly, this study uses in-demand skills and categorizes these skills from the WEF – FoJR reports. In Table 3, the top 10 in-demand skills and the skill categories (SC) they are associated with are presented.

Table 3. Top 10 In-Demand Skills & Skill Categories for Industry 5.0

	2015	SC	2020	SC	2023	SC	2027-forecast (from WEF-FoJR 2023 report)	SC
1	Complex problem-solving	CS	Complex problem-solving	CS	Analytical thinking	CS	Creative thinking	CS
2	Coordinating with others	SS	Critical thinking	CS	Creative thinking	CS	Analytical thinking	CS
3	People management	MS	Creativity	CS	Resilience, flexibility, and agility	SS	Technological literacy	TS
4	Critical thinking	CS	People management	MS	Motivation and self-awareness	SS	Curiosity and lifelong learning	SS
5	Negotiation	SS	Coordinating with others	SS	Curiosity and lifelong learning	SS	Resilience, flexibility, and agility	SS
6	Quality control	MS	Emotional intelligence	SS	Technological literacy	TS	System thinking	CS
7	Service orientation	ES	Judgment and decision-making	CS	Dependability and attention to detail	SS	AI and big data	TS
8	Judgment and decision-making	CS	Service orientation	ES	Empathy and active listening	SS	Motivation and self-awareness	SS
9	Active listening	SS	Negotiation	SS	Leadership and social influence	SS	Talent management	MS
10	Creativity	CS	Cognitive flexibility	SS	Quality control	MS	Service orientation and customer service	ES

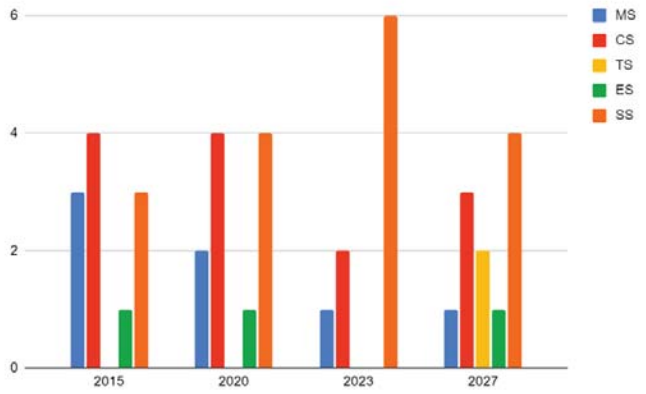
Note: The skills and skill categories in Table 3 are compiled from the Future of Jobs Report (2016, 2020, 2023), SC: Skill category,MS: Management skills, CS: Cognitive skills, TS: Technological skills, ES: Engagement skills, SS: Soft Skills.

As seen in Table 3, in this study, in-demand skills are examined under five categories. These categories are:

1. Soft skills
2. Cognitive skills
3. Engagement skills
4. Management skills
5. Technological skills

Based on Table 3, a comparison of the top 10 skills over 4 years reveals that, except for 2015, cognitive skills generally dominate the top 2 positions. Following this, cognitive skills are more prominent in the first two years, while soft skills stand out in the top 10 in the last two years. For a more detailed perspective, Graph 1 has been created.

Graph 1. In-demand Skills from WEF – FoJR (2016-2020-2023)

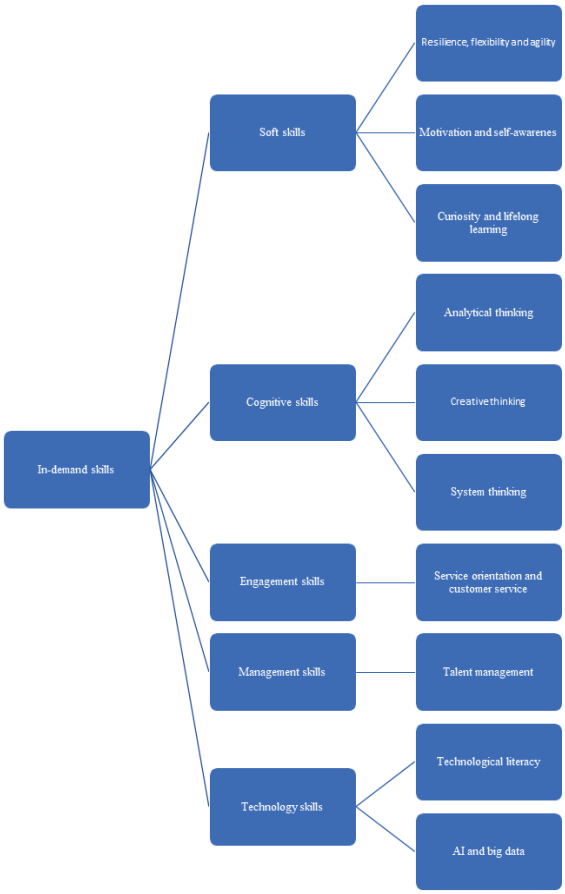


Note: MS: Management skills, CS: Cognitive skills, TS: Technological skills, ES: Engagement skills, SS: Soft Skills.

Graph 1, based on Table 3, presents the trends of in-demand skills over four years. As shown in Graph 1, over the years, demand for management skills has declined. In addition, cognitive and engagement skills have demonstrated relative stability in demand. Although the 2020 WEF – FoJR projected a rise in technological skills in 2025, these skills were not among the most in-demand by 2023. However, they are expected to reemerge by 2027. Among the five skill categories, soft skills are particularly noteworthy. These skills were the most demanded in 2020, peaked in 2023, and are anticipated to remain highly sought after in 2027.

To clearly present the categorization of in-demand skills, compiled from the WEF –FoJR2023 report, Figure 2 has been illustrated.

Figure 2. Categorization of In-Demand Skills



Source: WEF - FoJR 2023.

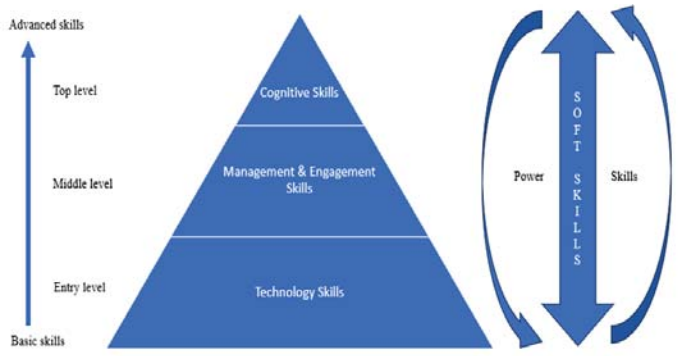
Figure 2 begins with soft skills. Soft skills encompass interpersonal, people, and behavioral skills essential for effectively applying technical skills and knowledge in the workplace (Hendarman and Cantner, 2018). These skills include personality traits, attributes, attitudes, qualities, and personal behaviors (Majid et al., 2019; Robles, 2022).Instead of being referred to as soft skills, these are suggested to be labeled power skills, given that the capacity to reskill, upskill, and reinvent oneself will be crucial in an increasingly uncertain world (Escamilla, 2020; Güğerçin and Güğerçin, 2021).As illustrated in Figure 2, under the soft skills category, the presented in-demand skills are 1) resilience, flexibility and agility, 2) motivation and self-

awareness, and,3) curiosity and lifelong learning. The second category is cognitive skills, which require active functioning of the human mind (Liu, 2003), encompassing analytical thinking, creative thinking, and systems thinking, as presented in Figure 2. These skills involve the ability to view systems from a broad perspective, engage in complex problem-solving and reasoning, and generate innovative, creative, and distinctive insights that can significantly impact the company (Mumford et al., 2017).Engagement skills, the third category, include service orientation and customer service, with a strong emphasis on marketing. These skills are crucial in managing and strengthening relationships with external stakeholders. The fourth category is management skills, which cover talent management. These skills are pivotal for effective management of a company's internal stakeholders and production processes. The last category is technology skills. In I5.0, which is characterized by the integration of advanced systems with human capabilities, technology skills are the basic skills. Without these skills, working in the I5.0 era would be akin to non-native speakers attempting to communicate with modern humans. The acquisition of technological literacy is particularly critical for mastering this skill set, ensuring employees can effectively navigate and contribute to the advanced technological landscape of I5.0. Additionally, in the context of I5.0, collaboration between humans and machines, enhanced by generative Artificial Intelligence (AI), fosters a dynamic partnership. As one of the critical enabling technologies for human-machine interaction, AI allows machines to learn from data and adapt to user behaviors, thereby making interactions more personalized and efficient (Mourtzis et al., 2023:11). Research supporting this notion indicates that superior system performance is achieved when humans and AI systems work together, resulting in the formation of collaborative intelligence (Wilson and Daugherty, 2018).

Hierarchical Categorization of In-Demand I5.0 Skills

In the context of RQ3b, it was examined whether there is any alignment of in-demand I5.0 skills with organizational levels. This is deemed crucial for both organizations and employees, yet, to the best of the authors' knowledge, no study was found in this regard. A clear delineation of the skills required at different organizational levels enables more effective recruitment processes and implementation of reskilling and upskilling programs for current employees, thereby fostering a more effective and efficient work environment. From this point forth, this study proposes a skill hierarchy, which is developed according to organizational levels, inspired by Maslow's need hierarchy pyramid and combined with the flexibility of Alderfer's ERG Theory. In this vein, the schema presenting the "Hierarchical Categorization of In-Demand I5.0 Skills", developed by the authors specifically for this study, is illustrated in Figure 3.

Figure 3.Hierarchical Categorization of In-Demand I5.0 Skills



Source: Author's elaboration.

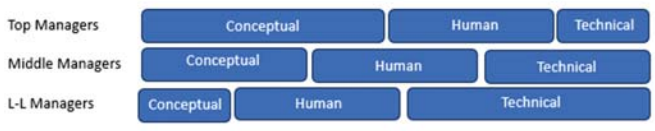
On the left side of Figure 3, employee levels are hierarchically represented. The progression from basic skills (technology skills) to advanced skills align well with Maslow's Hierarchy of Needs Theory. The proposed skill hierarchy suggests that once employees acquire the skills required for their current organizational level, they should begin developing new ones for the next level. This reflects Maslow's idea that higher-level needs become relevant only after lower-level needs are met. Additionally, the structure of the skill categorization resembles an organizational pyramid, with the greatest number of employees at the bottom, decreasing to the upper levels.

Starting from the bottom, technology skills, particularly technological literacy, are considered basic yet essential for entry-level employees. For newcomers to the work

environment or non-managerial employees, technological literacy is the primary skill sought after, as it is fundamental in the digital age. As employees advance within the company, transitioning to roles such as first-line or middle managers, they begin to develop management and engagement skills. However, the continuous evolution and change of technology necessitate the simultaneous maintenance and enhancement of both middle-level employee skills and technology skills. In the agile and dynamic context of the I5.0 era, skills required at lower levels may evolve over time, necessitating the development of more specialized areas. Consequently, the skill hierarchy must exhibit flexibility in accommodating the reskilling and upskilling needs of organizations in the I5.0 era. In this context, the importance of reverse mentorship alongside traditional mentorship in companies has become evident (Güğerçin, 2017).Additionally, as employees progress from the middle to the top levels, they are expected to focus on enhancing their cognitive skills.

Although the categorization of skills consists of a total of 5 skill sets (see Figure 2), the pyramid involves 4 skill sets at 3 levels. The remaining skill set is soft skills, as shown on the right side of Figure 3.Since soft skills relate to interpersonal, people, and behavioral skills (Hendarman& Cantner, 2018), these skills can be aligned with human skills in Katz Managerial Skills.Katz proposed that managers need three critical skills: technical, human, and conceptual skills. According to Katz (1955), the need for each skill varies depending on managerial levels. As depicted in Figure 4, all three management levels require a combination of these skills. However, according to Katz, technical skills are particularly important for lower-level (L-L) managers, while conceptual skills become increasingly important as one moves up to top-level management. A significant point in Katz's skills is that human skills are essential for effective administration and are of great importance at every level (Katz, 1974).

Figure 4. Katz's Managerial Skills



Within Katz's framework, similar to human skills, soft skills are critical at all levels. These skills have the potential to permeate all organizational levels. Consequently, an inexperienced employee with high soft skills may be better positioned than an employee who has not acquired or put effort into developing such skills. This is because employees with robust soft skills are likely to have superior problem-solving mechanisms. Therefore, an employee possessing soft skills is expected to make better use of cognitive skills, suggesting that they will not remain distant from top-level positions for long.

Conclusion and Discussion

Following the gap in the literature regarding the hierarchical categorization of I5.0 skills, this study began with the formulation of three research questions focusing on I5.0 skills, followed by a systematic literature review of articles in the Scopus database, aiming to develop a hierarchical categorization of in-demand I5.0 skills according to organizational levels.

The results of this review indicate that, in response to RQ1, studies in the systematic review's scope primarily feature soft, digital, technical, and cognitive skills. Regarding RQ2, the target audience most commonly addressed in studies on in-demand skills consists of industry workers/employees/personnel. Although skill categorizations were noted in response to RQ3a (Modgil et al., 2023; Poláková et al., 2023; Posillico and Edwards, 2024; Taverner et al., 2021), these skills were not categorized according to employees at different organizational levels, and no hierarchical skill categorization was found, as a response to RQ3b.

In this study, in-demand I5.0 skills have been examined across five categories: management, cognitive, technological, engagement, and soft skills, which are in line with the fine-grained classification offered by WEF – FoJR. Additionally, these skill sets have been hierarchically categorized inspired by Maslow's need hierarchy pyramid with the flexibility of Alderfer's ERG Theory, tailored to entry, middle, and top-level employees within organizations. This hierarchical approach allows for flexibility, where skills acquired at one level can be reskilled or upskilled when being at another level, (e.g., the

continuous evolution of technology and the need for ongoing training in this area at all levels).

At the lowest level of the hierarchy are technology skills, whereas middle-level skills correspond to management and engagement skills. At the top level are cognitive skills. The remaining skill set, soft skills, is expected to be required at all levels, regardless of employees' positions. Hence, this soft skill set is similar to human skills in Katz's Managerial Skills Categorization. The commonly used term "soft skills" is suggested to be more accurately termed "power skills" in the new era, emphasizing the necessity for these skills to be developed at all levels of the organization from the outset.

In one study, 38% of respondents (1,000 U.S. and U.K. workers from Starmind) reported feeling underutilized and uninformed (Bolden-Barrett, 2020). This indicates a gap between employees' potential and the roles they are currently fulfilling. Providing meaningful work is not necessarily about ensuring employee happiness, but about creating a fulfilling work environment (DeLoatch, 2019). Therefore, by creating a match between the potential workforce and the required workforce, facilitating this environment is expected to enhance the productivity of both employees and businesses alike. Additionally, the perspective that soft skills can strengthen the entire organization highlights the necessity for HRM to take steps to meet these needs through training, reskilling, and upskilling efforts. These initiatives can help employees feel more utilized, informed, and powerful.

On the other hand, younger generations, such as Generation Z and those following them, are often quicker and more adept at acquiring technology skills, which are considered essential. This can pose challenges for Generation X and Millennials (Generation Y). Therefore, it is crucial for all generations aspiring to be part of the I5.0 era to be aware of this skill hierarchy and focus particularly on developing soft skills to gain strength.

In future studies, with an emphasis on sustainability in I5.0, employees with sustainable/green skills will be increasingly sought after. The 2023 Future of Jobs Report (FoJR) also highlights environmental stewardship under soft skills. Although it has not yet been listed as an in-demand skill in the 2027 projections (see Table 3), it is anticipated that as the establishment of a sustainable environment advances, environmental stewardship and the associated green skills will become more prominent, as discussed by Taverner et al. (2021).

There are several limitations in this study. Firstly, as observed in the systematic literature review, there is a notable emphasis on technological/digital skills (Dornelles et al., 2023; Poláková et al., 2023; Singh and Alhabbas, 2024; Taverner et al., 2021; Ziatdinov et al., 2024). The lack of detailed elaboration on these skills could be considered a limitation of this study. In future research, it is recommended that researchers specifically categorize technological/digital skills. Secondly, this study does not suggest a specific time or geographic region for the necessity of I5.0 skills across the globe. This limitation highlights potential avenues for future investigation.

References

- Akyazı, T., Goti, A., Bayón, F., Kohlgrüber, M., & Schröder, A. (2023). Identifying the skills requirements related to industrial symbiosis and energy efficiency for the European process industry. *Environmental Sciences Europe*, *35*(1), 54.
- Alimam, H., Mazzuto, G., Tozzi, N., Ciarapica, F. E., & Bevilacqua, M. (2023). The resurrection of digital triplet: A cognitive pillar of human-machine integration at the dawn of industry 5.0. *Journal of King Saud University-Computer and Information Sciences*, 101846.
- Bakir, A., & Dahlan, M. (2023). Higher education leadership and curricular design in industry 5.0 environment: a cursory glance. *Development and Learning in Organizations: An International Journal*, *37*(3), 15-17.
- Bolden-Barrett, V. (2020, Feb 21).Workers say they're underutilized and uninformed. HRDIVE. https://www.hrdive.com/news/workers-say-theyre-underutilized-and-uninformed/572607/
- Branca, T. A., Fornai, B., Colla, V., Pistelli, M. I., Faraci, E. L., Cirilli, F., & Schröder, A. J. (2022). Skills demand

in energy intensive industries targeting industrial symbiosis and energy efficiency. *Sustainability*, *14*(23), 15615.

- Braun, G., Rikala, P., Järvinen, M., Hämäläinen, R., & Stahre, J. (2024). Bridging Skill Gaps–A Systematic Literature Review of Strategies for Industry. *Sustainable Production through Advanced Manufacturing, Intelligent Automation and Work Integrated Learning*, 687-696.
- Breque, M., De Nul, L., & Petridis, A. (2021). Industry 5.0. towards a sustainable, human-centric and resilient European industry. Luxembourg: Publications Office of the European Union.
- Broo, D. G., Kaynak, O., & Sait, S. M. (2022). Rethinking engineering education at the age of industry 5.0. *Journal of Industrial Information Integration*, *25*, 100311.
- Choi, T. M., Kumar, S., Yue, X., & Chan, H. L. (2022). Disruptive technologies and operations management in the Industry 4.0 era and beyond. *Production and Operations Management*, *31*(1), 9-31.
- Deloatch, P. (2019, Nov 1). "Every job counts: How HR can make work more meaningful" HRDIVE. https://www.hrdive.com/news/every-job-counts-how-hr-can-make-work-more-meaningful/565091/
- Dhaliwal, R. S., & Misra, P. (2020). Employability skills needed in hospitality industry: A scopious review. *Asian Journal of Education and Social Studies*, *10*(1), 18-34.
- Dornelles, J. D. A., Ayala, N. F., & Frank, A. G. (2023). Collaborative or substitutive robots? Effects on workers' skills in manufacturing activities. *International Journal of Production Research*, *61*(22), 7922-7955.
- Escamilla, J. (2020). Power skills are needed now. *HR Future*, 2020(7), 22-23.
- Foltynowicz, Z., Łupicka-Fietz, A., Jeszka, A. M., & Kowalczyk, D. (2024). Evolution of Social Competencies in Sustainable Supply Chains. *Sustainability*, *16*(6), 2581.
- Güğerçin, S. & Güğerçin, U. (2021). "How Employees Survive InThe Industry 5.0 Era: In-Demand Skills OfThe Near Future", International Journal of Disciplines Economics & Administrative Sciences Studies, (e-ISSN:2587-2168), Vol:7, Issue:31; pp:524-533.
- Güğerçin, U. (2017, November 2-4). Leveraging the Differences: A Case of Reverse Mentoring. In Proceedings of the 11th International Management Conference The Role of Management in the Economic Paradigm of the XXIst Century, Bucharest, Romania (pp. 36–52).
- Haputhanthrige, V., Asghar, I., Saleem, S., & Shamim, S. (2024). The Impact of a Skill-Driven Model on Scrum Teams in Software Projects: A Catalyst for Digital Transformation. *Systems*, *12*(5), 149.
- Hendarman, A. F., & Cantner, U. (2018). Soft skills, hard skills, and individual innovativeness. *Eurasian Business Review*, *8*, 139-169.
- Katz, R.L. (1955). Skills of an effective administrator.*Harvard Business Review*,*33*(1), 33-42.
- Katz, R.L. (1974).Skills of an effective administrator. *Harvard Business Review*, *52*(5), 90 102.
- Kolade, O., &Owoseni, A. (2022). Employment 5.0: The work of the future and the future of work. *Technology in Society*, *71*, 102086.
- Kralj, D., & Aralica, K. (2023). Safety at work within industry 5.0-quo vadis. *Sigurnost: časopis za sigurnost u radnoj iživotnojokolini*, *65*(3), 317-324.
- Leon, R. D. (2023). Employees' reskilling and upskilling for industry 5.0: Selecting the best professional development programmes. *Technology in Society*, *75*, 102393.
- Liu, M. (2003). Enhancing learners' cognitive skills through multimedia design. *Interactive Learning Environments*, *11*(1), 23-39.
- Majid, S., Eapen, C. M., Aung, E. M., & Oo, K. T. (2019). The Importance of Soft Skills for Employability and Career Development: Students and Employers'

Perspectives. *IUP Journal of Soft Skills*, *13*(4).

- Modgil, S., Singh, R. K., & Agrawal, S. (2023). Developing human capabilities for supply chains: an industry 5.0 perspective. *Annals of Operations Research*, 1-31.
- Mourtzis, D., Angelopoulos, J., & Panopoulos, N. (2023). The future of the human–machine interface (HMI) in society 5.0. *Future Internet*, *15*(5), 162.
- Mumford, M. D., Todd, E. M., Higgs, C., & McIntosh, T. (2017). Cognitive skills and leadership performance: The nine critical skills. *The Leadership Quarterly*, *28*(1), 24-39.
- Pang, T. Y., Lee, T. K., & Murshed, M. (2023). Towards a New Paradigm for Digital Health Training and Education in Australia: Exploring the Implication of the Fifth Industrial Revolution. *Applied Sciences*, *13*(11), 6854.
- Poláková, M., Suleimanová, J. H., Madzík, P., Copuš, L., Molnárová, I., &Polednová, J. (2023). Soft skills and their importance in the labour market under the conditions of Industry 5.0. *Heliyon*, *9*(8).
- Posillico, J. J., & Edwards, D. J. (2024). Developing a proof-of-concept curriculum foundation model for industry 5.0: A primary data survey of built environment academics. *Industry and Higher Education*, 09504222231224090.
- Robles, M. (2022, March). What do employers want? Hard Skills+ Soft Skills= Power Skills. In *9th Annual Conference March 24-25, 2022 Hosted by Eastern Kentucky University Richmond, Kentucky, 2*, 138.
- Saniuk, S., Grabowska, S., &Thibbotuwawa, A. (2024). Challenges of industrial systems in terms of the crucial role of humans in the Industry 5.0 environment. *Production Engineering Archives*, *30*(1), 94-104.
- Singh, A., &Alhabbas, N. (2024). Transforming KSA's local workforce into global talent: An Industry 4.0 and 5.0 initiative leading to vision 2030. *Int. J. Adv. Appl. Sci*, *11*, 94-106..
- Suciu, M. C., Plesea, D. A., Petre, A., Simion, A., Mituca, M. O., Dumitrescu, D., ... &Nasulea, D. F. (2023). Core competence—as a key factor for a sustainable, innovative and resilient development model based on Industry 5.0. *Sustainability*, *15*(9), 7472.
- Taverner, C., Trojan, L., Simion, O., &Szkudlarek, E. (2021). Design culture in the era of industry 5.0: A review of skills and needs. *Cultural Management: Science and Education*, *5*(1), 41-58.
- Trstenjak, M., Gregurić, P., Janić, Ž., & Salaj, D. (2023). Integrated Multilevel Production Planning Solution According to Industry 5.0 Principles. *Applied Sciences*, *14*(1), 160.
- Wilson, H. J., & Daugherty, P. R. (2018). Collaborative intelligence: Humans and AI are joining forces. *Harvard Business Review*, *96*(4), 114-123. https://hometownhealthonline.com/wp-content/uploads/2019/02/ai2-R1804J-PDF-ENG.pdf
- World Economic Forum. (2016). *The Future of Jobs 2016*. https://www.weforum.org/publications/the-future-of-jobs-2016/
- World Economic Forum. (2020). *The Future of Jobs Report 2020*. https://www3.weforum.org/docs/WEF_Future_of_Jobs_2020.pdf
- World Economic Forum. (2023). *The Future of Jobs Report 2023*. https://www.weforum.org/publications/the-future-of-jobs-report-2023/
- Ziatdinov, R., Atteraya, M. S., & Nabiyev, R. (2024). The Fifth Industrial Revolution as a transformative step towards society 5.0. *Societies*, *14*(2), 19.

Endnotes:

1. In the context of this study, the term 'employee' encompasses all individuals in the workplace, including both non-managerial staff and managerial personnel.