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Braun, G., Bokinge, M., Raty, P. et al (2026). The Concept of Skill Gaps: A Thematic Analysis of Global Industry Perspectives. 12TH SWEDISH PRODUCTION SYMPOSIUM, 2026, 1342. http://dx.doi.org/10.1088/1757-899X/1342/1/012071

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To cite this article: Greta Braun *et al* 2026 *IOP Conf. Ser.: Mater. Sci. Eng.* **1342** 012071

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IOP Conf. Series: Materials Science and Engineering **1342** (2026) 012071 doi:10.1088/1757-899X/1342/1/012071

The Concept of Skill Gaps: A Thematic Analysis of Global Industry Perspectives

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Abstract. The "skill gap" concept has emerged rapidly in the current industrial scenario, since demographic changes and industrial transformations are putting pressure on employers. A previous review of the literature defines skill gaps as the difference between the skills employees possess and the skills employers require. However, there is a lack of understanding industry's practical perspective on skill gaps. This paper contributes to this understanding by presenting a thematic analysis of interview data from 23 senior professionals across diverse industries worldwide, including Sweden, Finland, Germany, Canada, India, South Africa, South Korea, Italy, France, and Malaysia. The analysis reveals that while all respondents broadly describe skill gaps as a mismatch between the skills required and those available, their interpretations focus on different issues. First, skill gaps are framed as something occurring at multiple levels: the individual, the organisational, and the societal. Second, participants highlight various reasons for skill gaps. Third, definitions of 'skills' vary, ranging from technical skills to broader capabilities such as collaboration, leadership, and adaptability. By clarifying the diverse interpretations of skill gaps, the study provides a foundation for more targeted work to measure and bridge them through interventions in education, training, and workforce development. By unpacking how industry leaders define skill gaps, this study informs the design of human-centred upskilling strategies that would enable manufacturing industry to adapt sustainability transitions and digitalisation.

Keywords: Skill gaps; Upskilling; Human-centred manufacturing; Workforce development; Future skills.

1. Introduction

Skill gaps have long been a persistent issue, worsened by the shifts brought about by the fourth and fifth industrial revolutions. These changes have transformed work dynamics and raised questions about the role of human labour [1]. Industry 5.0 emphasises sustainability, resilience and human-centricity, complementing technological advancements [2]. The OECD [3] reports that rapid technological changes and new demands in the labour market make skill gaps more evident, as these changes lead to workforce shortages in industries where employees lack the necessary skills [4]. These industrial shifts thus create gaps between education and industry needs, job

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requirements and skills, organisational strategies and workforce competencies, complicating efforts to align skills with job demands [5, 6].

Technological advancements, therefore, are transforming work environments and changing the required knowledge, skills, and abilities [7]. An organisation's supply chain performance depends on its skills and capabilities [8]. Skill gaps, therefore, can hinder efficiency and limit collaboration and innovation [3]. Consequently, it is important to align workforce skills with broader organisational and societal goals through inclusive upskilling and sustainable development [9]. To bridge skill gaps, continuous adaptation is essential to align workforce capabilities with changing demands [10]. Companies worldwide feel the urgency to address pressing skill gaps and to start their upskilling initiatives, empower their employees with knowledge, measure the impact of upskilling, create a culture of learning, and implement learning technologies [11]. However, differing opinions on what constitutes these skill gaps make addressing them difficult. Therefore, research is crucial to understand how industrial practitioners identify and perceive such gaps. This study provides insights into how companies recognise skill gaps, thereby supporting skill development initiatives.

2. Theoretical background

The need to close skill gaps is emphasised by various global initiatives [12-14]. However, implementing this can be more difficult than expected. Even the word 'skill' itself is inherently ambiguous and dependent on context. For example, there is conceptual overlap between terms like skills, abilities, and competencies. Skills are specific learned abilities that can be cognitive or non-cognitive and are often required for particular jobs or sectors [15]. Abilities refer to a broader range of innate or developed capacities. Competence, in contrast, includes knowledge, skills, behaviour, and deeper aspects such as traits, motives, attitudes, values, and self-image [16, 17]. This study concentrates on skills because they are task-specific, observable, and measurable. According to OECD [15], skills can be effectively assessed through surveys and are directly linked to job performance, making them a practical focus for addressing skill gaps.

Earlier research has identified up to 18 distinct skills, highlighting the breadth and complexity of the concept [18]. Digitalisation has given rise to meta-work, which refers to the cognitive and emotional effort needed to engage with digital technologies [19]. This includes tasks such as adaptation, coordination, and technical maintenance, which require the development of specific meta-skills. In today’s evolving labour market, success relies not only on technical and generic skills but increasingly on core relational skills such as communication, problem-solving, and self-awareness [20].

Additionally, the skill gap is a complex and multifaceted phenomenon, making it challenging to define and measure consistently. Skills gaps can be understood in multiple ways. First, they may refer to a lack of necessary skills required to perform specific work tasks [21]. Second, they can indicate skill shortages—a mismatch between the supply and demand of particular skills in the labour market [22]. Third, they may reflect a skills mismatch, where an employee’s skill level does not align with the requirements of their job [23]. These layered mismatches complicate the challenge of aligning the right skills with the right people at the right time [5]. Skill gaps can thus be conceptualised as the difference between skill needs and current skill requirements, where the gap represents the skills that must be developed or acquired [24]. However, recent research shows that skill gaps do not necessarily reflect a lack of productivity, but may instead indicate employees’ motivation to grow and improve in demanding roles. This challenges the traditional view of skill gaps and highlights their potential as a positive developmental phenomenon [25].

Soft skills, such as communication and teamwork, are crucial in the workplace. However, job ads often do not highlight them. These skills are mainly developed through hands-on experience [4, 26, 27]. This creates tension and educational/training gaps [5]. Employers may not explicitly request specific skills, but education and training providers are responsible for helping students develop these skills and prepare for future job demands [27]. However, predicting these needs is challenging. It is challenging due to the varying preferences, expectations, and resources of employees, employers, and educational providers. These factors are further influenced by megatrends, operating environments, and the constantly changing realities of business [5].

Skill gaps, thus, manifest at both the individual and organisational levels. Technological changes can rapidly make employee skills obsolete [5]; therefore, individuals must continuously update their skills and embrace lifelong learning [10]. Organisations, in turn, struggle to identify and address skill gaps, which negatively impact performance and competitiveness [5, 11, 28, 29]. While upskilling current employees is a more sustainable solution for many organizations [27], organisations should collaborate with educators and policymakers to develop skill strategies and clearly communicate their needs [10]. Both individuals and companies should thus prioritize reskilling as a key aspect of career development [30].

3. Methodology

This study aims to develop a nuanced understanding of the concept of skill gaps. A qualitative research approach, using interviews, was chosen to elicit different perspectives on practitioners' understanding of skill gaps and to address the lack of empirical data on them. The work presented in this paper is part of a larger study aimed at understanding not only the term' skill gap,' but also how companies measure and manage skill gaps.

To address this challenge, a typical case study methodology [31] was used. The initial steps - planning and design - involved establishing the research question and organising the data collection. The guiding research question was: How do managers and individuals with learning-related job profiles define the term skill gap? The planning included deciding to gather data through interviews and a pre-interview survey. By discussing the identified research problems, the interview guide was created, and the pre-interview survey was designed. The interview guide included the question "How do you understand the term 'skill gap'?" and one set of questions about measuring skill gaps and another set of questions about bridging skill gaps. This pre-interview survey aimed to collect data on the interviewee's skill gap definition, their job role, the industry and company size, the competitiveness of their company, and their company's country and region.

In the next step – preparation – the sample was selected and contacted. The interviewees were chosen through purposeful convenience sampling [32]. Since the authors wanted to include diverse perspectives from multiple continents and roles, this approach enabled them to search for relevant profiles with high-level positions who held essential insights for the topic. Because the group of interviewees was purposefully selected, particular attention was paid to ethical considerations during the interviews and in the interpretation of the interview data. The resulting sample included 23 senior professionals from various industries and countries, including Sweden, Finland, France, Germany, Canada, India, South Africa, South Korea, Italy, and Malaysia. Their job roles ranged from CEO, education manager, EVP People & Leadership, line Manager, country manager, talent acquisition manager, head of R&D, to L&D strategy intern.

Next, data collection and analysis were conducted. Pre-interview surveys were distributed to the sample. Every interviewee completed the pre-interview survey before their interview. The

structured interviews were carried out online by three of the authors, following the interview protocol. The sessions were recorded, transcribed with AI, and the transcripts were manually verified. After completing the interviews, thematic analysis [33] was used to identify key themes and insights from the data. The 6-step thematic analysis [33] starts with step 1 - Familiarising with the data. The recordings and transcripts were reviewed to gain an overview, understand intentions, and highlight initial key insights. The survey results were skimmed. Next, step 2 – Generating initial codes – was performed by two authors for each interview, with each generating codes individually, which were then discussed and combined into a single code. One researcher coded the survey results. In step 3 – searching for themes – all interviews were analysed by two authors, each individually, to find similar codes that form a theme. Similarly, the survey codes were analysed by one researcher to identify themes. Step 4 – reviewing themes – involved three co-authors, who discussed and compared themes from the interview results and the survey. Step 5 – defining and naming themes – was carried out by the authoring team to establish clear, concise names for the themes. Finally, step 6 involved presenting the data.

4. Results

This section outlines the findings from the thematic analysis of 23 interview responses to the question "How do you understand the term skill gap?" The interviewees are identified by an ID assigned by the interviewer. It also summarises the survey responses to the same questions from the same participants.

4.1 Results from interviews

The analysis of the interview responses shows that although all respondents broadly describe skill gaps as a mismatch between the skills needed and those available, their interpretations highlight different issues. First, skill gaps are seen as something that can be viewed from multiple angles — organisational, individual, economic, or societal.

Skill gaps from different perspectives

Some respondents describe skill gaps merely from a managerial or organisational perspective, e.g. PR2 describes a skill gap as "a gap between desired competence and current competence in the workforce". Or as PR4 puts it, "for the organisation, the skill gap is the difference between the skills or the competences they have and what they actually need to reach their goal". Both of them describe the skill gap as a phenomenon organisations are facing when their workforce's skills don't match the skills the organisation needs to reach targets. Other respondents even see the skill gap from an economic or societal perspective, e.g. PR5, who describes skill gaps as a "gap that is between the needs of the companies and overall, the economic system and the skills that the employees have.". GB2 emphasises the societal perspective even more and highlights that there are a lot of high-skilled workers, but that society is not sufficiently making use of their competencies – "we have a highly educated workforce in Canada that we're not fully utilising because they lack specific skills to do the jobs that industry requires" (GB2). According to GB2, skill gaps negatively impact both individuals and employers - "that creates a double drag on the economy, by people not having the skills to have a better job and employers not having the talent they need to grow". At the same time, GB2 also highlights that when skill gaps are bridged, it benefits both individuals and employers - "So when we fix the skills gap, […] we turn a double drag into a double win". MB6 understands skill gaps as the lack of experienced, skilled people entering the job market – "my definition of skills gap is: Where people are entering the workforce".

Other respondents understand the term "skill gap" as an individual's skill deficit. GB4 understands the term skill gap as “knowledge, skills, abilities” that are needed to “do your job appropriately and meet all your responsibilities”. GB4 also adds that the skill gap, “it's where you are versus what the job that you're in expects out of you”. MB3 describes the skill gap as “the gap between the skills you think you have and the skills you think you need”. GB6 describes that their company defines the skills needed to be a “high performer” in a particular role and that the skill gap of an individual is relative to these defined skills – “skill gap means the performance gap between high performer and low performer, because in my company, we have some Sales competency model. It means that in our company, there is a definition of a high performer”.

Some respondents approach skill gaps from both the individual as well as the organisational perspective, like GB7 who highlights both the individual perspective – “once you have defined a skill should be up to a certain level, the gap is when you talk about individuals, it's you know what the person is missing in terms of skill, ability, to perform the task” as well as the organisational perspective – “When you look at organisation […] it's the same concept, […] but it's how much you may miss in your organisation in terms of required skills. So that's related more to workforce planning.”

Reasons for skill gaps

In their reflections, the respondents often cited reasons for the persistence of skill gaps. These reasons form the second theme related to the definition of skill gaps. One of the reasons for skill gaps, as mentioned by MB1, is a lack of talent with the necessary skills. According to MB1, skills gaps occur because talents do not acquire the required skills or there are not enough people - “the talents on the market are either not getting these skills and competencies, or we simply just don't have enough of these talents” (MB1).

Another reason for skill gaps is the constant change in industry and society, which creates a need for new skills. This is highlighted by MB4, who says that “we are one step behind the actual need today, all the time, which means that we don't think that much of what is the future need of this role?” or by PR4, who describes that within the same job role, skill demands change due to trends such as digitalisation – “even if I have the same role, the demands on me can change over time, especially now with the digitalisation and such”.

MB6 brought up a different reason for skill gaps at firms, namely, the challenge that employers are hesitant to invest in and upskill their employees because many employees leave to another company – “in the current environment of the millennials because they are not very loyal to the employer in South Africa, we are finding employers are not prepared to invest in training people because once you spend like a year investing in them, they leave you and go somewhere else and then you have to start with somebody else again”. This suggests that one reason for skill gaps could be that employers are hesitant to invest in their employees' learning, as they may not benefit from their new skills if they were to leave. MB6 also criticises governments for reducing the requirements to pass STEM programmes, “to get more people to pass. So, we don't have a good quality of people coming out of high school” (MB6).

Reflections on “skills” in skill gaps

The third theme identified through thematic analysis of the interviews was the definition of the term “skill” itself, where respondents’ perspectives varied from discussing skills, competencies, and abilities, to which kind of skills they emphasised, ranging from technical skills to broader skills such as collaboration, leadership, and adaptability.

MB6 reflects on the idea that skills are a combination of knowledge and experience, explaining that without work experience, individuals cannot add value to their employer: "without work experience, you can't actually add value to your employer. So, to me, skills mean qualification plus experience". This mirrors GB3's reflection on skills, emphasising that skills are not only acquired through education but also measured by how effectively a person can perform tasks – "It's not the hard competence from education, it is the way you can actually work with the competence you have". GB7 discusses different types of skills, noting that they can be either technical or soft skills – "can be either technical or soft kind of ability to perform a duty, a task, a piece of a process".

4.2 Results from survey responses

Thematically analysing the survey response data yields similar themes related to the definition of skill gaps.

Skill gaps from different perspectives

As in the interviews, most survey respondents reflect on individual, organisational or societal perspectives on skill gaps. Two respondents include both individual perspectives and societal or organisational perspectives.

"At an organisational level, the difference in what we have or are able to hire and what we need. On an individual level, the difference in current skill/competence and what is needed in their current position in 6-18 months due to development in technology or other." (PR4)

Without being specifically asked in the survey question, half of the respondents provide a rationale for closing skill gaps in their definitions. These rationales vary, ranging from competition-focused reasons (e.g., to be competitive, to succeed, or to be a high performer) to a sufficiently good baseline (e.g., being able to perform, adding adequate value, achieving deliverables, ensuring continuity, or working independently).

Reasons for skill gaps

As observed in the respondents' reflections during interviews, various reasons for skill gaps were also briefly noted in the survey responses. One third of the respondents reflect emerging future skill gaps due to evolving industry demands, new job roles, required future capabilities and needs, and technological advancements.

Some respondents report a lack of qualified personnel or talent with the requisite competencies and skills. One respondent describes it as a struggle to find these talents; another argues that there is a gap between the skills new employees acquire in school and the skills needed in their company.

Reflections on "skills" in skill gaps

In the survey, several respondents use and reflect on competence gap, capability gap, performance gap, or demand/supply without any clear distinction from skill gap.

"A difference in employees' capabilities relative to the required capabilities to perform their actual and future work. (I deliberately restricted myself to employees)." (GB1)

One respondent describes skill as the sum of qualifications and experience, saying “Skill = qualifications + experience” (MB6). Another respondent explicitly prefers the term 'capability gap' over 'skill gap' to emphasise the importance of applying skills and competence to achieve deliverables. They state, “I would prefer to use the capability gap, as it not sufficient to have a skill/competence, but you need to use it to achieve deliverables. For an organisation, it would be interesting to have a capability analysis (how many people have the skills at what levels).”

5. Discussion

In this chapter, the findings are reflected in comparison with previous literature, the methodology is discussed, the paper’s contribution is discussed, and future work suggested.

5.1 Compare with previous literature

This study adds to the discussion on how company leaders perceive and experience the concept of skill gaps as part of broader workforce and organisational development. Although the main definition of a skill gap is often seen as the difference between employees’ current skills and employers’ skill requirements [22], the present findings offer further insight into how companies see the phenomenon as more complex and adaptable than policy discourse usually suggests. In this context, three interconnected themes were identified.

First, skill gaps were viewed from different perspectives—individual, organisational, and societal. This multilevel understanding reflects earlier conceptualisations of skill gaps as complex and context-dependent phenomena [5]. At the individual level, respondents described skill gaps as the difference between a person’s current skills and those required to perform effectively in their role, aligning with McGuinness, et al. [21], who define skill gaps as the lack of necessary skills to complete specific tasks. At the organisational level, participants perceived skill gaps as collective capability shortfalls that hinder the achievement of strategic goals, resonating with earlier studies arguing [10] that organisations face ongoing challenges in identifying and addressing skill gaps that affect competitiveness and innovation. Finally, several respondents extended the concept to a societal level, framing skill gaps as structural mismatches between education systems, labour markets, and industry needs. By describing the resulting “double drag” on the economy—but also the potential “double win” when gaps are closed—interviewees added a practical dimension to earlier research, portraying skill gaps as shared challenges rather than one-sided deficiencies.

Second, participants shed light on a range of reasons why they believe skill gaps emerge. The explanations spanned both structural and behavioural perspectives. Respondents often attributed skill gaps to rapid digitalisation and the constant evolution of job demands, aligning with previous literature [5]. Another recurring explanation concerned the lack of necessary skills among employees or a misalignment between education and industry needs, echoing earlier studies [23]. In addition, several participants described employers’ hesitation to invest in upskilling as an important contributing factor, noting that short-term decision-making and fear of turnover can perpetuate existing gaps. This finding suggests that companies may contribute to the persistence of skill shortages by making only limited long-term commitments to employee development.

Third, participants reflected on the meaning of the term ’skill,’ revealing considerable variation. Some viewed skills as the combination of formal qualifications and practical experience, while others emphasised the ability to apply knowledge effectively in work contexts. Many respondents also used the terms skill, competence, and capability interchangeably, suggesting

that these concepts are fluid and context-dependent in organisational language. This observation supports previous research highlighting the conceptual ambiguity surrounding these constructs [15, 16]. Moreover, participants distinguished between technical and soft skills, acknowledging the growing importance of relational and adaptive abilities in modern work environments. This aligns with studies emphasising the emergence of meta-skills such as communication, collaboration, and adaptability as central to employability in digitalised labour markets [19]. Collectively, these reflections extend earlier theoretical discussions by demonstrating that companies operationalise the concept of "skill" flexibly, which may complicate the assessment and closing of skill gaps across sectors.

Figure 1 captures the three layers of skill gaps—individual, organisational, and societal—and the underlying issues that cause them.

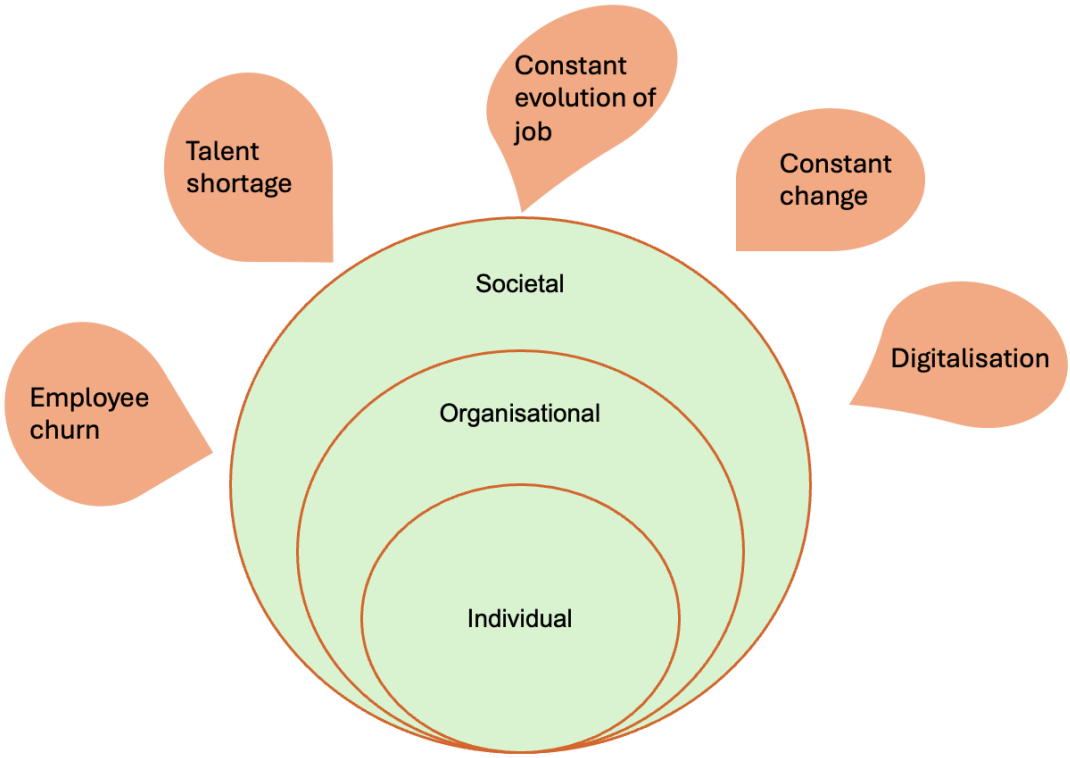

Figure 1 - The three layers of and the reasons for skill gaps

5.2 Discussing the methodology

Having three researchers conduct the interviews increased the study's credibility. In addition, two researchers coded the interviews, and later each interview was discussed by two researchers, which helped prevent biased analysis. The thematic analysis included the entire research team to discuss the identified themes and synchronise thoughts on names.

The inclusion of participants from around the world enabled us to gather a variety of experiences and perspectives from different industries and cultures. However, given the qualitative nature of this work, the dataset is relatively small, and involving more participants could have revealed additional aspects related to skill gaps.

5.3 Future work

The study enhances understanding of skill gaps across three levels – individual, organisational, and societal. Future research is needed to explore how individuals, organisations, and society

perceive these gaps and whether they recognise the urgency of the issue. In this study, only managers, those in managerial positions, and individuals in learning-related roles were surveyed, so perspectives from people with different backgrounds might differ, which would be valuable to investigate in the future.

6. Conclusion

This study provides a more detailed explanation of skill gaps and their underlying causes. By examining perspectives from practitioners worldwide and their insights across various companies and cultures, it demonstrates that skill gaps are not merely simple mismatches between supply and demand for skills but are complex, layered issues influenced by evolving technologies and organisational strategies, as part of a societal challenge. In the future, our results may support efforts to reduce skill gaps that challenge economies worldwide and in specific regions like Europe [6].

Three main conclusions emerge. First, the study confirms that skill gaps are perceived across multiple levels – individual, organisational, and societal. This shows that addressing skill gaps requires these stakeholders to be involved and take action. Second, the study emphasises the reasons behind skill gaps, ranging from rapid technological change and mismatches between education and industry's needs to hesitation about investing in upskilling. Third, the discussion of the term 'skill' itself emerged, indicating that participants held diverse views on its definition. Some participants reflected on skills as a bridge between knowledge and experience, while others used the terms 'competence' and 'capability' alongside 'skills' and used them interchangeably, indicating that these concepts can be fluid in context.

Acknowledgements

As part of the Ingenjör4.0 project, the Swedish Innovation Agency, Vinnova, and the national research and innovation programme Produktion 2030 partially fund the work presented in this paper. Moreover, the Production Area of Advance at Chalmers University of Technology supports this research. Additionally, this work received partial support from the Academy of Finland (grant number 336231 and 372920) and from the European Regional Development Fund and the Regional Council of Central Finland under Grant [A80001]. We greatly appreciate this funding.

References

[1] M. Pinzone, G. Braun, and J. Stahre, "Contemporary and Future Manufacturing – Unveiling the Skills Palette for Thriving in Industry 5.0," in *Advances in Production Management Systems. Production Management Systems for Volatile, Uncertain, Complex, and Ambiguous Environments*, Cham, M. Thürer, R. Riedel, G. von Cieminski, and D. Romero, Eds., 2024// 2024: Springer Nature Switzerland, pp. 444-456.

[2] M. Breque, L. de Nul, and A. Petridis, "Industry 5.0 - Towards a sustainable, human-centric and resilient European industry," *Policy brief European Commission,* 2021.

[3] OECD, "Understanding Skill Gaps in Firms: Results of the PIAAC Employer Module," in "OECD Skills Studies," OECD Publishing, Paris, 2024.

[4] S. Ferguson Melhorn and I. Lucy, "Data deep dive: Upskilling and reskilling our workforce." [Online]. Available: https://www.uschamber.com/workforce/education/data-deep-dive-upskilling-and-reskilling-our-workforce

[5] P. Rikala, G. Braun, M. Järvinen, J. Stahre, and R. Hämäläinen, "Understanding and measuring skill gaps in Industry 4.0 — A review," *Technological Forecasting and Social Change,* vol. 201, 2024/04/01/ 2024, doi: https://doi.org/10.1016/j.techfore.2024.123206.

[6] R. Hämäläinen, S. Cincinnato, A. Malin, and B. De Wever, "VET workers' problem-solving skills in technology-rich environments: European approach," *International Journal for Research in Vocational Education and Training,* vol. 1, pp. 57-80, 01/01 2014.
[7] J. Bokrantz, A. Skoogh, C. Berlin, T. Wuest, and J. Stahre, "Smart Maintenance: an empirically grounded conceptualization," *International Journal of Production Economics,* vol. 223, p. 107534, 2020/05/01/ 2020, doi: https://doi.org/10.1016/j.ijpe.2019.107534.
[8] A. Chari *et al.*, "Dynamic capabilities for circular manufacturing supply chains—Exploring the role of Industry 4.0 and resilience," *Business Strategy and the Environment,* vol. 31, no. 5, pp. 2500-2517, 2022, doi: https://doi.org/10.1002/bse.3040.
[9] L. Gamberini and P. Pluchino, "Industry 5.0: A comprehensive insight into the future of work, social sustainability, sustainable development, and career," *Australian Journal of Career Development,* vol. 33, no. 1, pp. 5-14, 2024, doi: 10.1177/10384162241231118.
[10] G. Braun, P. Rikala, M. Järvinen, R. Hämäläinen, and J. Stahre, "Bridging Skill Gaps – A Systematic Literature Review of Strategies for Industry," presented at the Swedish Production Symposium, 2024.
[11] G. Braun *et al.*, "The skill bridge – A global qualitative analysis of skill gap management," *Journal of Environmental Management,* vol. 395, p. 127738, 2025/12/01/ 2025, doi: https://doi.org/10.1016/j.jenvman.2025.127738.
[12] G. Braun, J. Stahre, B.-G. Rosén, and M. Bokinge, "Ingenjör4.0 – A National Upskilling Programme to Bridge Industry's Skill Gap," *Procedia CIRP,* vol. 120, pp. 1286-1291, 2023/01/01/ 2023, doi: https://doi.org/10.1016/j.procir.2023.09.164.
[13] C. Tan, "Lifelong learning through the SkillsFuture movement in Singapore: challenges and prospects," *International Journal of Lifelong Education,* vol. 36, no. 3, pp. 278-291, 2017/05/04 2017, doi: 10.1080/02601370.2016.1241833.
[14] Government of Canada. "Upskilling for Industry Initiative." https://ised-isde.canada.ca/site/upskilling-industry-initiative/en?wbdisable=true#:~:text=About%20the%20call%20for%20applications,via%20a%20single%20lead%20recipient. (accessed 10 July, 2025).
[15] OECD, "Getting Skills Right: Skills for Jobs Indicators," in "Getting Skills Right," Paris, 2017.
[16] M. Mulder, "Conceptions of Professional Competence," in *International Handbook of Research in Professional and Practice-based Learning*, S. Billett, C. Harteis, and H. Gruber Eds. Dordrecht: Springer Netherlands, 2014, pp. 107-137.
[17] M. Salman, S. A. Ganie, and I. Saleem, "The concept of competence: a thematic review and discussion," *European Journal of Training and Development,* vol. 44, no. 6-7, pp. 717-742, 2020, doi: 10.1108/ejtd-10-2019-0171.
[18] T. Enders *et al.*, "Future skills: six approaches to close the skill gap," *World Government Summit,* 2019.
[19] P. Rikala, V. Heilala, A. Karhapää, and R. Hämäläinen, "Exploring Technostress and Meta-Work: Identifying Subgroups Among Finnish Employees," *International Journal of Human–Computer Interaction,* pp. 1-25, 2025, doi: 10.1080/10447318.2025.2531276.
[20] X. Bi and L. Boo, "Workplace Learning for Critical Core Skills Development: Empirical Evidence From Singapore," *International Journal for Research in Vocational Education and Training,* vol. 12, pp. 316-337, 05/09 2025, doi: 10.13152/IJRVET.12.3.1.
[21] S. McGuinness, K. Pouliakas, and P. Redmond, "Skills mismatch: Concepts, measurement and policy approaches," *Journal of Economic Surveys,* vol. 32, no. 4, pp. 985-1015, 2018, doi: https://doi.org/10.1111/joes.12254.
[22] G. Quintini, "Right for the Job: Over-Qualified or Under-Skilled?," in "OECD Social, Employment and Migration Working Papers," OECD Publishing, Paris, 2011, vol. 120. [Online]. Available: https://www.oecd-ilibrary.org/content/paper/5kg59fcz3tkd-en
[23] G. Brunello and P. Wruuck, "Skill shortages and skill mismatch: A review of the literature," *Journal of Economic Surveys,* vol. 35, 04/01 2021, doi: 10.1111/joes.12424.
[24] R. Habash, *Professional Practice in Engineering and Computing: Preparing for Future Careers*. CRC Press, 2019.
[25] S. McGuinness and E. Staffa, "Measuring the Incidence and Impacts of Skill Gaps Among European Workers," in "IZA Discussion Papers No. 17993," Bonn, 2025.
[26] L. Babashahi *et al.*, "AI in the Workplace: A Systematic Review of Skill Transformation in the Industry," *Administrative Sciences,* vol. 14, no. 6, p. 127, 2024. [Online]. Available: https://www.mdpi.com/2076-3387/14/6/127.
[27] N. Shmatko and G. Volkova, "Bridging the Skill Gap in Robotics: Global and National Environment," *Sage Open,* vol. 10, no. 3, p. 2158244020958736, 2020, doi: 10.1177/2158244020958736.
[28] T. Elo, S. Pätäri, H. Sjögrén, and M. Mättö, "Transformation of skills in the accounting field: the expectation–performance gap perceived by accounting students," *Accounting Education,* vol. 33, no. 3, pp. 237-273, 2024/05/03 2024, doi: 10.1080/09639284.2023.2191289.

[29] C. Ravenscroft, "Closing the retrofit skills gap," 2025. [Online]. Available: https://www.gatsby.org.uk/app/uploads/sites/2/2025/08/closing-the-retrofit-skills-gap-finalpdf.pdf
[30] L. Li, "Reskilling and Upskilling the Future-ready Workforce for Industry 4.0 and Beyond," *Information Systems Frontiers,* vol. 26, no. 5, pp. 1697-1712, 2024/10/01 2024, doi: 10.1007/s10796-022-10308-y.
[31] R. K. Yin, "Case study research and applications," ed: Sage Thousand Oaks, CA, 2018.
[32] M. Saunders, P. Lewis, and A. Thornhill, *Research Methods for Business Students*. 2023.
[33] V. Braun and V. Clarke, "Thematic analysis," *APA handbook of research methods in psychology, Edition: FirstChapter: Thematic analysis.Publisher: American Psychological Association,* Book vol. Vol. 2: Research designs: Quantitative, qualitative, neuropsychological, and biological, pp. 57-71, 2012.