(article starts on next page)

Research article

The skill bridge – A global qualitative analysis of skill gap management

Greta Braun [a,*] [iD], Paavo Räty [b] [iD], Mattias Bokinge [c] [iD], Pauliina Rikala [b] [iD], Raija Hämäläinen [b] [iD], Anna Syberfeldt [a] [iD], Johan Stahre [a] [iD]

[a] *Chalmers University of Technology, Sweden*
[b] *University of Jyväskylä, Finland*
[c] *Halmstad University, Sweden*

ARTICLE INFO

ABSTRACT

Disruptive technological development and new evolving business models are changing the strategic scenarios for most companies. Companies need to handle new technology while still responding to environmental, economic, and societal challenges. Thus work and work requirements on managers and workforces are changing. New skills are needed across industries, domains, and positions, resulting in increasing skill gaps among companies worldwide. These challenges are intensified by demographic realities in Europe, China, and the USA, where declining birth rates lead to shrinking and ageing populations. Political and industrial leaders are questioning how the skill gaps can be managed to retain competitiveness. The research community is searching for a deeper and more prescriptive understanding of skill gap management, but in previous literature, conclusive strategies seem so far to be scarce, diverse, and often lacking empirical foundation. This paper identifies practices that successfully bridge skill gaps in organisations and highlights challenges faced by companies. Empirical data was gathered through interviews with 23 leaders from companies globally and analysed qualitatively. The study concludes with a set of directions for organisations to develop skill gap strategies. The paper describes how empirical findings converge into the Skill Bridge, consisting of five priority areas, i.e. Skill development initiatives, Knowledge empowerment, Impact and business results, Leadership and culture, and finally Learning technologies and innovation.

1. Introduction

In today's changing industrial scenario, companies in the production and manufacturing industry need to urgently respond to environmental, economic, and societal pressures, requiring disruptive innovation, adoption of new technologies, and adaptation of business models (Lenton et al., 2023; World Manufacturing Foundation, 2024; World Economic Forum, 2025; González Chávez et al., 2023). Thus, complexity is rapidly increasing, and people's knowledge and skills need to rise accordingly to handle that complexity (World Economic Forum, 2025). As of now, the polarisation of societies, jobless growth, and rising inequality are creating increased societal imbalance (World Manufacturing Foundation, 2024). Globally, governmental organisations are trying to guide industry in a direction allowing them to be more prepared for disruptive geopolitical situations and to be able to create and deliver more value in spite of fewer resources and declining demographic trends (Statista, 2025; Breque et al., 2021). However, to date,

there is a lack of clarity in defining strategies and responsibilities when developing solutions to effectively prepare organisations and their workforce for the future of work (Rikala et al., 2024), despite studies showing that misalignment of training and skill gaps leads to inadequate investments (McGuinness and Ortiz, 2016).

Consequently, in the current industrial scenario, companies are facing a big challenge, as the workforce often lacks the skills necessary to leverage new technology for being innovative and competitive (González Chávez et al., 2023; World Manufacturing Foundation, 2024; World Economic Forum, 2025), and quickly adapt to new requirements (e.g. concerns connected to ESG, cybersecurity, adapting to AI, electrification, among many other trends) (Trevisan et al., 2024). According to the World Economic Forum's 2025 Future of Jobs report, 39 % of employees' skills will be transformed or eventually become outdated within the next five years (World Economic Forum, 2025). These facts highlight one of the main concepts framing this study - skill gaps. A "skill gap" is defined as the gap between the available skills of the workforce

and the skills required by industry (Rikala et al., 2024; McGuinness and Ortiz, 2016). In the past, industry mainly relied on external hiring as a main solution to the skill gap problem. But in future scenarios, this will become increasingly difficult. For instance, it is expected that in 2040, Europe will be faced with 2 million people retiring from the job market each year (Draghi, 2024). 75 % of employers claim they have experienced increased challenges in hiring a sufficiently skilled workforce (ManPowerGroup, 2024). Similar demographic trends in the US, Canada, and China show declining birth rates leading to decreased talent availability (World Economic Forum, 2025; Statista, 2025; Eurostat, 2019). These global trends indicate that external hiring alone will not be a sufficient strategy to cover skill gaps, especially not in countries with demographic workforce decrease trends. Instead, other strategies have been identified as applicable when covering existing and future skill gaps in industry (World Economic Forum, 2025). For example, the WEF report points towards a latent 29 % of the workforce that will need upskilling to stay in their role, while 19 % will need reskilling to be re-deployed in another role (World Economic Forum, 2025).

Overall, there is an urgent need for a collective effort where policymakers, education providers, companies, and individuals, work together, to prioritise a structured and conscious transition towards addressing skill gaps while striving towards a sustainable future (Braun et al., 2024b). Policymakers are actively providing direction through several initiatives. At the European level, the EU is working to transform industry towards Industry 5.0 – focusing on human-centricity, sustainability, and resilience (Breque et al., 2021). A key part of this agenda is to focus on humans working in industry, making the transition inclusive by equipping people with the right skills and providing them with good working conditions (Pinzone et al., 2024, European Commission and S. A. A. I, 2025). For instance, the recent report by M. Draghi highlights skills as one of three priority areas and clearly outlines the need for increased competitiveness in Europe (Draghi, 2024). This official EU report lays out a clear diagnosis and provides concrete recommendations for the pursuit of inclusive economic growth. As a consequence, in early 2025, the Union of Skills was proposed as a key policy initiative from the European Commission to empower, upskill and reskill the workforce and ensure the development of future-oriented skills (European Commission and S. A. A. I, 2025). Presently, policy initiatives to enhance skill levels among citizens and employees are being put into action by, e.g. Canada and Singapore (Tan, 2017; Palette Skills, 2025). However, in recent literature, such initiatives are rarely compared to and bridged with industrial reality.

Although there is strong evidence of the urgency of the skill gap problem (World Economic Forum, 2025), there is a lack of understanding of how industrial companies measure and manage their skill gaps and the practical challenges they face (Rikala et al., 2024; Braun et al., 2024b). There is evidence that skill gaps cause increasing labour costs and productivity slowdown (Brynjolfsson et al., 2020; Brynjolfsson, 1993), but measuring those gaps is essential, yet under-researched (McGuinness and Ortiz, 2016). Firms often lack skill measurement processes and rely on recruitment, which highlights the gap in empirical research evaluating which strategies work (OECD, 2024). This research gap needs to be filled with empirical data to understand how industrial leaders could be supported, since they play a key role in the skill gap ecosystem.

Problems addressed by this paper include the following aspects: 1) the organisations face skill gaps but struggle to define what a skill gap really is; 2) employee skills are not at the right level in relation to expectations from the job market; 3) governmental initiatives attempt to provide direction, but very few evidence-based studies document how industrial companies actually bridge their skill gaps. Our study takes a qualitative approach to describe and analyse how companies manage skill gaps and the challenges they encounter while doing so. The core question addressed by this paper is *"How can skill gaps be managed?"*.

While policy documents and prior literature provide a conceptual and strategic understanding of the skill gap issue, there is limited empirical research on how companies respond to these gaps in practice. Much of the current research relies on quantitative assessments or theoretical frameworks that do not capture the more nuanced, context-specific challenges companies face. Therefore, a qualitative, empirical approach was chosen to generate in-depth insights into the real-world practices and organisational constraints. This method allows exploration of how industrial actors perceive skill gaps and implement internal strategies to address their workforce transitions.

The paper is structured into the following sections: Section 2 provides a theoretical background to industrial transitions, skill gaps, skill management, and strategies to address skill gaps. Section 3 outlines the research approach employed in conducting this qualitative interview study. Section 4 presents the results by identifying the practices and challenges within five key themes. Lastly, the results, methods, implications, and future work are discussed in Section 5 and concluded in Section 6.

2. Theoretical background

Managing skill gaps is directly linked to current and future transformations of work. Therefore, technological advancements and workforce transformations should be considered when defining required skills. Secondly, this study is anchored in the definition of skill gaps, which is further developed in subsection 2.2. Additionally, the role of education in covering skill gaps is detailed there. Lastly, subsection 2.3 covers existing literature's strategies for addressing skill gaps.

2.1. Technological advancements and workforce transformation

As technological advancements, efforts toward decarbonization, and social changes reshape the future of work, employees will need to acquire new skills to thrive in this evolving landscape (Brasse et al., 2024; Felsberger et al., 2022; Huckstep and Dempster, 2024; Pasmore et al., 2019; Selesi-Aina et al., 2024). For example, as the Operator 4.0 typology suggests (Romero et al., 2020), utilising technologies to augment workers is a way to strengthen their capabilities and leverage their skills most efficiently. The Mckinsey Global Institute Et Al. (2024) predicts that by 2030, up to 30 % of current work hours could be automated due to advancements in generative Artificial Intelligence. Multiple factors are likely to shift employment demand, including the push for net-zero emissions, ageing workforces, increased spending on e-commerce, infrastructure, technology, and overall economic growth. Industries are also undergoing significant transformation driven by AI, robotics, and cloud computing, technologies that enhance productivity but also present challenges such as workforce displacement and ethical concerns (Selesi-Aina et al., 2024; Acemoglu and Restrepo, 2018). The ongoing green transition is expected to create high demand for skilled workers, particularly for skills currently in short supply globally (Trevisan et al., 2024; Huckstep and Dempster, 2024). The transition to Circular Economy demands new job profiles and asks education providers to address new learning objectives (Beducci et al., 2024). These developments require a new skill set for employees to succeed in the future workforce. Consequently, business leaders and policymakers must make critical decisions about how much to embrace technological change and investment while ensuring that workers are trained and redeployed into future jobs (Mckinsey Global Institute Et Al., 2024). The "Operator 5.0" concept (Romero and Stahre, 2021) envisions a manufacturing industry that becomes resilient by having resilient workers. Industrial leaders need to predict problems, visualize the issue, and create awareness for problem-solving, to enable their workers to become agile and flexible problem-solvers while taking care of their human needs (Romero and Stahre, 2021).

2.2. Skill gaps and educational reforms

The mismatch between skills required by employers and skills

possessed by employees is often referred to as the "skill gap" (McGuinness et al., 2018; Quintini, 2011; Enders et al., 2019; Rikala et al., 2024). This mismatch presents a significant challenge in ever-evolving workplaces, leading to substantial issues across various industries and hindering innovation, growth, competitiveness, and overall productivity increase (Rikala et al., 2024; Brynjolfsson et al., 2020). Although reforms in the education system are frequently proposed to address these skill gaps, they can be costly and may not always align with the needs of employers (Rathelot et al., 2023). Educational frameworks need to be adaptable to changing technologies, and companies should invest in continuous skills training. Experiential learning environments, such as Teaching or Learning Factories, have emerged as a successful approach to train learners in Industry 4.0 or Industry 5.0 skills that require practice-based and realistic activities, including cloud competencies or robotics (Abele et al., 2015). These Learning Factories are designed to bridge the gap between research, theoretical education, and real-world industrial practice (Abele et al., 2015). To meet the industry's skill needs, Learning Factories are designed and built together with industrial partners (Mattsson et al., 2018).

A skill gap also refers to the difficulty of matching the right skills with the right individuals at the right time (Rikala et al., 2024). It arises from the preferences, expectations, and supply of three key actors—employees, employers, and education providers—which are broadly influenced by megatrends, operational environments, and business realities (Rikala et al., 2024; Braun et al., 2024b). Understanding the concept of a skill gap can help assess the skills an individual lacks and guide the setting of specific goals and resources for training, upskilling, and reskilling (Braun et al., 2022).

Skill gaps are inherently complex and multi-dimensional, covering areas such as technical skills, cognitive abilities, soft skills, and even personality traits. Gaps can be either general or specific to particular jobs, and their impact can vary across different industries and regions (Rathelot et al., 2023). Substantial skill gaps may harm sustainable business transformation and the implementation of new technologies (Brynjolfsson et al., 2020; González Chávez et al., 2023), thus raising the need for assessment methods. Measuring skill gaps requires a thorough approach that takes into account technical, behavioural, and contextual skills, as well as the specific skill requirements of each job and the unique skill sets of individual workers (Fareri et al., 2023; McGee and Crowley-Koch, 2021). The World Economic Forum (World Economic Forum, 2024) recommends a skills-first approach to address skill gaps by pinpointing current skill needs and offering skills-based training programs. A comprehensive skills-discovery process is essential for effective skills-based hiring and training strategies. Tools like "Worker profiler", skill frameworks, or skill matching platforms help assess skills, identify gaps in expertise, and develop customised training plans (Trevisan et al., 2024; Robins, 2024; Braun et al., 2024a). Various methods can be utilised to measure skill gaps, including formal assessments, self-assessment tools, and performance metrics. Such tools are instrumental in identifying areas where skills are lacking and in directing targeted training efforts (Fareri et al., 2023; McGee and Crowley-Koch, 2021).

A concept for assessment and skills portability that has gained popularity since the late 1990s is the Skills Passport. However, implementing this idea has proven to be challenging. An efficient skills passport requires data aggregation from multiple sources, must be portable across various locations and contexts, and should facilitate mapping and tagging of skills (Kitto, 2024). To address these issues, a "Worker Profiler" tool has been developed to provide a more accurate and comprehensive understanding of workers' skill gaps while offering practical solutions to bridge these gaps (Fareri et al., 2023). This holistic approach is crucial because employees often overestimate their skills, reflecting their career aspirations rather than the requirements of their current roles (McGuinness and Ortiz, 2016). In a skill-first economy, continuous learning and adaptability are necessary for employees to keep pace with evolving industry demands (Siddiqi, 2024). Particularly

in industry, employees must become accustomed to new working methods that promote continuous learning, to ensure that they remain valuable and relevant to their organisations and society (Braun et al., 2022).

2.3. Strategies to address skill gaps

Both employees and employers must commit to training, reskilling, and upskilling. It is essential to make learning opportunities accessible, available, and affordable (Li, 2024). Managers play a vital role in fostering successful learning cultures. Human resource practices can enhance the skills and abilities of employees, increasing their motivation to engage in innovative activities. This helps develop a culture conducive to learning and the adoption of new knowledge and ideas, which in turn enhances open innovation outcomes (Naqshbandi et al., 2023). Employers often use rewards, recognition, and money to enhance employee motivation levels. However, adequate and relevant training also substantially impacts levels of motivation as perceived skill gaps may lead to a lack of confidence in the ability to accomplish tasks well (Shanthi and Sharma, 2019). Additionally, employees need to be motivated and ready to constantly enhance their skills, as skill gaps largely depend on their abilities and preferences (Rikala et al., 2024). However, the issue is more complex than individual motivation. Even if a person is highly motivated to participate, they may face challenges if they live in a country where lifelong learning policies are not prioritised (Boeren, 2023). In such cases, employees may find it difficult to engage in lifelong learning opportunities. Inequalities and gaps can widen over time, and it is important to understand the cumulative nature of education and training over the lifespan (Boeren, 2023).

Addressing skill gaps is a complex challenge. No one-size-fits-all solution exists, and significant work still needs to be done. Educators, employers, employees, students, and policymakers must recognise the importance of their roles in bridging these skill gaps. Collaboration among all these stakeholders is crucial (Rikala et al., 2024; Braun et al., 2024b; Siddiqi, 2024). Actions and initiatives at the policy and strategy level are also needed. One recent and ambitious example of the aim to bridge skill gaps is the European Union's European Year of Skills (2023) (European Union), which aims to address skill gaps by promoting a mindset of reskilling and upskilling and supporting skills-related activities and events across Europe, thus helping people to get the right skills for high-quality jobs. Prioritising lifelong learning is essential for strengthening how skills can enrich cultural, social, and material aspects of the lives of individuals, workplaces, and society as a whole (Brandi et al., 2023).

In summary, efficient addressing of skill gaps is essential for adapting to the future of work and maintaining economic competitiveness. A multi-faceted approach that includes data-driven analysis, stakeholder collaboration, and continuous learning is vital for bridging these gaps. The goal should be to use research and evidence-based data from various perspectives to make effective investments in recruiting, re-training, and training (Rikala et al., 2024; Braun et al., 2024b).

3. Research approach

This study aims to create a nuanced understanding of practitioners' experiences when bridging skill gaps. The authors followed a qualitative research approach (Creswell and Creswell, 2017) based on interviews to gather insights on perspectives within the interviewed companies, including detailed information about how they manage skill gaps.

The research process generally follows the case study methodology proposed by Yin (2018). This methodological decision is grounded in the ambition to gather knowledge from an organisational-related phenomenon. The six steps performed were: 1) planning, i.e. the research questions and structure of the study were defined, 2) design, i.e. target organisations and individuals were defined, and profiling survey and interview questions were designed, 3) preparation, i.e. a sample of

individuals was defined, interview meetings were booked, 4) collect, i.e. survey data was collected, and interviews were conducted, recorded, and transcribed, 5) analyse, i.e. a 6-step thematic analysis was conducted (Braun and Clarke, 2012), and lastly, 6) share, i.e. the results were documented in this research paper.

An overview of the approach and the accomplished results is provided in Fig. 1. Further subsections 3.1-3.3 describe the research activities that compose the research process.

3.1. Plan & design

The intention was to understand how skill gaps are managed in industrial firms. Hence, the overall research question is: How can skill gaps be managed? For this purpose, we planned to gather data from industrial managers through a profiling survey and interview.

- Profiling survey: We collected data about the interviewee's job role, industry, company size, the competitiveness of their company, their understanding of the term skill gap, and the country and region their work is based.
- Interview: We collected data about the companies' methods to assess and bridge skill gaps, and the interviewees' reflections on successes and challenges.

The interview questionnaire was designed based on the identified research gap from the authors' previous research about defining and measuring skill gaps (Rikala et al., 2024). The interview protocol was developed to gather data on how companies assess and bridge their skill gaps. The questions included in the interview study were designed to gather knowledge about the programmes and initiatives the interviewees use to bridge skill gaps, their reflections on success, the challenges encountered when bridging skill gaps, the balance between training and external hiring, the involvement of managers, and the ways the company supports lifelong learning. The whole interview guide can be found in the appendices.

3.2. Preparation

The preparation of the interviews was a key step in this study. The authors' objective was to capture diverse and varied insights from experts across multiple industrial sectors to reduce bias and achieve research outputs that can be generalised to some extent. Therefore, the study benefited from using purposeful convenience sampling (Saunders et al., 2023), which enabled the authors to maximise the value from rich networks and select a sample with relevant expertise that meets the research question. Although the sample was based on convenience, we applied purposeful criteria by including only respondents in managerial or leadership roles who had direct involvement in employee development, e.g. Head of learning, CEO, HR managers, education manager, as their roles enabled them to share valuable insights on the strategies employed to bridge skill gaps. Because skill-gap management spans strategic HR, production, digitalisation, and external training offers, we selected the described profiles. The initial pool of potential participants was collected in an Excel sheet by scouting for relevant profiles in the authors' professional networks, accumulated through research projects, industry collaborations, and networking events. In addition, snowball sampling was applied when the contacted potential participants referred the authors to colleagues or other potential participants better suited for providing relevant information for this study. This combination of direct scouting and snowballing created a rich diversity in the sample. Although the sampling did not prioritise organisations of a particular size, the final sample consisted of medium-sized and large companies. This outcome is related to the networks and projects through which the participants were identified, since larger companies are more likely to be involved in upskilling programmes, to have established learning and development structures, and to have publicly visible upskilling programmes.

This approach ensured both accessibility and relevance to the research question. Our aim was not to achieve statistical generalisation, but to gain comprehensive, practice-oriented insights into how organisations address skill gaps. Therefore, including respondents from various functional areas allowed us to gather a well-rounded perspective on organisational strategies and practices. To understand companies' strategies for addressing their skill gaps independently of their
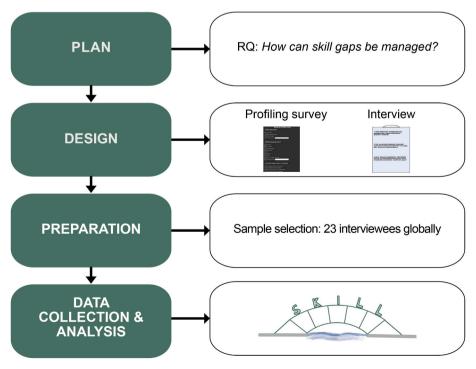

Fig. 1. Methodological approach of the study, including accomplished results, adapted from (Yin, 2018).

employees' locations, the sample was intentionally gathered with high geographical diversity. Despite the varied roles, we observed thematic saturation in the data, suggesting that similar patterns and practices were consistently present across different organisational functions. To maintain participant anonymity, we kept company descriptions limited.

Table 1 presents the interviewees' IDs for this study, which are named after the initials of the interviewing researcher. The table includes their job roles, the countries in which they work, the countries or regions where the people they manage are located, and the company sizes. Additionally, the respondents' companies were mapped to a precise ISIC class. The ISIC Rev. 4 is the UN's official industry taxonomy, recommended for international statistical comparability (UNITED NATIONS DEPARTMENT OF ECONOMIC AND SOCIAL AFFAIRS, 2008).

3.3. Data collection and analysis

The study collected primary data through 23 structured interviews,

conducted in 2024. Three of the authors conducted and recorded interviews through video calls.

This study intends to capture important themes that answer the research question. Braun and Clarke (2012) 6-step approach for thematic analysis was selected as a suitable and thorough strategy that promotes research rigour and reduces bias when capturing how the companies manage their skill gaps. The six steps of thematic analysis include: 1) familiarising with the data, 2) generating initial codes, 3) searching for themes, 4) reviewing themes, 5) defining and naming themes, and 6) producing the report.

The six steps were done by actively including all co-authors in the research process and are described below.

- **Step 1 - Familiarise with the data:** The transcripts were read multiple times to fully grasp both the broader context and subtle details, e.g. company-specific upskilling initiatives. Then, the authors noted their initial thoughts and recurring themes identified, e.

Table 1
Sample characteristics with job role, country, company activities, company size.

Interviewee ID	Job role	Country	Responsible for employees in	ISIC Rev. 4 classification	Company size
MB1	CEO	France	Europe	M 72 – Scientific research & development	Medium-sized enterprise (50–249 employees)
MB2	Talent Acquisition manager	Sweden	Sweden	C 28 → 2814 - Manufacture of bearings, gears, gearing and driving elements	Large enterprise (250 or more employees)
MB3	Education manager	Sweden	Sweden	C 28 → 2814 - Manufacture of bearings, gears, gearing and driving elements	Large enterprise (250 or more employees)
MB4	Education manager	Sweden	Europe North America Asia	C 29 → 2910 – Manufacture of motor vehicles	Large enterprise (250 or more employees)
MB5	Education manager	Sweden	Europe North America South America Australia	C 29 → 2910 Manufacture of motor vehicles	Large enterprise (250 or more employees)
MB6	Director in Consulting Business	South Africa	Africa	M 69 → 6920 – Accounting, auditing & tax consultancy	Large enterprise (250 or more employees)
PR1	Talent Acquisition manager	Finland	Europe	J 62 – Computer programming, consultancy & related activities	Large enterprise (250 or more employees)
PR2	Competence Development Manager	Finland	Europe	J 61 – Telecommunications	Large enterprise (250 or more employees)
PR3	COO	Finland	Europe North America Asia Australia Middle East	C 25 → 2572 – Manufacture of locks and hinges	Large enterprise (250 or more employees)
PR4	Education manager	Sweden	Europe	C 29 → 2910 – Manufacture of motor vehicles	Large enterprise (250 or more employees)
PR5	Technology manager	Finland	Europe	J61 – Telecommunications	Large enterprise (250 or more employees)
PR6	Senior R&D leader	Finland	Europe	C 26 → 2630 – Manufacture of communication equipment	Large enterprise (250 or more employees)
PR7	Line Manager	Finland	Europe	C 26 → 2651 – Manufacture of measuring, testing & control instruments	Large enterprise (250 or more employees)
PR8	Head of R&D	Finland	Europe, Global	C 26 → 2651 – Manufacture of measuring, testing & control instruments	Large enterprise (250 or more employees)
PR9	Customer Lead	Finland	Europe	J62 – Computer programming, consultancy and related activities	Large enterprise (250 or more employees)
PR10	Head of IT and SW architecture team	Finland	Europe	J62 – Computer programming, consultancy and related activities	Large enterprise (250 or more employees)
GB1	EVP People & Leadership	Germany	Worldwide	C 27 – Manufacture of electrical equipment	Large enterprise (250 or more employees)
GB2	CEO	Canada	North America	P 85 → 8550 – Educational support activities	Medium-sized enterprise (50–249 employees)
GB3	HR manager	Sweden	Europe North America	M 72 – Scientific research & development	Medium-sized enterprise (50–249 employees)
GB4	L&D Strategy Intern	India	Asia	C 24 → 2410 – Manufacture of basic iron and steel	Large enterprise (250 or more employees)
GB5	Country Manager	Malaysia	Asia	C 28 → 2814 – Manufacture of bearings, gears, gearing and driving elements	Medium-sized enterprise (50–249 employees)
GB6	Sales Enablement team	South Korea	South Korea	J 63 → 6311 – Data processing, hosting & related activities (cloud SaaS)	Medium-sized enterprise (50–249 employees)
GB7	CEO	Italy	Europe	C 21 → 2100 – Manufacture of pharmaceuticals, medicinal chemical & botanical products	Large enterprise (250 or more employees)

g. the big differences between how open leaders talk about the performance of their employees. Last, the authors listened to the recordings to capture tone, context, and nuances, such as frustration about certain practices. Finally, the key points and patterns that emerged were summarised.

- **Step 2 - Generating initial codes:** The authors independently generated initial codes for each interview, i.e. the one who conducted the interview and a second co-author. These two codes were discussed in bilateral meetings to create a final synthesised coding. In most cases, consensus was found quickly. The researchers' individual codes complemented each other by discussing and synthesising two different codes.
- **Step 3 - Searching for themes:** Two researchers independently formed categories and themes by searching for patterns and bundling codes with the same themes.
- **Step 4 - Reviewing themes:** Themes and categories were compared and discussed in three meetings with the complete authoring team. The volume and complexity of the data required iteration from all the researchers involved to clearly differentiate challenges and practices.
- **Step 5 - Defining and naming themes:** The themes were synthesised into a comprehensive visualisation, the authors naming this contribution the Skill Bridge.
- **Step 6 - Producing the report:** After concluding the themes, the team discussed the prioritised data to be documented and presented in this article.

Fig. 2 illustrates a sample from the coding process, showing how two different researchers coded the selected initial transcript, and then synthesised into one code. In a subsequent, iterative step, themes were developed to encompass the identified codes. After recognising the themes, sub-themes were created by determining whether a code was framed as a practice or a challenge.

4. Results

This section presents the findings from thematically analysing 23 interviews, highlighting how companies manage skill gaps and the challenges they encounter. The five identified themes incorporate practices and challenges that interviewees describe. These are then described, theme by theme, in five subsections, i.e. 1) Skill development initiatives, 2) Knowledge empowerment, 3) Impact & business results, 4) Leadership and culture, and 5) Learning technologies and innovation.

4.1. Skill development initiatives

This theme covers practices and challenges connected to training and upskilling initiatives. Here, interviewees report on the programs the companies have in place to upskill their employees, giving free access to learning, and the obstacles connected to budget, resources, and the fast pace of change and updating curricula.

4.1.1. Practices

Respondents describe their initiatives to upskill their employees. MB1, PR7, PR8, and GB1 describe their partnerships with external training providers like Coursera and LinkedIn Learning. Some respondents say their companies offer internal training programs tailored to the specific needs of the organization (MB1, MB4, PR1, GB4) and that they put effort into establishing their internal education system (MB5).

> *"No one else can give that competence because in a big company like ours where we use specific tools, the tools are adapted to our way of working […]. There is so much competence that is based on the internal way of working."* (MB4)
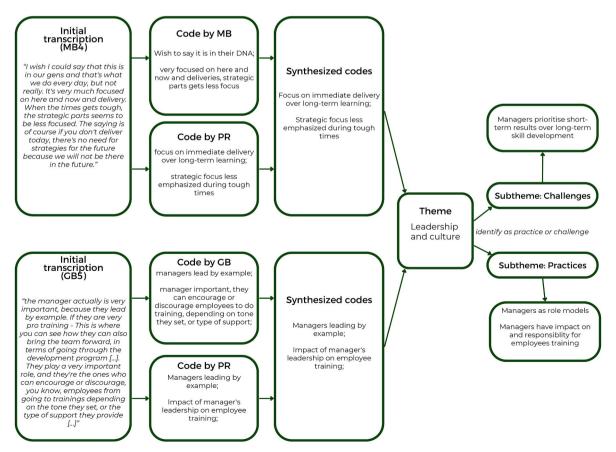

Fig. 2. Examples from the coding process and finding themes.

PR2, PR6, PR10, GB5, MB5 and PR7 describe their targeted reskilling and upskilling programs for emerging technologies, such as AI or cloud specialists, and ESG skills (MB6). It is also mentioned that training should be tailored to the employee's skill level (GB5) and customized for continuous improvement (GB6). GB5 also mentions the need for post-training feedback to increase continuous improvement. This is connected to the comment of GB3 about the need for a structured way of continuous improvement work and having a "good people plan". One important factor highlighted by several respondents was that learning should be accessible for all employees for free (MB1, GB1, GB7) and that learning should be flexible through online learning (MB4).

"We […] offer all our employees free of charge access to nearly every learning environment that you can have from LinkedIn learning to Coursera, to Harvard Business Review to whatever you can imagine […]. And no matter whether it's blue collar or white collar. So free access to nearly every, at least digital, learning opportunity […]. So that is one cornerstone of the strategy, which, by the way, was also pretty remarkable when we introduced it." (GB1)

4.1.2. Challenges

Some interviewees' challenges are connected to the training and development initiatives. Firstly, there are challenges linked to training costs with limited budgets (MB1, PR4, PR10), especially when training must be available in multiple languages. Secondly, training programmes' timetables could be challenging due to the individual work schedules of employees (PR4, PR10). Moreover, GB2 claims that academia doesn't move fast enough in adapting its curriculum to training needs. Especially, by making advanced training content available for employees to develop deeper expertise, interviewees see challenges (MB5, PR10).

"Take the knowledge in three areas: you can have sort of an awareness area, […] a skill level so you know how you could work with it, or the expert knowledge, you really know how to research and you really know how to utilise it and then research and develop things around it. And there are a lot of available things when it comes to the awareness area. There you can find plenty of things, but to put things in people's hand where you need to actually dig a little bit deeper, do a job and actually study a little bit by yourself. Here it's less things that are available." (MB5)

MB1 also claims that some skills are not easily trained online, but through longer training programmes or through gaining experience in them. In addition, blue-collar employees working in factories often don't have access to PCs, and therefore, it becomes challenging to upskill them online (GB7).

4.2. Knowledge empowerment

This theme describes how interviewees engage their employees and the challenges their employees face. This includes the employees' experiences with learning platforms, mentorship programmes, communities and networking, self-motivation and taking responsibility, adaptability to change, democratising skills, prioritising learning, self-assessment bias, and stress caused by constant change.

4.2.1. Practices

As a practice to engage employees in training and upskilling, some of the interviewees described their user-friendly learning platforms using external resources like Coursera courses, LinkedIn learning, and internal training that makes it possible to track learning (GB7, PR8) or even have internal learning competitions (GB1).

"What is very helpful obviously, is, from an HR perspective, instead of tracking the employees, tracking the overall learning hours and make a competition out of this, which part of the company learns more than the others and make this visible" (GB1)

Some of the companies offer mentorship programmes and access to communities and forums to drive employee-driven learning (PR2, PR6, MB3), or give employees opportunities for external networking through industry conferences (GB5, GB7). Some respondents highlighted the importance of embedding lifelong learning into the company culture, driving self-motivation (PR10, MB1, GB5). In addition, individual responsibility for own skills was highlighted (MB1, MB3), and it has been beneficial to focus on the people motivated to learn (MB1) and not being scared of change (PR5).

"I think it's the kind of success strategy is, […] is to be brave enough to […] change your existing way of working […] and try new things bravely and not be afraid of failing. […] And then, as I said, you need to be patient." (PR5)

At the same time, employees need support from their managers to find their motivation and acquire new skills (MB1, MB3, GB5), but also from team leaders and colleagues (PR3). PR10 mentions that they both offer time during work hours for learning and payment of the courses and certifications. PR2 mentions their incentives for learning through monetized rewards when certificates are achieved.

"So, if it's like either it's time and money or it's both. So, I mentioned previously that, for instance, sometimes we need to have a certificate program, certain number of people that become certificate on the specific technologies. For that, we are actually supporting people on just giving them money for achieving those certificates." (P10)

"We actually compensate people and encourage them with monetary rewards when they acquire a new certificate in a technology field […] which is internally designed by us." (PR2)

PR6 highlighted the importance of employees' ability to adapt to change, and GB7 also acknowledged that rapid change challenges human capacity. To take charge of their own skills, MB3 and PR1 suggest to "democratize skills" to ensure that individuals organize their skills in a system.

4.2.2. Challenges

A major obstacle mentioned by the interviewees is the employees' reluctance to learn (MB1), due to change resistance (PR3), their mindset, interest, intellectual capability (GB5), and lack of motivation (PR3).

"You have certain people who don't want to learn new skills and competences. You can only walk with the people who are willing to develop and learn new skills, so there is always a people management challenge. I mean, in the research, there is always out of 10 people you will have 2 reluctant people you will not move. So, you shouldn't waste your time on these people. They do deliver what they have to deliver and you focus on the ones who are willing to develop. So that's one challenge to obviously consider." (MB1)

"Change resistance is in the nature of people, it typically is that 'let's do the same, let's hire the same people. Let's do what everybody else does in our company.[…] And then I guess it's a bit laziness. It's easier to do things like you have done […]." (PR3)

"The mindset is very important, because then motivation can come, the interest for them to learn, new things." (GB5)

"It could be a mix of different things, it could be interest, it could be attitude, it could also be that this is maybe beyond the intellectual […] ability of that person to master a certain skill set. So that's where […] we really need to understand […] what is the reason for this gap, or maybe certain resources not been provided to this person to be able to really close this gap" (GB5)

The last comment of GB5 here highlights that the interviewee puts effort into understanding what underlying reasons there could be for a person's skill gap and why it's not closing.

Another challenge is the difficulty of prioritising learning in their

day-to-day responsibilities (PR8, GB6), also because the change is never-ending and new skill needs are arising before previous skill gaps have been filled (GB7).

"In the last 15–20 years, we have seen the speed of organizational change increasing, and the time last between one change and the other one: reducing, reducing, reducing.[…]so it's constantly asking people to change now, then there was digitization, and then it was the pandemic, and then […]. So I see people under a lot of pressure, stress." (GB7)

MB5 gives even more perspective to this, saying that some employees are physically tied to their workstations with very little or no time to learn in between tasks.

"If you have jobs that tie you physically to a location or an activity, then it's sort of set by a schedule.[…] So you need to plan to bring the people out of this ongoing production processes. And replace with some other so that they have capability to do this." (MB5)

GB6 raises a challenge connected to the employees' perception of training and their doubts about the effectiveness or feeling that the training is repetitive. This could be connected to other respondents' reflections, saying that learning content often is not sufficiently aligned with employees' real-world job needs (PR8, GB4). But also, some employees perceive the quality and relevance of training as repetitive or ineffective, making them unmotivated to take part in more training (GB6, PR8). Hence, it is difficult to distinguish the training needs of employees.

Another challenge lies in the overconfidence of current skills (PR1) and different self-perceptions depending on the field, e.g. that IT experts would be more modest than employees working in sales (PR3, GB4). Lastly, MB1 brings up the challenge that not all employees might have the ability to acquire necessary skills, since humans have different pre-requisites. This connects to what GB5 said about the importance of assessing employees' capability to absorb training.

"I guess these skills are not necessarily easy to acquire for everyone. […] I think there is an assessment to have when you try to help some people to develop certain skills and competencies and also realize that certain skills and commitments may not fit the person. […] Usually, these people are willing to learn, but they don't succeed necessarily to acquire the right competencies because it's just not for them. So, you need to rethink, take a step back and maybe think of other alternatives or other competencies we can bring to these people to help them still develop. But in a path which will be more adapted for them. […] I mean, if you have someone who is coming with a background on, I don't know advanced technology, and you want to bring that person into facilitating a big workshop, to be a people person, you should not. There is so much of a stretch you can push people towards. We need to be mindful of that." (MB1)

4.3. Impact and business results

This theme highlights the practices and challenges the interviewees describe regarding the impact of learning on their business, but not many describe that they have KPI's connecting business outcomes to learning. Interviewees described the importance of strategically aligning skill gap management with overall business goals and long-term impact, but at the same time described the challenges in measuring learning impact, especially in a fast-changing, complex environment. One clear challenge that crystallised from the interviewees is the difficulty in finding key performance indicators (KPI) that relate to learning and upskilling impact.

4.3.1. Practices

Respondents highlighted the need to do strategic workforce planning to identify current, but also future skill needs (PR2, PR10, MB6, GB4). They also express the need to do a skill gap analysis regularly (GB1, MB6, PR1). According to GB7, business results and costs are primary

indicators of success, and therefore skill gap KPIs should be tightly linked to those and evaluate the efficiency and effectiveness of initiatives and investments. PR8 and PR10 point out the need to tie employee retention and employee transitions across projects as KPIs to measure successful skill gap management. PR1, PR10, and GB5 see value in having certifications for skills to achieve a structured path for career progression and expertise building of employees. PR10 points out the need to evaluate the long-term impact of skill development on business results. In addition, training investments had a long-term impact but there was not yet witnessed any long-term impact from personal development plans (PR7).

"Long term impact - well on top of my mind now is the cloud transformation that we are ongoing with and it seems like maybe without the investment into the trainings […] we probably would not be as successful in that. Other than that, some of the internal knowledge transfer sessions things like that we've implemented, I think, those have also been seen as very useful and enabling people to perform better, better quality and better efficiency. But for example, one thing is that I haven't witnessed any long-term success when it comes to for example those personal development plans that have, they really impacted in a positive way or not. There's the assumption that they are beneficial, but I haven't seen any evidence of that yet." (PR7)

The last quote shows a pattern in the interviews, i.e. many companies lack knowledge about the impact of their skill gap management measures.

4.3.2. Challenges

A lot of challenges mentioned by interviewees are related to long-term planning of the workforce, strategic talent management, and the effects of skill gaps on business results. MB2 expresses a lack of awareness for strategic competence management and MB2 and MB3 see a lack of competence development prioritisation among management. GB4 describes a misalignment between skill development and performance management. Other interviewees find that management is missing a unified skill development approach or strategy (PR1, PR4). PR2 finds that the company lacks an overarching picture of its skill gaps. Further, MB3 points out the lack of strategy to proactively tackle skill gaps, and MB4 and PR4 criticise the lack of focus on future skill needs.

These strategic issues impact budget allocation for skill development. PR4 points out the challenge of balancing investments in skill development with financial constraints. PR8 claims that skill development competes with day-to-day business and deliverables. PR4, PR7, and PR10 bring up that skill gap management requires effort. At the same time, interviewees are struggling with time constraints (PR7, GB5, GB6).

In addition, interviewees report increased difficulties in talent management, due to uncertainty in technological transformation and continuously changing skill needs (MB5, PR1, PR4).

"I think the biggest challenge is that in the transforming world, there are a lot of unknowns, so it's really hard to say where does this go. We have so many new technologies coming into play at the same time. […] The challenge is really to - how do I take a good enough decision on where we need to go in our competence journey? […] And then the next connecting challenge is to get people to actually articulate - What is this specific knowledge that you need to have? I mean, if we need to be very good in electrification. OK, what do we need to know? Is it the chemicals in the battery that you need to be expert on? Is it the utilization, how you manufacturing the batteries?" (MB5)

GB7 says there has been an increasing speed of change over the last years, making it increasingly difficult to keep up with the change, for managers and employees, since these changes also questions the current organizational model.

Furthermore, MB2 highlights talent scarcity as a main challenge. As a solution to succeed with talent management, MB3 claims there is a need

for something new, like a skill-based approach.

"The first thing is to even start mapping or realising what you might need in the future and also the key skills that you need today[…]. And the next thing is to get the whole picture, or drive the whole picture. All the talent management of a department. That's also a lot of job, but I guess that's why we are starting the skill-based organisational project here, to do something else. That we see that we need something new. In the way of working with skills and also with talent management, if we want to call it talent management[…]. But yeah, a new way of working." (MB3)

Interviewees also highlight certain challenges in their processes for managing skill gaps. For instance, MB3 explains that in many cases, they only conduct skill gap analyses but then fail to utilise the knowledge about the skill gap to direct employees to training, or they struggle with knowing where and how to find training. Additionally, some interviewees perceive a lack of centralised control or processes to oversee training, or express resistance towards it (MB5, PR1, PR6).

According to GB1, addressing skill gaps is challenging, especially for non-technical skills. MB3 also addresses the difficulty of mapping today's and future skill needs. MB4 struggles with keeping up with all the topics that employees need to learn about and finding external training providers. From a talent management perspective, it is often challenging to identify key areas of expertise (MB5).

"And then the next connecting challenge is that to get people to actually articulate or define or put a word on what is this really? What is this specific knowledge that you need to have? I mean, if we need to be very good in electrification. OK, what do we need to know? Is it the chemicals in the battery that you need to be expert on? Is it the utilization, how you manufacturing the batteries? Or is it the energy power management system within the product, how you maximise the utilisation of the energy where you need to be good? I mean here the challenge is both to see what knowledge do we see with all these disruptive technologies coming into play, which don't really have a steady state yet. How we will utilise them. And the other is how can you articulate and put really specific words on: this is what we need." (MB5)

Lastly, a challenge regarding training initiatives in companies is that the impact of training is not always immediate. Therefore, it can be challenging to balance short-term and long-term thinking (GB5).

"But then if, let's say things are not in a very critical stage, […] this is where the managers may be, then also inclined to provide certain trainings, to use the time meaningfully, to build up the skills for the skills for the future, because you don't see the effects of the training immediately. Sometimes, it may take a while before you see certain results, but it requires the manager to also think a bit long term, and not just the short term of seeing - Okay, getting the job done, but then, if the employees is doing this every day, they are not really improving to be able to meet the skills for the future." (GB5)

4.4. Leadership and culture

This theme describes the practices and challenges that leaders in the case companies have regarding leadership and creating a culture of learning. Topics brought up here are the role of leaders in setting the strategy and direction, creating a culture that fosters learning, giving mental support, being a role model, incentivize mangers to foster learning, and transparency and awareness about the managers' own skill gap.

4.4.1. Practices

Some respondents emphasised the responsibility of leaders to act as visionaries and coaches who set strategic directions regarding learning and foster a culture of lifelong learning (PR3, GB7, MB3).

"They [managers] play a very important role, and they're the ones who can encourage or discourage, […] employees from going to trainings depending on the tone that they set, or the type of support that they provide" (GB5)

At the same time, PR7, MB1, and MB5 explain the importance of combining top-down with bottom-up approaches, meaning that managers set the strategy and direction and individuals bring their internal motivation. For that, leaders need to create a culture of openness and courage (GB1). Managers are responsible for facilitating their employees' development through goal setting and individual development plans and discussions (PR7, GB5, GB6).

"The real change or transformation needs to be, that people need to feel that it's coming from them, […]. And at the same time, you have some people to kind of tease them in the right way." (MB1)

Also, managers are responsible for collaboration with their ecosystem to stay updated on industry trends (PR1, PR6, GB7). According to PR3 and PR5, leaders must commit to strategic capabilities, skills, resourcing and training. Some interviewees raise managers' role of creating emotional and mental support connected to the change their employees have to go through, like offering mindfulness classes and psychological support (GB7) or addressing the question "do you feel safe in your job?" (GB3) and try to make them feel acknowledged and safe. Some respondents said their companies even create accountability for skill development by tying managers' bonuses or incentives to the learning outcomes of their employees (GB1, PR7). PR9 describes how they have introduced competency leaders for different areas to drive certain competency questions forward and inspire others. Lastly, GB7 brings forward the importance of being a role model as a leader and explains their commitment to their own learning. This can be read in the quote below, where the manager describes their commitment to learning, even if that means they are learning while eating a lunch sandwich:

"And I decided to, we don't ask people to do training out of working time. But in my case, I said, Okay, today I will just have a sandwich and just do the course, because otherwise I don't never find the time. So we really keep telling people, making people aware. Training is there […]. It's not about your boss […] it's about the outcome you are producing. They should stimulate a virtual loop where people, the more they see the impact they can have, the more they are encouraged by themselves to learn and asking for specific training. And then the manager, who is, as I said, vision, architect, catalyst and coach should help facilitate when in learning, but this should be a lot bottom up and driven also by this need of making an impact. That's the key point." (GB7)

4.4.2. Challenges

One of the challenges brought up regarding leadership and culture is that managers often lack humbleness and transparency to address their own skill gaps (GB3, PR6). In many cases, managers were outspoken about their employees' skill gaps but not about their own (GB1).

"I think they (the managers) are quite outspoken but they are less outspoken about their own skill gaps." (GB1)

According to PR4, PR8, and GB3, managers' fixed mindsets could hinder innovation and skill prioritisation. Further, a challenge highlighted by GB5, PR4, MB4 and PR1 is that many managers prioritise short-term results over long-term skill development.

"Our culture works against us […]. The culture is so strong to deliver on time right now. Not what we can deliver in two years. It's what we can deliver today, not what we will be able to deliver in two or five years […]. So the most important is what we can deliver today. And that doesn't help us, encourage us for lifelong learning." (PR4)

In addition, GB3 talks about psychological safety and the challenge

that skill gaps are not always visible if a person doesn't feel safe. Further, GB7 mentions cultural challenges that require a culture shift. Constant change would cause stress and pressure on employees (GB7).

"It's a psychological support because we understand that the speed of change and the complexity of change we have to deal with is more and more non-human." (GB7)

4.5. Learning Technologies and Innovation

Theme 4 addresses how companies leverage technologies and innovation, to enhance and analyse learning. This subsection is about the new tools companies use, or start to use, to map and track skills, assess skill gaps and leverage AI. The interviewees also describe the challenges, including employees' and managers' non-consistency in using the tools and the fast pace of change.

4.5.1. Practices
MB3 described a simpler way of mapping skills, using AI, compared to manual mapping:

"We have tried similar things before. I mean it's about mapping skills for example, but it's too much job, it has been too much work for individuals to map and it has been huge Excel files, but we think now, and we have seen some technical solutions, that AI can provide a simpler way of doing it, and that we get more out of it as well." (MB3)

Using AI for skill mapping and forecasting future skill gaps through scenario planning is something PR9 and MB6 report to do in their companies. GB1 and PR6 have implemented platforms with skill assessment functionalities into their LMS, and GB1 and PR9 have integrated dashboards in their LMS to visualize skills and progress.

"Skill gap assessment is part of this [learning platform]. It's included there, but obviously, the use of it is up to the respective units, whether they by the way, they use it for some purpose or not." (GB1)

Some of the interviewees describe an integrated skill gap analysis tool and AI tools in their learning platform (GB1, GB7, PR9, MB6). Some of the interviewees are currently developing or implementing AI tools to evaluate employees' skills and match them to suitable learning or jobs (GB2).

"So, a participant looking for training and jobs will come through, they'll be evaluated by the AI system […]. They'll create a profile that matches them to opportunities and those opportunities are matched to jobs. And that's the way we're looking at it, but really break it down to foundational fundamental skills to do something versus degrees and diplomas. So [name of the software tool] is one of many software tools out there. It's a big movement, I think, right now in education and training, this kind of skills profile that AI can support generating." (GB2)

PR6 also integrates personalised skill tracking into their annual planning. PR2, PR4, and PR10 claim they have certain processes for strategically planning future skill needs. All interviewees refer to some sort of internal learning platform or LMS. One of the interviewees said they developed an LMS-integrated chatbot to answer learning-related questions (PR9).

4.5.2. Challenges
One of the main challenges related to technological and innovative solutions is the large uncertainty in predicting technical and organizational needs due to the fast speed of change and the complexity of skill needs (GB1, MB5, PR10).

Another challenge is the actual use of the innovative solution, because if employees and managers don't use the innovative platforms or don't enter data in a sufficient manner (GB7). In addition, there are challenges due to the maturity and complexity of systems, meaning a lot of work for Learning and Development departments when a change or

transformation occurs (GB4). MB4 mentions the complexity of their skill matrix system, which causes an administrative burden.

"The maturity of our systems itself. […] bringing about any change becomes a mammoth of a task, and that is where sometimes that internal buy in from the L&D itself suffers because it just means a lot of more work for the people who are working within the department." (GB4)

Finally, MB5 highlights the challenge of individual bias when self-assessing skills with the skill assessment tool, and the need to still discuss between manager and employee the results of the assessment and the direction the company wants to go.

"We have it in the company tools to follow up the skills both on talent level and on individual discussions level […]But in the end, it's still subjective to what one or two person thinks about one and two things. And it's not the tool itself that is the critical thing, it's the discussion and the evaluation between people and the setting of the level between people when they do this review together, as a manager and employee, when you discuss this, that's where you get the most value and understand most accurate where are the skill level today. Where are we supposed to be? And how do you make a mitigation plan to close the gap?" (MB5)

To gain an overview, Table 2 synthesises the practices by which industrial representatives manage skill gaps and the challenges that hinder them.

5. Discussion

Our study examined how global business leaders from nine countries manage skill gaps amid current industrial transformations. Our findings resulted in the identification of the five key themes – representing Skill development strategies, Knowledge empowerment, Impact and business results, Leadership and culture, and Learning technologies and innovation.

This section discusses our findings and their contribution to the existing literature on the topic, as well as their implications for organisations and policymakers, and provides directions for future research.

5.1. Comparison to existing literature

Our findings reinforce prior research, which demonstrates the importance of lifelong learning as a response to rapid industrial transformations (World Economic Forum, 2025; Rikala et al., 2024) and the multi-faceted nature of skill gaps (Rikala et al., 2024; Rathelot et al., 2023). Firstly, the importance of continuous learning and upskilling is highlighted by literature and our interviewees as a necessity for an adaptable workforce (Braun et al., 2024b; World Economic Forum, 2025; Beducci et al., 2024; Li, 2024). Even if prior literature highlights the urgent need for sustainability skills (Beducci et al., 2024; Fareri et al., 2023), the representatives mainly mention specific upskilling or reskilling for technological skills. This data is surprising, still, two respondents specifically mention environmental sustainability and their ESG-related targets, and how they think about upskilling their workforce to achieve those targets. Our study emphasises the importance of self-motivation, lifelong learning, and the individual's adaptability as critical factors for addressing skill gaps. Recently published literature recommends skills-first approaches (World Economic Forum, 2024; Robins, 2024), which align with our interviewees' integration of mentorship programmes and learning platforms, as well as tools like the "worker profiler" (Fareri et al., 2023) where skills, not certificates, are in the foreground. Using AI to enhance human capabilities and training the workforce to implement AI is highlighted as a priority for companies (MCKINSEY GLOBAL INSTITUTE et al., 2024). Novel insights from our study emphasise democratising skills, highlighted by (Kitto, 2024), and empowering employees to take their learning into their own hands by offering tools, e.g. for AI-driven skill mapping (Braun et al., 2024a).

This study identified several challenges to managing skill gaps, such

Table 2

Overview of the practices and challenges across the five themes.

Theme	Practices - How companies manage skill gaps	Challenges - What hinders them
Skill-development initiatives	• External partnerships (Coursera, LinkedIn Learning) • In-house academies • Targeted up-/reskilling for AI, cloud, ESG etc. • Free digital access for all employees • Continuous-improvement cycles	• Training budgets and cost of providing in multiple languages • Scheduling around shift work/production lines • Academic curricula lag behind industry needs • Scarcity of expert-level learning content • Hands-on skills hard to teach online
Knowledge empowerment	• User-friendly LMS with leader-boards or learning "competitions" • Mentorships, communities of practice, external networking • Culture of lifelong learning • Incentives for certificates (e.g. money) • Active managerial coaching & support	• Resistance to change, low intrinsic motivation • Hard to prioritise learning time over day-to-day work • Constant waves of change create stress • Self-assessment bias/overconfidence • Limited PC access for shop-floor employees
Impact & business results	• Strategic workforce planning tied to future tech roadmaps • Recurring skill-gap analyses with dashboards • KPIs linking training, retention, employee wellbeing • Certification frameworks for career progression • Limited tracking of ROI on learning investment	• Lack of unified competence strategy • Difficulty defining KPIs that capture learning impact • Budget/time trade-offs with short-term delivery pressure • Rapidly shifting skill demand • Gap-analysis data not always turned into action
Leadership & culture	• Leaders act as visionaries, coaches, role models – have a responsibility • Top-down vision combined with bottom-up initiative • Psychological safety: mental-health & mindfulness support • Learning outcomes tied to managers' bonuses • Ecosystem collaboration to stay ahead of trends	• Managers' fixed mind-sets • Managers' reluctance to admit personal skill gaps • Short-term thinking culture hinders strategic thinking • Low psychological safety hides true gaps • Change fatigue & stress during continuous transformation
Leveraging technology & innovation	• AI-based skill mapping • LMS add-ons for gap assessment & visual dashboards • AI-based skills-matching linking people to learning or jobs • Chatbots answering learning queries • Annual personalised skill-tracking loops	• High uncertainty as tech requirements evolve • Low user adoption/inconsistent data input • Legacy-system complexity slows roll-outs • Self-rating bias in automated assessments • L&D workload spikes during platform changes

as employee resistance to change, lack of motivation, and stress caused by ongoing organisational transformations. These challenges often emerge in fast industrial changes, which can undermine employees' capacity to upskill. Rikala et al. (2024) emphasise that skill gaps are a multifaceted issue that impacts all main stakeholders in the skill gap issue, namely employees, employers, and education providers. Their study highlights that these constant technological transformations increase complexity and strain all stakeholders involved in skill development. Similarly (Boeren, 2023), underlines that continuous learning participation is not only a matter of having access to learning but also depends heavily on motivation and support systems. Our findings confirm that without organisational support and commitment to psychological and motivational aspects, efforts to close skill gaps risk being ineffective, regardless of the tools or training initiatives. Through the interviews, we realised that companies have challenges related to handling skill gaps, no matter the company size. It is challenging for them to keep up with the fast changes in the complex world including various stakeholders.

What is new from our findings is the depth with which we present leadership behaviours that could hinder effective skill gap management, e.g. when managers lack transparency or are unconscious of their own skill gaps. In addition, this study reveals some practical barriers, such as training timetables or language issues, that have been underexplored so far. These findings could potentially open up a discussion about the reasons why traditional training programmes often fail despite strong theoretical support.

Through our study, we were also able to explore companies' adoption of AI tools for skill mapping, forecasting required skills, and personalised skill matching and tracking. Our interviewees also describe their challenges with these tools, including the complexities when predicting the future, system maturity issues, and getting employees and managers to use them consistently. Previous literature frequently highlights the importance of leveraging technological solutions, such as those for skill gap assessments and AI-based learning recommendations (Braun et al., 2022, 2024a; Fareri et al., 2023; World Economic Forum, 2024). However, previous literature doesn't provide details about how companies actually operationalise these tools and also address accompanying challenges, such as resistance to using platforms.

Existing articles mention the need to align training investments with

organisational goals and define meaningful KPIs (MCKINSEY GLOBAL INSTITUTE et al., 2024, Brynjolfsson et al., 2020; Fareri et al., 2023; McGee and Crowley-Koch, 2021). Our study brings novel insights into the link between skill gap KPIs and business outcomes, such as customer satisfaction, but also highlights the difficulties in practically measuring the impact of upskilling on long-term business success.

5.2. Towards a skill bridge

The authors' *Skill Bridge* synthesises the practices and challenges into five actionable dimensions, providing practical business strategies, as visualised in Fig. 3 by a 5-stone bridge consisting of 1) Skill development initiatives; 2) Knowledge empowerment; 3) Impact and business results; 4) Leadership and culture; and 5) Learning technologies and innovation. Each stone in the *Skill Bridge* integrates both practices and challenges related to managing skill gaps. This bridge addresses literature's call for strategies to manage skill gaps, involving employees, leaders, and technological tools. This multi-stakeholder approach is discussed in the literature on skills development (Rikala et al., 2024; Braun et al., 2022; World Economic Forum, 2024), and the importance of HR and innovation within HR leadership is highlighted (Naqshbandi et al., 2023), which is also reflected in the *Skill Bridge*.

In summary, our *Skill Bridge* framework aligns with previous broader suggestions of skill gap strategies. However, our framework operationalises these strategies by presenting practical company actions, e.g. incentivising learning through bonuses and implementing AI tools for skills tracking. The connection between upskilling, business outcomes, and KPIs is relatively underexplored, but we believe our framework can make a valuable contribution to understanding the identified connections.

5.3. Implications for theory and practice

This study contributes to the existing literature about skill gap management by providing a new, holistic perspective that includes leadership, employee engagement, technology adoption, and the impact on business outcomes.
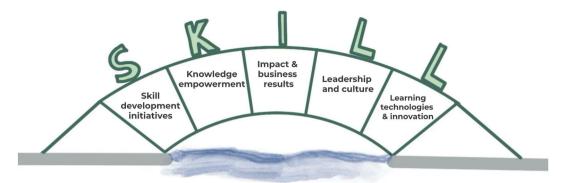
Fig. 3. The Skill Bridge resulting from thematically analysing interviewees' perspectives on managing skill gaps.

5.3.1. Implications for theory

Previous research describes skill gaps as the mismatch between the supply and demand of skills (Rikala et al., 2024). Now, with this empirical study, we were able to illustrate the complexities of this quite static definition, such as workforce resistance to change, high speed of technological transformation, and organisational priorities. Our findings imply that skill gap management needs to be highly dynamic and adapted to different contexts. More research and analysis of our data is needed to understand the context- and culture-specific challenges and to find out how to manage in a highly dynamic world.

Our study expands previous literature about HR and management, where it's often assumed that learning is the individual's responsibility. Through our interviews, we could see that leadership and building a culture of lifelong learning are key to making employees thrive.

Moreover, this study contributes to the empirical findings on AI technologies for skills mapping, work forecasting, learning recommendations, and the practical challenges associated with them. This has been missing in the literature, even though the use of AI in this context has been discussed previously.

Previous literature discusses the importance of connecting business KPIs to training outcomes. Our study adds practical recommendations on how to connect skill development to performance reviews and connect skill gaps to innovation, retention, and customer satisfaction.

5.3.2. Implications for practice

The findings in this paper can be instrumental for managers, HR leaders, policymakers, and education providers working with upskilling or skill gap questions in their organisations.

Business leaders and HR can use these findings to understand how to train their leaders to support their employees in learning, but also address their own skill gaps. In addition, organisations could use the findings to build incentives for managers tied to their own and their employees' training outcomes. This could potentially motivate them to include long-term goals rather than only focusing on day-to-day business and short-term goals. Moreover, leaders or organisations as such could use the findings to work on the integration of AI-based tools supporting skill management and ensure the adoption of these in the daily lives of their employees and leaders by e.g. providing user-friendly and integrated dashboards. HR departments could use the findings as a recommendation to implement regular skill gap assessments and forecasting exercises to ensure the workforce is up-to-date with necessary skills. In general, our findings show business leaders that for a resilient workforce, they need to move away from a reactive skill gap management to a more proactive approach.

Policymakers could use the findings to create incentives and funding opportunities for companies to invest in upskilling programmes. In addition, policymakers should incentivize the collaboration between industry and academia and ensure academia is adapting their curricula to current needs.

Education providers can use our findings to rethink their training offer into providing modular, skill-based certifications rather than longer programmes. This would allow employees to gain new skills while working. Lastly, academia and other education providers should continuously communicate with industry to align their curricula to current needs.

5.4. Suitability of methods, subjective values, and biases

The precision of results was increased by 1) having three researchers collaboratively conducting the interviews, 2) having two researchers coding each interview independently, and 3) having two researchers discussing and synchronising the coding. Data analysis was done first by the three researchers who conducted the interviews through thematic analysis, then by including the whole research team, see list of authors, to discuss which relevant topics to bring forward and how to frame them in the most useable way.

The empirical method approach provided insights to answer the question, "How can skill gaps be managed?". By identifying key leaders from different parts of the world, we acquired experiences from a range of cultures. Through detail-oriented interview questions, we could draw clear pictures of the practitioners' skill gap management. The thematic analysis gave a clear overview of key topics and enabled a first framework, describing the key stones that companies should include in their skill gap management, i.e. The Skill Bridge. However, the qualitative nature of this work only allowed a relatively small sample size and more data is needed to draw conclusions regarding practices and challenges in smaller companies, different parts of the world, industry-specific needs, individual employees' special needs, and more.

5.5. Future work

In the forthcoming steps of this work, The Skill Bridge will be further developed and operationalised, requiring the gathering of empirical data from a wider range of industries and organisational sizes. It is important to enable in-depth analysis of contextual differences such as location, culture, and sector-specific challenges. In the current study, the majority of the companies were large, global corporations, and their practices will probably differ from those of smaller companies when it comes to managing skill gaps. Therefore, we aim to undertake a subsequent study explicitly targeting small and medium-sized enterprises, which represent a dominant share of all businesses. The sampling for this study showed that there is limited visibility into how startups and small companies work with their skill gaps. However, these organisations have significant skill gap challenges, which is why it's important to consider focused research on small companies and startups in the future. Moreover, research on skill gap management has emerged, but there is a need to conduct in-depth case studies on skill gap management in companies to gain a deeper understanding of the practices and challenges faced by various stakeholders within a company, and to develop support for them. Furthermore, each stone of the Skill Bridge will be further refined

based on deepened discussions with industrial practitioners and through evaluation of the applicability of the framework in different business environments. This work includes efforts to link upskilling initiatives to business KPIs and outlining methods for measuring the long-term business benefits of adopting the Skill Bridge. Lastly, as the urgent need to sustainably transform industry becomes more prevalent, there should be specific research about skill gap management for sustainability skills. There is a lack of research that focuses on skill management targeting environmental goals and leadership driving a sustainable skills transformation.

6. Conclusion

The broad range and availability of skills needed to handle rapid technological development and global threats related to climate change are crucial for industry and society. A better understanding of the challenges involved in meeting these demands and closing the rapidly emerging skill gaps is urgently needed. Unfortunately, existing literature does not provide conclusive directions to address the problems.

The global interview study presented in this paper reveals companies' practices and challenges when managing skill gaps in their organisations. Through our interviewees' valuable insights, we were able to answer the question: *How can skill gaps be managed?* Our analysis revealed five key themes and building blocks, describing the practices that organisations work with to manage their skill gaps, i.e. 1) Skill development initiatives; 2) Knowledge empowerment; 3) Impact and business results; 4) Leadership and culture; 5) Learning technologies and innovation. The five themes converge into the *Skill Bridge*, a novel way to conceptualise practices to effectively bridge skill gaps. We conclude that the *Skill Bridge* adds theoretical and practical value, motivating extended research in these five fields while helping practitioners to effectively implement measures to bridge skill gaps in their organisations. From our interviews, we learned about the nature of the skill gaps among participating companies, including real accounts of ways to manage skills while facing identified challenges. However, while this study offers new insights, it has limitations based on its qualitative nature and smaller sample, which are discussed in subsections 5.4 and 5.5. Thus, the Skill Bridge may constitute a base for researchers as well as a generic instrument to build a specific company's skill gap strategy.

CRediT authorship contribution statement

Braun Greta: Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Conceptualization. **Paavo Räty:** Writing – review & editing, Methodology, Investigation, Formal analysis, Conceptualization. **Mattias Bokinge:** Writing – review & editing, Methodology, Investigation, Formal analysis, Conceptualization. **Pauliina Rikala:** Writing – review & editing, Writing – original draft, Investigation, Formal analysis, Conceptualization. **Raija Hämäläinen:** Writing – review & editing, Supervision, Funding acquisition, Conceptualization. **Anna Syberfeldt:** Writing – review & editing, Writing – original draft, Supervision, Conceptualization. **Johan Stahre:** Writing – review & editing, Writing – original draft, Supervision, Funding acquisition, Conceptualization.

Declaration of competing interest

Nothing to declare.

Declaration of competing interest

Acknowledgements

Appendix

Interview protocol

Warm-up Question: How do you understand the term "skill gap"?

Give our definition, that we use in this interview: A skill gap is the gap between the skills that employers require and the skills their employees possess.

Questions: Measuring Skill gaps

- How do you measure skill gaps in your organisation?
- What methods or tools is your company currently using to identify skill gaps among employees?
- Could you reflect on the effectiveness of these methods? Are there any challenges faced during implementation of them?
- How do you measure skill gaps of individuals or groups of people?
- How often does your organisation collect data about skill gaps?
- Which are the specific key performance indicators (KPIs) your company uses to understand the extent of skill gaps?
- Who is involved in the process of measuring skill gaps?
- What is the difference (if any) between understanding the skill gaps of blue-collar versus white collar?

Questions: Bridging Skill gaps

- What initiatives or programs does your company use to support employees in acquiring new skills?
- Can you provide examples of successful cases where employees bridged their skill gaps with the support of the company?
- How does your organization determine the training and development needs of individual employees to address their specific skill gaps?
- What strategies has your company adopted to proactively tackle skill gaps and prevent them from widening?
- What are the challenges your organization has encountered in implementing strategies to address skill gaps?
- How does your company balance internal training with external hiring to address skill gaps?
- Can you share any insights into the long-term impact or success of strategies implemented to address skill gaps within your organization?
- In what ways does your company encourage a culture of continuous/lifelong learning among employees?
- How outspoken are managers about existing skill gaps?

Data availability

Data will be made available on request.

References

Abele, E., Metternich, J., Tisch, M., Chryssolouris, G., Sihn, W., Elmaraghy, H., Hummel, V., Ranz, F., 2015. Learning factories for research, education, and training. Proced. CIRP 32, 1–6.

Acemoglu, D., Restrepo, P., 2018. The race between man and machine: implications of technology for growth, factor shares, and employment. Am. Econ. Rev. 108, 1488–1542.

Beducci, E., Acerbi, F., Pinzone, M., Taisch, M., 2024. Unleashing the role of skills and job profiles in circular manufacturing. J. Clean. Prod. 449, 141456.

Boeren, E., 2023. Conceptualizing lifelong learning participation. Theoretical perspectives and integrated approaches. In: PUBLIKATION, W. (Ed.), Internationales Jahrbuch Der Erwachsenenbildung 2023. Researching Participation in Adult Education. Bielefeld.

Brandi, U., Hodge, S., Hoggan-Kloubert, T., Knight, E., Milana, M., 2023. The european year of skills 2023: skills for now and in the future? Int. J. Lifelong Educ. 42, 225–230.

Brasse, J., Förster, M., Hühn, P., Klier, J., Klier, M., Moestue, L., 2024. Preparing for the future of work: a novel data-driven approach for the identification of future skills. J. Bus. Econ. 94, 467–500.

Braun, G., Bokinge, M., Rosén, B.G., Syberfeldt, A., Stahre, J., 2024a. Mastering industry's skill gap - matching employee needs with new learning challenges. In: 2024 IEEE International Conference on Industrial Engineering and Engineering Management (IEEM), 15-18 Dec. 2024, pp. 668–672.

Braun, G., Rikala, P., Järvinen, M., Hämäläinen, R., Stahre, J., 2024b. Bridging skill gaps – a systematic literature review of strategies for industry. In: Swedish Production Symposium. Sustainable Production Through Advanced Manufacturing, Intelligent Automation and Work Integrated Learning Ed.

Braun, G., Stahre, J., Hämäläinen, R., 2022. Skills matching for a greener industry 4.0 – a literature review. In: Swedish Production Symposium.

Braun, V., Clarke, V., 2012. Thematic analysis. In: APA Handbook of Research Methods in Psychology, Edition: FirstChapter: Thematic Analysis.Publisher: American Psychological Association, vol. 2, pp. 57–71. Research designs: Quantitative, qualitative, neuropsychological, and biological.

Breque, M., DE Nul, L., Petridis, A., 2021. Industry 5.0 - towards a Sustainable, human-centric and Resilient European Industry. Policy brief European Commission.

Brynjolfsson, E., 1993. The productivity paradox of information technology. Commun. ACM 36, 66–77.

Brynjolfsson, E., Rock, D., Syverson, C., 2020. The Productivity J-Curve: How Intangibles Complement General Purpose Technologies. NBER Working Paper, 25148.

Creswell, J.W., Creswell, J.D., 2017. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. Sage publications.

Draghi, M., 2024. The Future of European Competitiveness. European Commission.

Enders, T., Hediger, V., Hieronimus, S., Kirchherr, J., Klier, J., Schubert, J., Winde, M., 2019. Future Skills: Six Approaches to Close the Skill Gap. World Government Summit.

European Commission, 2025. Union of skills communication. In: S A A I (Ed.), DIRECTORATE-GENERAL FOR EMPLOYMENT.

European Union. European year of skills [Online]. Available: https://year-of-skills.europa.eu/about_en.

Eurostat, 2019. Ageing Europe - statistics on working and moving into retirement [Online]. Available: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Ageing_Europe_-_statistics_on_working_and_moving_into_retirement&oldid=581874. (Accessed 23 January 2023).

Fareri, S., Apreda, R., Mulas, V., Alonso, R., 2023. The worker profiler: assessing the digital skill gaps for enhancing energy efficiency in manufacturing. Technol. Forecast. Soc. Change 196, 122844.

Felsberger, A., Qaiser, F.H., Choudhary, A., Reiner, G., 2022. The impact of industry 4.0 on the reconciliation of dynamic capabilities: evidence from the European manufacturing industries. Prod. Plann. Control 33, 277–300.

González Chávez, C.A., Unamuno, G., Despeisse, M., Johansson, B., Romero, D., Stahre, J., 2023. Analyzing the risks of digital servitization in the machine tool industry. Robot. Comput. Integrated Manuf. 82, 102520.

Huckstep, S., Dempster, H., 2024. Meeting skill needs for the global green transition: a role for labour migration? In: C P P (Ed.), 318. Washington, DC.

Kitto, K., 2024. Will a skills passport ever get me through the lifelong learning border?: two critical challenges facing personalised user models for lifelong learning. In:

Proceedings of the 32nd ACM Conference on User Modeling, Adaptation and Personalization. Association for Computing Machinery, Cagliari, Italy.

Lenton, T.M., Laybourn, L., Armstrong Mckay, D.I., Loriani, S., Abrams, J.F., Lade, S.J., Donges, J.F., Milkoreit, M., Smith, S.R., Bailey, E., Powell, T., Fesenfeld, L., Zimm, C., Boulton, C.A., Buxton, J.E., Dyke, J.G., Ghadiali, A., 2023. In: EXETER, U. O. (Ed.), Global Tipping Points Report: 'Summary Report'. Exeter, UK.

Li, L., 2024. Reskilling and upskilling the future-ready workforce for industry 4.0 and beyond. Inf. Syst. Front. 26, 1697–1712.

Manpowergroup, 2024. Global talent shortage. In: Manpower. Experis Manpowergroup & Talent Solutions Manpowergroup.

Mattsson, S., Salunke, O., Fast-Berglund, Å., Li, D., Skoogh, A., 2018. Design concept towards a human-centered learning factory. Procedia Manuf. 25, 526–534.

Mcgee, H.M., Crowley-Koch, B.J., 2021. Performance assessment of organizations. J. Organ. Behav. Manag. 41, 255–285.

Mcguinness, S., Ortiz, L., 2016. Skill gaps in the workplace: measurement, determinants and impacts. Ind. Relat. J. 47, 253–278.

Mcguinness, S., Pouliakas, K., Redmond, P., 2018. Skills mismatch: concepts, measurement and policy approaches. J. Econ. Surv. 32, 985–1015.

Mckinsey Global Institute, 2024. In: HAZAN, E., MADGAVKAR, A., CHUI, M., SMIT, S., MAOR, D., SINGH DANDONA, G., HUYGHUES-DESPOINTES, R. (Eds.), A New Future of Work: the Race to Deploy AI and Raise Skills in Europe and Beyond.

Naqshbandi, M.M., Meeran, S., Wilkinson, A., 2023. On the soft side of open innovation: the role of human resource practices, organizational learning culture and knowledge sharing. R&D Management 53, 279–297.

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

Palette Skills, 2025. *Unleashing Canada's potential* [Online]. Available: https://paletteskills.org/upskill-canada/about-upskill-canada. (Accessed 9 April 2025).

Pasmore, W., Winby, S., Mohrman, S.A., Vanasse, R., 2019. Reflections: sociotechnical systems design and organization change. J. Change Manag. 19, 67–85.

Pinzone, M., Braun, G., Stahre, J., 2024. Contemporary and future manufacturing – unveiling the skills palette for thriving in industry 5.0. In: THÜRER, M., RIEDEL, R., VON CIEMINSKI, G., ROMERO, D. (Eds.), Advances in Production Management Systems. Production Management Systems for Volatile, Uncertain, Complex, and Ambiguous Environments, 2024//. Springer Nature Switzerland, Cham, pp. 444–456.

Quintini, G., 2011. Right for the Job: Over-Qualified or Under-skilled? OECD Social. OECD Publishing, Paris. Employment and Migration Working Papers.

Rathelot, R., VAN Rens, T., Chan, S.-Y., 2023. Rethinking the Skills Gap. IZA World of Labor.

Rikala, P., Braun, G., Järvinen, M., Stahre, J., Hämäläinen, R., 2024. Understanding and measuring skill gaps in industry 4.0 — a review. Technol. Forecast. Soc. Change 201.

Robins, S., 2024. Charting new career pathways: partnering with community colleges in Maryland on skills-based hiring. Association of Community College Trustees.

Romero, D., Stahre, J., 2021. Towards the resilient operator 5.0: the future of work in smart resilient manufacturing systems. Proced. CIRP 104, 1089–1094.

Romero, D., Stahre, J., Taisch, M., 2020. The operator 4.0: towards socially sustainable factories of the future. Comput. Ind. Eng. 139, 106128.

Saunders, M., Lewis, P., Thornhill, A., 2023. Research Methods for Business Students.

Selesi-Aina, O., Obot, N.E., Olisa, A.O., Gbadebo, M.O., Olateju, O.O., Olaniyi, O.O., 2024. The future of work: a human-centric approach to AI, robotics, and cloud computing. J. Eng. Res. Rep. 26.

Shanthi, D., Sharma, J., 2019. Conceptual Model on Skill - Gap Theory of Motivation.

Siddiqi, M., 2024. Navigating the skill-first economy: the evolving role of lifelong learning and career services at community colleges. N. Dir. Community Colleges 2024, 159–168.

Statista, 2025. Global employment figures [Online]. Available: https://www.statista.com/statistics/1258612/global-employment-figures/. (Accessed 17 February 2025).

Tan, C., 2017. Lifelong learning through the SkillsFuture movement in Singapore: challenges and prospects. Int. J. Lifelong Educ. 36, 278–291.

Trevisan, A., Acerbi, F., Dukovska-Popovska, I., Terzi, S., Sassanelli, C., 2024. Skills for the twin transition in manufacturing: a systematic literature review. J. Clean. Prod. 474, 143603.

United Nations Department Of Economic And Social Affairs, 2008. International standard industrial classification of all economic activities (ISIC). Rev 4.

World Economic Forum, 2024. Putting Skills First: Opportunities for Building Efficient and Equitable Labour Markets.

World Economic Forum, 2025. Future of Jobs Report.

World Manufacturing Foundation, 2024. 2024 World Manufacturing Report – New Perspectives for the Future of Manufacturing: Outlook 2030.

Yin, R.K., 2018. Case Study Research and Applications. Sage, Thousand Oaks, CA.