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Change in Labour Force Skillset for the Fourth Industrial Revolution: A Literature Review

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Abstract. The Fourth Industrial Revolution entails the evolution of technology toward more automated means and implementation of the Internet of Things. This technological change will impact jobs, whereby some become obsolete while others are created. The workforce needs to acquire new skills to survive the Fourth Industrial Revolution. This literature review aims to identify new skills required by the workforce in the Fourth Industrial Revolution. This study involves a review of relevant literature, such as scholarly articles and organizational reports. The literature review was done to identify recommended skills based on the themes of "Fourth Industrial Revolution," "Skills," "Change," and "Labour force." The literature obtained was organized based on the type of skills suggested in the studies. The workforce requires high-level technical skills, higher-order cognitive skills, and human or interpersonal skills for the Fourth Industrial Revolution. Creative thinking, decision-making, critical thinking, negotiation, and persuasion will be required, as machines lack these abilities. While this literature review covers a broad range of skills needed for the Fourth Industrial Revolution, it may not apply to all organizations. An external variable, such as education standards, may influence skills that different firms might require. This paper will assist supervisors and training providers in understanding the skills needed for the workforce in the Fourth Industrial Revolution.

Keywords: Fourth Industrial Revolution; Industry 4.0; Skills; Workforce

1. Introduction

Organizations have been implementing Industry 4.0 into their systems and operations. With this implementation, most companies have become either semi-automated or fully automated. Industry 4.0 also involves the transformation to digital industrial manufacturing systems. It also connects various strategic partners through the Internet of Things (IoT) to meet more diverse needs (Naruetharadhol et al., 2022). Industry 4.0 technologies help increase the efficiency and effectiveness of the energy product life cycle and value chain (Berawi et al., 2020). This automation may pose issues for employees as there is a risk that the automation will completely take over existing jobs. As a result, there will be a rise in unemployment among the workforce should companies choose to release some employees. However, new jobs requiring advanced skills will be created (World Economic Forum, 2016). Instead of hiring new talent, organizations can choose to reskill and upskill their existing employees.

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1.1. The Fourth Industrial Revolution and Industry 4.0

The Fourth Industrial Revolution is a form of disruptive change in technology that covers multiple drivers of change (Frey & Osborne, 2013). This change ranges from shifting the nature of work, consumer ethics, the Internet of Things, robotics, cloud computing, and many more. It generally involves large-scale digitalization and technological advancement in various industries and sectors. Industry 4.0 plays a role in the Fourth Industrial Revolution by applying disruptive technologies mentioned in the previous section. For example, such applications would be implementing robotics or automation in a factory's assembly line. The significant difference between Industry 4.0 and the currently existing technology would be focused on automation rather than manual labor for specific tasks (Taylor, 2005).

1.2. Skills Shift with Industry 4.0

According to McKinsey Global Institute (2017), future job changes will affect the demand for skilled workers. Companies will struggle to determine what kind of skills and talents are required in the future (McKinsey Global Institute, 2017). Industry 4.0 will shift the job landscape and change how workers perform their jobs. Some jobs will become obsolete, while others will be created with different skill requirements. (Ministry of International Trade and Industry, 2018). Besides that, as automation reduces the need for intensive labor, firms can shift their focus from productivity concerns to product quality and innovation, necessitating employee upskilling or reskilling. By upskilling their employees, automation can fully benefit from highly trained and skilled employees (Sharif and Huang, 2019). Automation for most firms provides a competitive advantage in terms of continuous product quality improvement (Chumnumporn et al., 2022).

1.3. Skills Shift with Industry 4.0

According to the Future of Jobs Report (World Economic Forum, 2020), the skills necessary for Industry 4.0 include analytical thinking, complex problem-solving, critical thinking, technological, self-management, and social skills. According to a study conducted by Islam (2022) noted that business skills (critical thinking, cognitive flexibility, complex problem-solving, adaptive thinking abilities, qualitative skills, and communication skills, as well as technical skills (programming, quantitative skills, data interpretation, data visualization, and virtual collaboration), are important for employability in Industry 4.0. Karacay (2017) states that to perform tasks in an Industry 4.0-based system, all employees must have information and communications technology (ICT) skills and soft skills such as collaboration, communication, and autonomy. The skills predicted for Industry 4.0 can be categorized as high-level technical, higher-order cognitive, and human and interpersonal skills.

2. Methods

This literature review followed the five-step systematic review method proposed by Khan, et al. (2003). The steps are as follows:

Step 1: Framing questions for a review (discussed in Section 2.1)
Step 2: Identifying relevant work (discussed in Section 2.2)
Step 3: Assessing the quality of studies (discussed in Section 2.3)
Step 4: Summarizing the evidence (discussed in Section 2.4)
Step 5: Interpreting the findings (discussed in Section 3 and Section 4)

2.1. Framing questions for a review

This literature review is being conducted to identify the new skills required by the workforce in the Fourth Industrial Revolution. Therefore, this literature review aims to answer the open-ended question, "What are the skills required by the workforce for the Fourth Industrial Revolution?"

2.2. Identifying relevant work

These articles were chosen from three databases: Emerald, Science Direct, and Sage Publications. To increase relevance with the theme of the Fourth Industrial Revolution, the literature was also limited to publications from 2012 to 2022. The articles were selected based on the keywords "Fourth Industrial Revolution," as well as the abbreviations of "4IR", "4th IR", and "IR 4.0", followed by "Skills and Skillset," "Change" or "Shift," and "Labor force" or "Workforce."

2.3. Assessing the quality of studies

Articles were read and selected based on the review question from the search results based on keywords. The mentioned articles must have their main theme based on The Fourth Industrial Revolution or Industry 4.0. In addition, articles must discuss the necessary skills or mention what skills are required by the future or current workforce regarding The Fourth Industrial Revolution. Based on this criterion and the number of search results, 20 articles were chosen from the Emerald and Science Direct database, whereas ten were selected from Sage Publications.

2.4. Summarizing the evidence

Based on the skills mentioned in Section 1.4, this literature review will categorize the articles based on three skill groups: High-level technical skills, higher-order cognitive, and human and interpersonal skills.

High-level technical skills include but are not limited to Data Analysis, ICT skills, and programming. This also includes mentions of the requirement of knowledge regarding The Fourth Industrial Revolution and Industry 4.0 technologies. Higher-order cognitive skills include but are not limited to complex problem-solving, critical thinking, and decision-making skills. Human and interpersonal skills include but are not limited to social and communication, negotiation, creativity, and emotional skills. Table 2 illustrates how the skillsets mentioned in the articles were identified and categorized.

Table 1 Summary of Search Results

Keyword(s)	Fourth Industrial Revolution, 4IR, 4th IR, IR 4.0	Skills Skillset	Change Shift	Labour force Workforce	Selected Papers
Online Database					
Emerald	8,739	4,717	2,909	973	20
Science Direct	23,826	7,544	4,882	1,177	20
Sage Publications	20,317	8,750	5,785	1,494	10

The keywords used for selecting relevant articles from the databases chosen in the literature review are shown in Table 1.

Table 2 The organization of literature according to the type of skills discussed

No.	(Author, Year)	Skills		
		High-level Technical	Higher-Order Cognitive	Human and Interpersonal
1	(Organisation for Economic Co-operation and Development, 2016)	x		
2	(Chang et al., 2016)	x		
3	(Kipper et al., 2021)	x		
4	(Grenčíková et al., 2021)	x		
5	(Autor, 2016)		x	x
6	(MacCrory et al., 2014)		x	
7	(Guzmán et al., 2020)			x
8	(Wahab et al., 2021)	x	x	x
9	(Hughes et al., 2019)	x		
10	(Ghobakhloo, 2018)	x		
11	(Schiele et al., 2021)	x		
12	(Teng et al., 2019)		x	x
13	(Faridi & Malik, 2020)		x	
14	(Low et al., 2021)		x	x
15	(Butt et al., 2020)	x	x	x
16	(Alam et al., 2021)	x		
17	(Kazancoglu & Ozkan-Ozen, 2018)	x	x	x
18	(Whysall et al., 2019)	x	x	
19	(Aly, 2022)	x	x	x
20	(Lee & Meng, 2021)	x	x	
21	(Teo et al., 2021)			x
22	(Mourtzis et al., 2019)	x		x
23	(Li et al., 2021)	x	x	
24	(Jo & D'agostini, 2020)	x		
25	(Marin & Vona, 2019)	x	x	x
26	(Salvatore & Stefano, 2021)	x	x	x
27	(Holloway et al., 2019)		x	
28	(Panagou et al., 2021)			x
29	(Ciarli et al., 2021)	x	x	
30	(Nikitas et al., 2021)	x	x	x
31	(Shet & Pereira, 2021)	x	x	x
32	(Reiman et al., 2021)	x	x	x
33	(Cacciolatti et al., 2017)	x	x	x
34	(Hulla et al., 2019)	x	x	x
35	(Chinoracký & Čorejová, 2019)	x	x	x
36	(Cimini et al., 2020)	x	x	
37	(Sallati et al., 2019)	x	x	x
38	(Cimini et al., 2021)	x	x	x
39	(Neumann et al., 2021)	x	x	
40	(Kumar et al., 2021)	x		
41	(Bennett & McWhorter, 2021)	x		
42	(Schäfer, 2018)	x		

43	(Weaver & Osterman, 2017)	x	x	x
44	(Fixsen & Ridge, 2019)			x
45	(Mehta & Awasthi, 2019)	x	x	
46	(Hora & Blackburn-Cohen, 2018)	x	x	x
47	(Fleming, 2019)		x	x
48	(Islam, 2022)	x	x	
49	(Ayinde & Kirkwood, 2020)	x	x	x
50	(Carter, 2017)		x	x

3. Results and Discussion

3.1. Skills for Industry 4.0

Based on the findings, the most frequently mentioned skills in these 50 articles were high-level technical skills (76%), followed by higher-order cognitive skills (66%), and finally, human and interpersonal skills (54%). Each one of the three skill sets is mentioned in at least half of the articles chosen. Therefore, it is reasonable to conclude that all three skill sets are deemed critical for the Fourth Industrial Revolution.

3.1.1. High-level Technical Skills

The first skill necessary for Industry 4.0 of various sizes is high-level technical skills (Grenčíková et al., 2021). This requires a more in-depth understanding of information and communications technology (ICT) and an understanding of Industry 4.0 technologies such as Big Data, data analysis, network management, and programming (Organization for Economic Co-operation and Development (OECD, 2016).

Specific sectors, such as automotive and Electrical and Electronics (E&E), are predicted to demand higher-skilled technicians and engineers capable of managing new automation processes as workers increasingly work alongside collaborative robots. Other skills required for the technology shift in these industries are considerable data analytic skills and knowledge of 3D printing (Chang et al., 2016). In addition, Kipper et al. (2021) considered high-level technical skills required for the Fourth Industrial Revolution. Employees with specialized skills can analyze data, develop software, and solve technological problems.

3.1.2. Higher-Order Cognitive Skills

Another one of the skills discussed is higher-order cognitive skills. These cognitive skills involve complex problem-solving, critical thinking, and decision-making skills. One of the main drives is that machines cannot logically think or perform problem-solving (Autor, 2016). Although devices can be programmed to perform tasks based on the received input, they cannot spontaneously make decisions that diverge from the information provided, unlike humans.

MacCrory et al. (2014) discovered that workplace skills were cognitive and manual. "Complex problem solving, critical thinking, deductive reasoning, oral comprehension, speed of closure, and written expression" are cognitive skills. This shows that cognitive skills have become more prioritized with technological change because as machines take over manual tasks, employees will be needed to solve other arising problems, thus requiring a cognitive skill set.

3.1.3. Human and Interpersonal Skills

The final skill identified in this literature review is human or interpersonal skills. According to Autor (2016), automation allows employees to use more innate human skills, such as "social and emotional capabilities, providing expertise, coaching and developing

others, and creativity." These skills will become necessary because of the incapability of machines to replicate them perfectly.

Some human and interpersonal skills that are required would be communication and interpersonal skills. According to Guzman et al. (2020), leadership skills are relevant for Industry 4.0. Employees who are promoted to management positions will need more experience and interpersonal skills. Communication skills deemed critical are speaking and active listening, while the necessary interpersonal skills would be negotiation and persuasion skills. Moreover, machines could not effectively imitate these skills, making such skills highly desirable among employees as technology evolves over time (Wahab et al., 2021).

3.2. Discussion

Based on the literature review, high-level technical skills such as data analysis are required for Industry 4.0 (OECD, 2016). Employees need to learn high-level technical skills to fully comprehend how to operate the newly implemented Industry 4.0 technologies. Higher-order cognitive skills such as complex problem-solving and critical thinking are essential for Industry 4.0. As companies implement Industry 4.0 technologies, the nature of jobs will evolve from manual-labor-based tasks to problem-solving and decision-making responsibilities. Finally, human and interpersonal skills will play an essential part in the future of Industry 4.0. There will still be tasks and jobs that require close human interaction, such as negotiation with stakeholders or leadership-based tasks. Even though AI can imitate human communications, such as helpdesk AI and chatbots, they cannot always recreate the same human connection as face-to-face communication due to a lack of intonation and facial expressions.

4. Conclusions

Based on the literature review results, the three important skills for Industry 4.0 are high-level technical skills, higher-order cognitive skills, and human or interpersonal skills. It is important to note that despite these skills being the newly sought-after skills, it does not mean any pre-existing skills held by low and middle-skilled workers are irrelevant. This is because pre-existing skills will be the foundation to develop high-level and higher-order skills.

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