Industry 4.0 Technology on Workforce Employability and Skills

Subjects: Industrial Relations & Labor
Contributor: Md. Tota Miah, Szilvia Erdei-Gally, Anita Dancs, Mária Fekete-Farkas

The Fourth Industrial Revolution (Industry 4.0 or I4.0) has gained increasing attention both in the academic and non-academic domains. Industry 4.0 was a term coined in 2011 in Germany. Since then, the academic literature describing and analyzing I4.0 technologies has grown considerably. While so-called Industry 3.0 introduced computers, Industry 4.0 is characterized by advancements in computing technology including expanded digitalization in logistics, cognitive and connected machines in various industrial processes, and data analytics.

Keywords: Industry 4.0; South Asia; workforce employability; artificial intelligence; data analytics; digital skills; labor market

1. Introduction

The Fourth Industrial Revolution (Industry 4.0 or I4.0) has gained increasing attention both in the academic and non-academic domains. Industry 4.0 was a term coined in 2011 in Germany. Since then, the academic literature describing and analyzing I4.0 technologies has grown considerably (Cannavacciolo et al. 2023; Rad et al. 2022; Pereira et al. 2018). While so-called Industry 3.0 introduced computers, Industry 4.0 is characterized by advancements in computing technology including expanded digitalization in logistics, cognitive and connected machines in various industrial processes, and data analytics (Rahman et al. 2022). Leong et al. (2020) refer to I4.0 as having nine technological pillars: the Internet of Things, cloud computing, robots and autonomous systems, big data analytics, augmented reality, cybersecurity, simulation, system integration, and additive manufacturing. This new technological frontier is transforming the way businesses create value, how individuals perform their work, and the manner in which people connect and communicate with each other. I4.0 has significantly transformed job roles and the skill profiles required of workers (Ghislieri et al. 2018). These technologies are the cornerstones of changing industrial processes to substantially enhance productivity.

However, the rapid shift in robotization and digitalization are also a growing concern. Particularly in South Asian countries (e.g., Bangladesh, India, Pakistan, Nepal, Bhutan, Sri Lanka, Maldives, and Afghanistan), unemployment resulting from replacing jobs with robots is feared. Yet, employers and employees can adopt to technological changes in a timely way for the better of the future labor market (Bajaj et al. 2018). Researchers from engineering to management have increasingly concentrated their academic research on enabling Industry 4.0 technologies (Weerasekara et al. 2022; Perez Perales et al. 2018). Several studies particularly focused on the success factors and benefits of Industry 4.0 technologies while bypassing their downsides (Kadir et al. 2019; Bolbot et al. 2022; Echchakoui and Barka 2020). Studies are lacking that examine the effects of Industry 4.0 technologies on employment and skills.

2. Concept of Industry 4.0

Since the industrial trade fair Hannover Messe, Germany in 2011, the term “Industrie 4.0” has ignited a vision of a new industrial revolution and has been inspiring a lively, ongoing debate about the future of work (Dregger et al. 2016). The Fourth Industrial Revolution refers to the transformation of technology in the 21st century. It is creating a radical shift for employees, organizations, and society as a whole, given the impact of included and emerging technologies such as artificial intelligence and Internet of Things (Ross and Maynard 2021; Kowalikova et al. 2020). Savytska and Salabai (2021) consider I4.0 a trend within the Fourth Industrial Revolution. They found that businesses could benefit from new opportunities, expand operations, and increase efficiencies by integrating digital processes. Industry 4.0 covers a wide range of topics, such as production methods, productivity, data management, consumer relationships, and competitiveness. (Piccarozzi et al. 2018). According to Culot et al. (2020), I4.0 has evolved significantly, leading to similar concepts often referred to as “smart manufacturing”, “digital transformation”, and “fourth industrial revolution”. However,
Erboz (2017) identified that the development of highly automated industries through human–machine interaction is one of the main aspects of Industry 4.0. Freund and Al-Majeed (2021) highlighted the effect of Industry 4.0 on both the micro and macro levels, including the financial, political, and socio-cultural spheres.

3. Historical Overview of the Industrial Revolution

Technological trends have a historical perspective. Figure 1 utilizes two sources to illustrate the history of industrial revolutions. The first industrial revolution, which started at the end of the 18th century, shifted production from labor-intensive to more capital-intensive production. The biggest changes came in the form of mechanization. The invention of steam-powered machines combined with the division of labor changed production technology from piece-to-piece production to mass production. The second industrial revolution started at the end of the 19th century, and by the middle of the 19th century, there were technological advancements helped the emergence of new sources of energy. This era saw the spread of electrification across the world, and radical transformation in transportation including the development of the automobile and the airplane. The third wave of industrialization started in the early 1970s with the development of the computer. This third industrial revolution led directly into the fourth because of how those computing technologies advanced. By the beginning of the 21st century, huge developments in communication and information technologies and software-based production technologies enabled the development of smart systems. Davies (2015) reported that the Europe Union was at the beginning of a new industrial revolution—Industry 4.0—in 2015. Member states began sponsoring national initiatives, such as “Industrie 4.0” in Germany, “the Factory of the Future” in France and Italy, and the Catapult centers in the United Kingdom. In the few short years since then, Industry 4.0 has spread everywhere and changed the production paradigm through a shift from work previously done by humans to work that is now automated (Klingenberg et al. 2022). Today, managers cannot ignore the technological revolution in the field of robotics, artificial intelligence, the Internet of Things, cyber-physical systems, augmented reality, virtual reality, biotechnology, nanotechnology, autonomous vehicles, cloud computing, and 3D printing (Sharma et al. 2021).

Figure 1. Timeline of the Industrial Revolutions based on: (Kagermann et al. 2013; Vaidya et al. 2018).

4. South Asia and Industry 4.0

South Asia is comprised of India, Pakistan, Bangladesh, Sri Lanka, Nepal, Bhutan, the Maldives, and Afghanistan. With its large population, emerging markets, government support, innovative culture, global supply chain presence, and digital infrastructure development, it is indeed an important region for the adoption of I4.0 technologies (Katekar and Deshmukh 2021; Rajamanickam 2016). According to the International Monetary Fund (2023), South Asian countries had a GDP of $4.65 trillion U.S. dollars, around 5% of the world economy, in 2023. Among these, India contributes the highest GDP of $3.73 trillion with Bangladesh at $446.35 billion U.S. dollars. Nepal, Bhutan, and Sri Lanka were among the countries with the lowest GDP in the Asia-Pacific region. In South Asia, the main economic activities include the services, industrial, and manufacturing sectors. Despite having tremendous economic potential, previous studies by Imrana et al. (2021) and Bishwakarma and Hu (2022) found gaps in human capital and innovation including the skills and training of the region’s current workforces.

As these countries continue to modernize their industries, I4.0 is poised to play a pivotal role in shaping their economic future and addressing critical social challenges. Studies, such as those by Su et al. (2017) and Schöning (2018), show productive outcomes in accelerating production, enhancing processes, and creating new opportunities by integrating I4.0 technologies. But there are significant challenges that need to be overcome. For example, in Bangladesh, the lack of awareness, insufficient capital, infrastructure limitations, shortage of skilled workers, and weak government policies are hindrances to the implementation of I4.0 (Bhuiyan et al. 2020; Suha and Sanam 2022). They emphasize the need for an information and communications (ICT) policy that focuses on integrating ICTs with smart industrialization. Hossain et al. (2023) found technical knowledge in the manufacturing industry is a key barrier to adopt the I4.0 in Bangladesh. In Pakistan, studies by Ali and Xie (2021) and Imran et al. (2018) found managerial challenges in adopting I4.0 technologies,
including the need for competitive management, infrastructure, and economic stability in the textile industry and service sector. In India, the manufacturing and service sectors need more productivity and efficiency to manage these digital transformations (Jha 2021; Smolka and Papulova 2023). Researchers Kanji and Agrawal (2020) and Mezina et al. (2022) found I4.0 may increase social inequality while creating a heightened need for highly qualified personnel. The authors argue that appropriate policies and partnerships need to be implemented to ensure inclusive development in developing countries, especially in India, Bangladesh, and Pakistan.

I4.0 has significant implications on the future of work and skills required. The changes in the value chain and increased competitiveness among firms and consumers can impact global labor markets (Anuşlu and Frat 2019; Mohiuddin et al. 2022). According to Asian Development Bank (2021), 4IR technologies like the IOT, artificial intelligence, cloud computing, and cognitive computing could profoundly influence jobs and skills.

Labor markets in developing and developed countries are likely to undergo major transformations in the coming years and decades. By 2030, the region is expected to create more jobs than it displaces (Balliester and Elsheikhi 2018). Yet, the Global Innovation Index (GII) of 2023 shows that South Asian countries are not yet ready for I4.0 technology adoption. The index provides a comprehensive assessment of the innovation ecosystem across 132 economies in the world. The analysis shows (Figure 2) that India leads among lower middle-income countries in the world and ranks overall 40th in the world. Among other South Asian countries, Bangladesh, Nepal, Pakistan, and Sri Lanka exhibit poor ranking in creative outputs, impeding their ability to generate new ideas and innovations, and infrastructure readiness, which are critical factors for I4.0 success. These countries, along with India, face challenges in other key areas such as market sophistication, knowledge and technology outputs, and institutions. Moreover, many displaced workers may struggle to transition smoothly to new roles. South Asian countries need to prepare their workforce for the impending labor market changes with substantial and timely investments in skills development, especially within the key sectors of the automotive industry, textiles, and tourism.

Figure 2. Global innovation index on seven pillars. Source: Brás (2023).

References


