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Research Article

Fourth Industrial Revolution and Future of Work in Asia

Falendra Kumar Sudan

Department of Economics, University of Jammu, India
E-mail: fk_sud@rediffmail.com

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Abstract: The Fourth Industrial Revolution (4IR) has significant implications on the future of work and skills required in the gig economy. In the recent past, a large supply of young workers had led to rapid economic transformation in many Asian countries through well-suited education systems to create skills needed for employment. However, the old model of education and production will no longer sustain rapid growth in the decades ahead due to the rapidly changing demand for skills. Against the above backdrop, the paper has analyzed Asian experiences in technological transition, skills mismatches and labour market outcomes in the context of existing technical and vocational education and training (TVET) systems. What are the challenges and opportunities of the 4IR for skill development through TVET in Asia? The paper has suggested a model for 4IR compatible skill development for the future of the work and draws the implications for the future. 4IR induced massive job losses calls for adequate skills development or retraining of displaced workforce and new entrants in foundational skills to enable them to tap the opportunities of new technologies. This requires robust TVET systems to equip workers with new skills for emerging jobs, which can be possible by increasing the quality of program structure to meet the needs of labour market. The technical training should be integrated into with the secondary education through education reforms to impart skills to thrive in the knowledge economy. The system of quality apprenticeships should be evolved with the active collaboration of potential employers in the curriculum development of TVET programs.

***Keywords*:** Fourth Industrial Revolution, future of work, technical and vocational education and training, skill development, Asia

JEL Codes: J24, L16, M53, N35, O33

1. Introduction

The Fourth Industrial Revolution (4IR) refers to blended technologies which link the physical, digital, and biological realms with greater velocity, scope, and systems impact. The 4IR has considerable repercussions on the future of work with significant variations across country and culture, which require different approaches to address the problems of automation and digitalization. The 4IR has posed substantial challenges to both developed and developing nations. The developed countries have prepared well to face the challenges of new technologies fast to derive the benefits of its effects, while most developing countries are unaware of its consequences on their economies and societies. The 4IR has significant implications for the rapid application of robots, big data analytics, and artificial

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intelligence for business decisions. Innovations have facilitated the firms in the gig economy by tapping the immense opportunities linked to enhanced human capital and knowledge. At the same time, the use of emerging technologies could displace millions of workers in low- and middle-skill jobs. Therefore, firms should reshape their organizational structures, cultures, and processes faster to align with new technologies, failing which the skills gap between current and future talent can be widened.

Vocational skills equip an individual to understand a subject and procedure applicable to a specific career for a productive economic activity to derive sustainable livelihoods. The technical and vocational education and training (TVET) refers to the acquisition of practical skills, attitudes, understanding, and knowledge related to work and occupations. The 4IR necessitates the application of highly sophisticated robots and automotive technologies (Asian Development Bank (ADB), 2018) and has immense potentials to change our lives and work culture (Tadeu & Brigas, 2018) through innovative production techniques, work organization, and employment arrangements and greater application of new technologies such as robotics, big data, internet of thing, and artificial intelligence. The 4IR has substantial implications for the future of work, which requires the acquisition of new skills in science, technology, engineering, and mathematics (STEM) for employability and entrepreneurship. Current education and training systems are unable to adequately meet the new cognitive skills required for the 4IR due to rapid technological transformation, which calls for fast acquisition of new skills, reskilling, and upskilling. Against the above backdrop, the paper intends to analyze the challenges and opportunities of the 4IR and the future of work through TVET in Asia.

The paper has analyzed Asia's experiences in technological transformation, skills mismatches and labour market outcomes in the context of existing TVET systems. The paper has also analyzed the challenges and opportunities of the 4IR for skill development through TVET in Asia, exploring the skills needed for 4IR and suggested a model for 4IR compatible skill development, listed the major challenges of 4IR for TVET system and offered solutions for the future of the work in the context of the 4IR and skills gaps in the labour markets and draws the conclusion.

2. Review of literature

Significant time lag exists between education and technological progress (Schleicher, 2015) due to which the labour markets experience considerable skills shortages (Banerjee & Duflo, 2008; Weaver & Osterman, 2017) and lead to increase the workload of existing employees and outsourcing to reduce reliance on highly-skilled workers. Skills surpluses also pose significant challenges to policymakers (Sutherland, 2012). The skills mismatches occur not upon entering the workforce and but also in each job change (Organisation for Economic Co-operation and Development (OECD), 2012) due to which displaced workers experience wage losses (Poletaev & Robinson, 2008; Kambourov & Manovskii, 2009; Gathmann & Schonberg, 2010).

New and disruptive technologies pose substantial employment adjustment costs (Granovetter, 2017). In the recent past, Information and Communication Technologies (ICTs) have facilitated a gradual transition from manufacturing to services jobs (Barany & Siegel, 2017) compared to the transition from agricultural to manufacturing employment (Atkinson & Wu, 2017), which confirms slower job creation in new technology industries. In recent years, demand for skills has changed rapidly, while the demand for routine cognitive and manual skills declined and non-routine cognitive and manual skills increased (Autor et al., 2003), which reflect variations in labour market outcomes (Heckman & Kautz, 2012). Relatively social-skill intensive jobs grow rapidly compared to low social-skill jobs (Deming, 2017).

Over the past two decades, cognitive, intra-personal and inter-personal skills have been widely embedded into education systems. The policy debates also focused on knowledge versus skills (Christodoulou, 2014). Automation of many low-skilled and medium-skilled occupations has displaced many jobs (Autor et al., 2008). However, full automation of work activities is likely to be low (Frey & Osborne, 2017). Recent policy debates also focused on the impact of the 4IR on the future of work, employment and skills landscape (World Economic Forum (WEF), 2016a). However, little research has been conducted on how the 4IR is changing the demand for jobs, what are the implications of the 4IR on the future of work in developing Asian countries, will automation and robots displace jobs across industries, and what are its likely effects. Therefore, the present study is an attempt to fill this knowledge gap by analyzing the challenges and opportunities of the 4IR, Asia's experiences in technological transformation, skills mismatches and labour market outcomes in the context of existing TVET systems. The paper has also explored the skills needed for 4IR and suggested a model for 4IR compatible skill development, listed the major challenges of 4IR to TVET system and offered solutions for the future of the work in the context of the 4IR and skills gaps in the labour markets and draws the implications for the future.

2.1 *Technological transition and skill supply: Asian experiences*

All new technology does not displace human labour. Technological development in medical care, biotechnology, education, and social security do not destroy jobs, but increase the quality of these services. The past technological developments have enhanced labour productivity and created jobs and thus boosted economic growth. On the other hand, the current technological transition and automation have immense jobs displacement potential, and thus affects future employability, income, and living standards (ADB, 2018), which will also depend on labour market institutions.

The 4IR has significant implications on the future of work and skills required in the gig economy. The blockchain technology is set to transform businesses worldwide, which refers to a digital, distributed ledger that keeps a record of all transactions across participating peer-to-peer networks. Therefore, increasingly complex tasks are automated in the 4IR (Autor, 2015; Acemoglu & Restrepo, 2018; ADB, 2018). New technologies can displace jobs and also create new jobs and new skills (Autor, 2015).

Big data and AI help automation of highly complex jobs. At the same time, it is estimated that more than two-thirds of jobs in developing Asian economies are at risk of automation. In recent years, the stock of industrial robots has increased substantially in Asia (ADB, 2018). The use of industrial robots has negative effects on labour market outcomes (Acemoglu & Restrepo, 2020; United Nations Conference on Trade and Development (UNCTAD), 2017), while significantly reduced employment of low-skilled workers compared to modest effect on middle-skilled workers and no significant effect on high-skilled workers (Graetz & Michaels, 2018). Automation-induced job displacement is more in developing countries. New technology poses both risks and opportunities (Chang et al., 2016). New technologies generate employment market optimism by creating new occupations and industries (ADB, 2018). The net effect of new technologies is positive at an aggregate level (Bessen, 2017) with an increase in productivity growth and higher wages in new jobs (Khatiwada & Veloso, 2019).

In the recent past, a large supply of young workers had led to rapid economic transformation in many Asian countries through well-suited education systems to create skills needed for employment. However, the old model of education and production will no longer sustain rapid growth in the decades ahead due to the rapidly changing demand for skills. The quantitative performance of secondary education, post-secondary TVET and higher education remained much lower in developing countries of Asia (United Nations Educational, Scientific and Cultural Organization (UNESCO) & United Nations Children's Fund (UNICEF), 2013). In East, Southeast, and South Asia, attainment of upper secondary education, including TVET programs have been restricted to less than half of youth in about half of the countries (WEF, 2014a; WEF, 2014b). The gross enrollment rates in tertiary-level education were comparatively better in North and Central Asia (56%) compared to 14% in South and Southwest Asia (United Nations (UN), 2012). The quality and relevance of education in many countries in Asia remained inadequate. A relatively small proportion of upper secondary level students has entered TVET systems, which have significant implications for skills mismatches and competitiveness. In India, 13 million people enter the labour market per annum, of which only 25% are enrolled in TVET due to low public spending in technical education. On-the-job training is also very limited in many Asian countries, despite skill shortages in most firms. The quality of TVET infrastructure and instructors is also inadequate, which calls for revamping curriculum and pedagogy in TVET institutions to bridge massive skills mismatch in Asian countries.

2.2 *Challenges and opportunities of the 4IR*

The 4IR have deep impacts on the labour market and pose substantial challenges and opportunities for the future of work (Frey & Osborne, 2017; OECD, 2018a; Schwab, 2016). Automation affects all sectors and geographical regions. Globally, 64 million youth are unemployed and 20% of them are not in education, training, or employment (International Labour Organization (ILO), 2019). Adoption of ICT affects the older workers more than younger workers (Meyers et al., 2010) due to expected low returns (OECD, 2006).

New technologies depreciate the skills and consequently reduce productivity (Lovasz & Rigó, 2013). New technologies lead to a loss of many jobs (Chui et al., 2016) and the emergence of new jobs (ADB, 2018). Young workers participate more in trans-disciplinary skills (Brewer & Comyn, 2015) and soft skills training (ILO, 2015) to cope with the impact of technology (ILO, 2017). About 39% of employers reported skills shortages and unfilled vacancies, which calls for new learning and skill development (Schröder & Dehnbostel, 2019) through reorienting TVET systems for future labour market demands.

Technological disruptions raise issues around the types of skills and learning required for the future of work, which call for reskilling and upskilling of the workforce (WEF, 2016b) due to shortages and mismatches in required digital skills (UN, 2018; Hernandez & Roberts, 2018) by reorienting the education and training systems to bridge the skills gaps. Work-based learning and TVET are interlinked. TVET systems and the quality of work-based learning need to be revamped to provide new skills for new entrants and older workers that need to reskill (OECD, 2018b; UNESCO, 2016). Good TVET uses the "learning by doing" approach (Doel, 2018).

Developing Asian countries are facing a demographic opportunity in the form of youth bulge, which needs to be effectively tapped by creating jobs and skills for the future of work (Bandura & Hammond, 2018), for which TVET should be a viable option and need to be strengthened through stronger collaboration between public and private sector. Excellent TVET collaborates with potential industrial employers through apprenticeships. The contemporary Asian economies need to revisit skills in networking and interpersonal skills. Vocational learning needs to be more interactive and collaborative in the digital economy, which calls for redesigning of TVET courses to promote social skills and high-level technical skills to meet the ever-changing labour market demand (OECD, 2018b).

The vulnerable populations have limited opportunities to gain from reskilling and digital dividends in rapidly transforming digital economy (Chetty et al., 2017), which calls for targeted actions to build a future workforce through bridging the divide between skills, training and employability (International Monetary Fund (IMF), 2017). Digital skills development strategy should identify the digital skills development goals at all levels of education including TVET for vulnerable populations by appropriate capacity building to support life-long learning and meet the rapidly changing needs of industries. Digital learning platforms should be widely used for the transfer of digital skills to vulnerable populations using inclusive learning approaches (Hernandez & Roberts, 2018). Public-private collaboration should be actively promoted to support the needs of digital skills of vulnerable populations.

3. Methodology

The study is qualitative in nature and used a desk research approach to analyze the available literature to analyze the phenomenon under investigation and to draw future implications. Qualitative research refers to a description of the phenomenon under investigation using an interpretive approach, while desk research refers to a collection of secondary data and information from published resources from libraries and the internet. Application of qualitative methodology using the desk review of the available resources on the internet has been accomplished for literature review, analyzing the Asian experiences on technological transition and skill supply, investigating the challenges and opportunities of the 4IR, understanding of the demand and supply of skills in different phases of industrial development, developing a framework of the 4IR compatible skills and a model for the 4IR compatible skill development, besides analyzing the challenges of the 4IR to TVET, workforce and society, and finally developing the 4IR compatible learning model and drawing the conclusion.

3.1 *Phases of the industrial revolution and skills supply and demand*

Figure 1 shows that the First Industrial Revolution focused on water use and steam power to mechanize production, and the Second Industrial Revolution concentrated on the use of electric power for mass production, while the Third Industrial Revolution centered on the use of electronics and information technology to automate production, whereas the 4IR stimulated extreme automation, greater connectivity, and wider application of artificial intelligence, which will profoundly affect economic activities. The 4IR has immense potential to displace some jobs and create many new jobs and the overall net effect will be positive. Asia region has a large share of global young workforce. The global future of work is very closely linked to Asian labour market outcomes, which faced substantial challenges and opportunities posed by the 4IR.

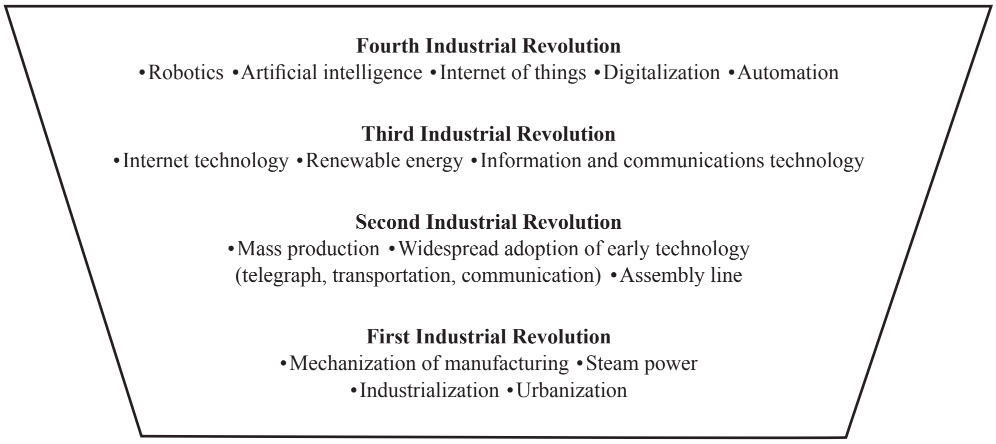

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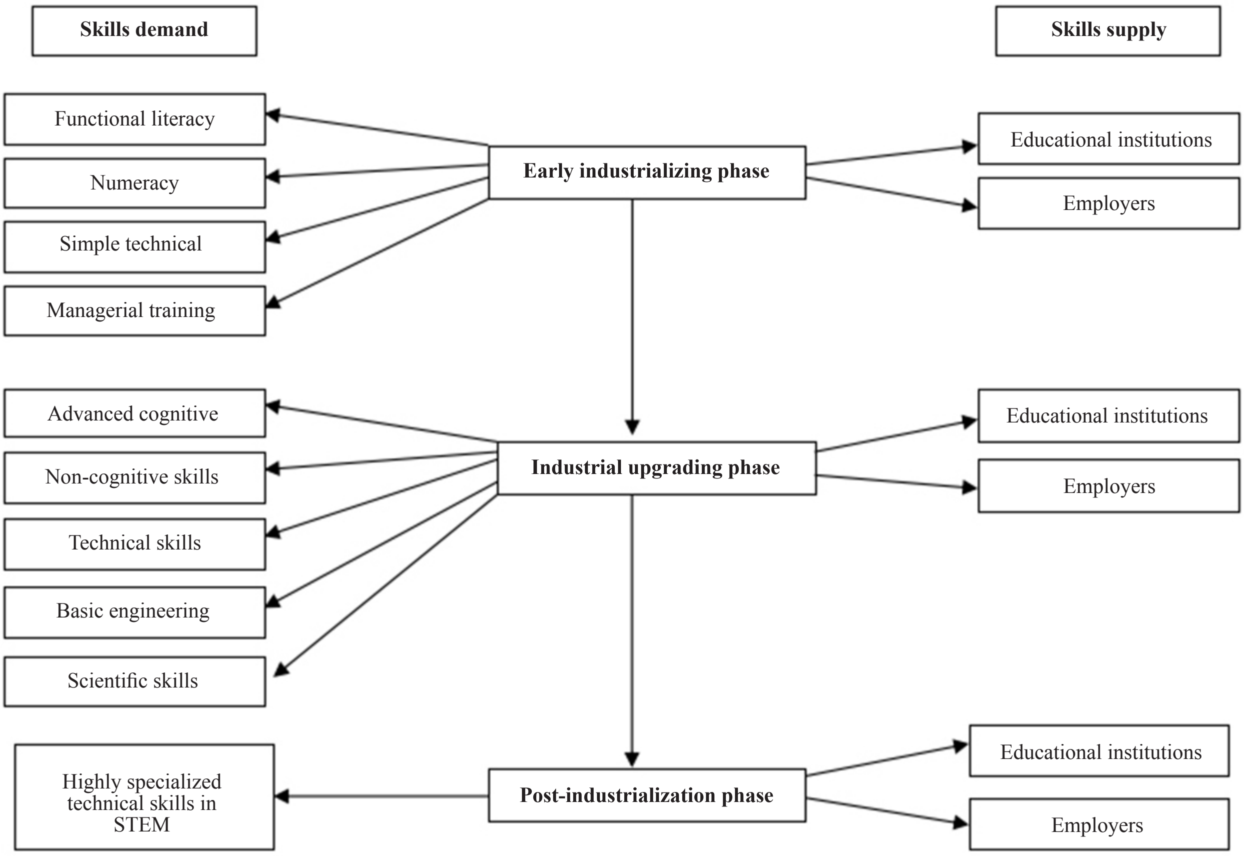
Figure 1. Phases of the industrial revolution



Source: Author's creation and compiled from UNIDO (2013) and UNESCO (2012)

Figure 2. Demand and supply of skills in different phases of industrial development

Figure 2 shows the skills supply and demand in different phases of industrial development. In the early industrializing phase, overall skills demand includes skills in functional literacy, numeracy, simple technical and managerial training to be supplied by formal primary education and informal learning. In the industrial upgrading phase, skills demand to include more advanced cognitive and non-cognitive skills, technical skills, basic engineering and scientific skills, and entrepreneurial skills to be supplied by secondary education and TVET and firm-based training. In the post-industrialization phase, demands for highly specialized skills, including advanced technical skills in STEM are to be higher education and advanced TVET including firm-based training. Skills development is essential for industrial transformation. However, there is a need to evolve strategies to produce matching hard and soft skills needed by current industries and progressive industrial upgrading (United Nations Industrial Development Organization (UNIDO), 2013).

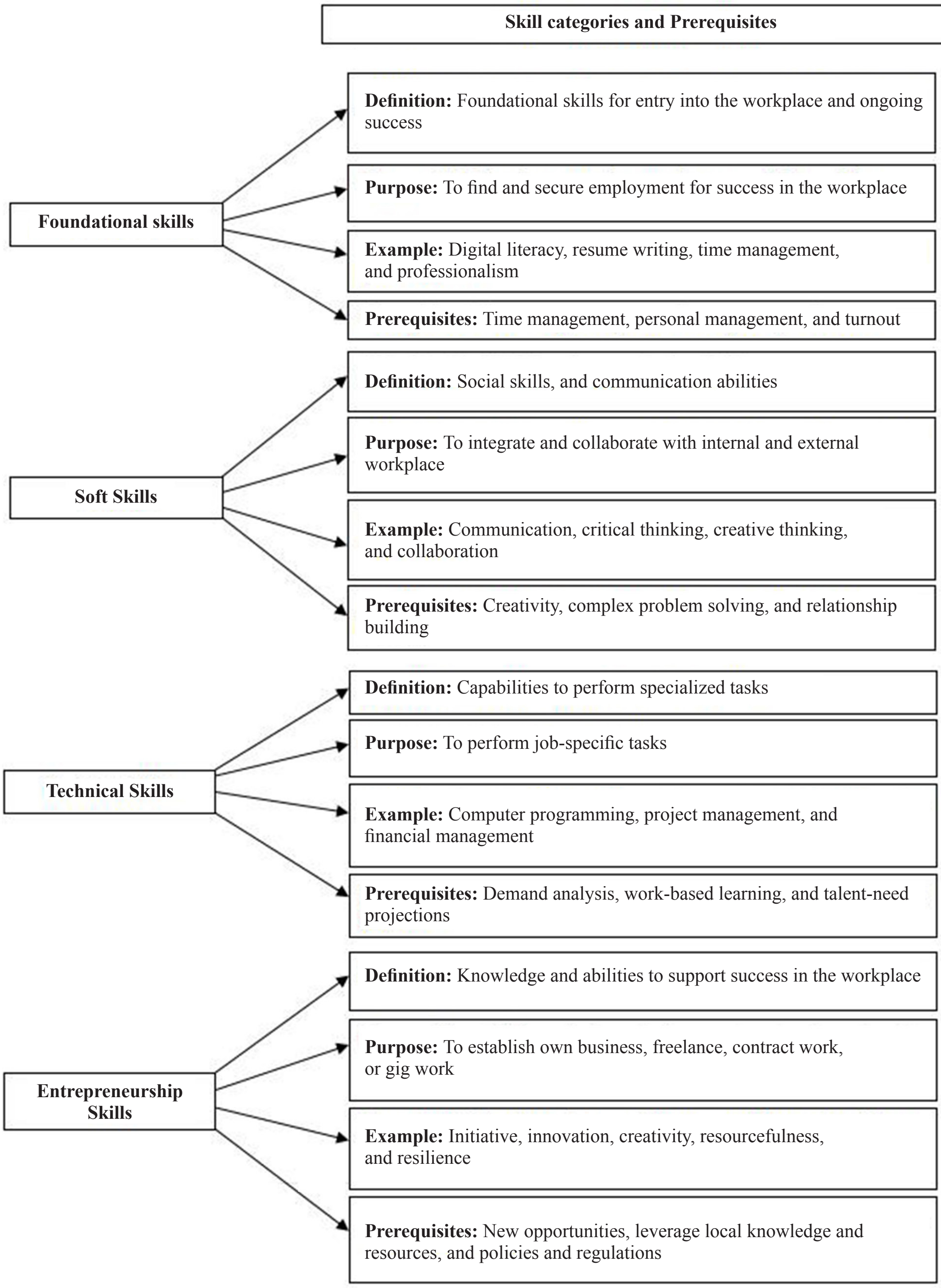


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Figure 3. Framework for 4IR compatible model

3.2 *4IR compatible skills: A framework*

Youth unemployment has been high in developing countries. Alongside, firms have been facing immense challenges in recruiting and retaining talent to meet their requirements of human capital, which led to human resource scarcity in the competitive economic environment. The global economy has been facing severe deficits of workers with tertiary and secondary education and a surplus of low-skilled workers, which are distributed unequally due to mismatch in supply and demand of talent and employment opportunities. High-skill workers have been absorbed in high-paying jobs, while low-skill workers are needed for lower-paying tasks, which faced substantial threats of emerging automation, which can increase existing economic and social inequalities in general and gender inequalities in particular. Therefore, there is a need to address the mismatch between supply and demand of skilled workforce for the new world of future of work. Figure 3 provides a framework of the 4IR compatible skills to prepare youth for a future in which jobs and required skills will change rapidly. There should be greater emphasis on agility and continuous learning for a sustainable growth of businesses in the future.

4. Results

The results of the paper are discussed in the following sub-sections: a model for the 4IR compatible skill development; challenges of the 4IR to TVET, workforce and society; challenges of TVET system, and the 4IR compatible learning model.

4.1 *Model for the 4IR compatible skill development*

A model for 4IR compatible skill development helps in understanding the mechanisms for collaboration, investment and linked initiatives to overcome the gaps and opportunities in program implementation suitable to the local workforce ecosystem.

The first step is to select the geographical location of youth to be served for need assessment and programming to address those needs. The geographic boundaries of the targeted youth can be a village, city, state, region, or country. The number of targeted beneficiaries indicates the proportion of the youth covered in the programs. This will help understand the populations potentially over or under-represented in the programs. The number of youth enrollment in education, employed, and/or NEET in target geography can be ascertained.

The second step is to develop the program design, its key features, and the delivery method. The key features of the program indicate the basic model and structures and its impact on the youth population, which can help identify the collaborative opportunities and complementary programming. It is important to understand that the program is demand-driven or skills-driven. The program duration, the mechanism for quality monitoring and assessment, and wraparound services are to be decided in advance.

The third step is to decide the program delivery method for teaching and training skills. It is to be decided whether the program is to be delivered through personal, virtual, blended, and autonomous learning. Teaching methods to be adopted should depend on the skills needed by the target beneficiary group. The specific gaps in skill development and outcomes can also be understood. In this context, the key skills to be taught in the training should include workforce readiness skills, soft skills, technical skills, and entrepreneurial skills. It is to be identified, which skills are most in-demand in targeted geography and beneficiary group.

The final step is to develop the metrics to be used to measure program and system outcomes, which will help understand the type of data to be collected for measuring outcomes and to improve the program and strategy design. The impact of programming cannot be the same in different geographies. One way to measure the results of programming is to know potential employment opportunities created for the youth and direct linkages of the program to the employment marketplace.

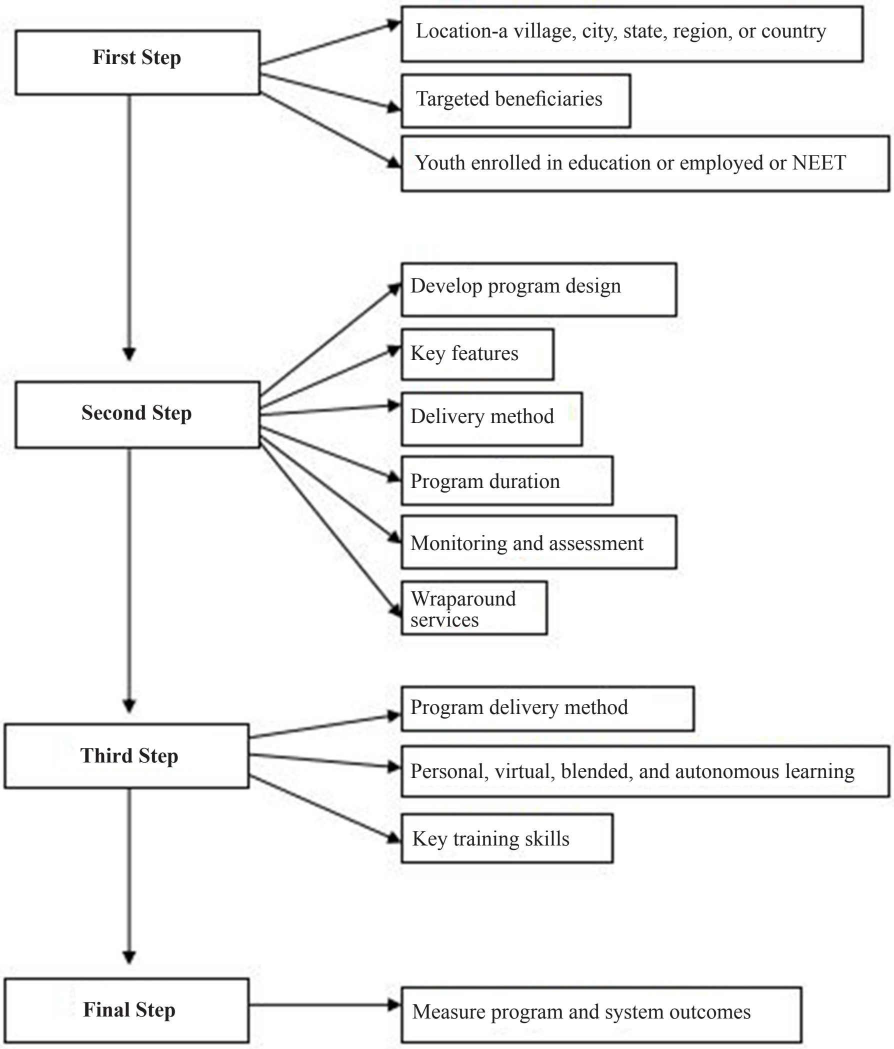

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Figure 4. Model for 4IR compatible skill development

4.2 Challenges of the 4IR to TVET, workforce and society

Figure 5 shows that the 4IR and associated disruptions have immense challenges for TVET transformation to elevate learning and reskilling the displaced workers. New technologies pose a real challenge to revamp the existing education and training systems to equip the workforce with foundational knowledge and skills. For instance, the 4IR induced industrial transformation leads to increased automation of the textile industry, thus requiring only very few highly skilled workers in low-wage locations near markets, and/or sources of raw materials. New technologies will impact more the future of work in digitally compatible sectors such as retail, hospitality, transport and logistics, manufacturing, construction, and financial and professional services than non-digital sectors such as healthcare through direct and indirect effects, spillover effect, income effect, and disruption effects. The immense increase in productivity of digital sectors: consumer goods, retail, hospitality, food services, energy, mining, media and communications, transport and logistics, manufacturing, construction, and financial and professional services.

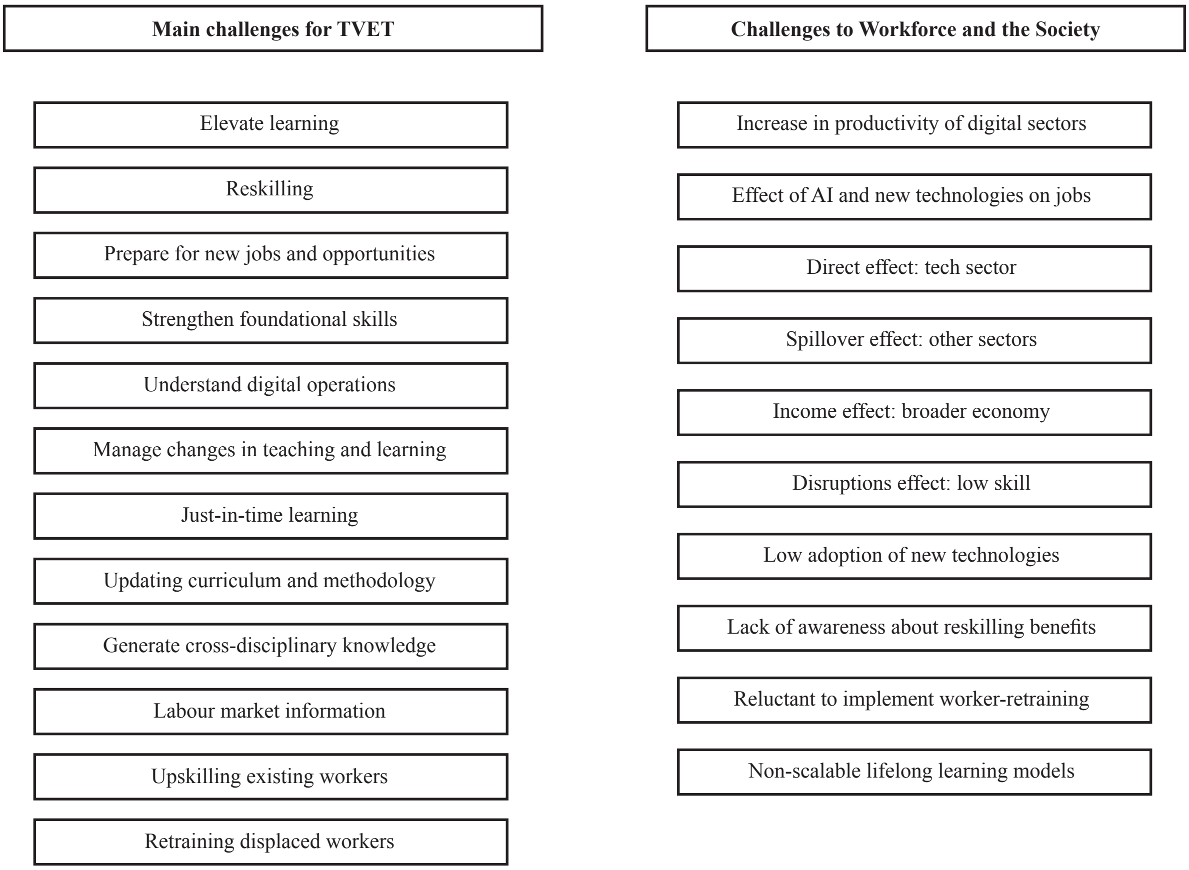

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Figure 5. Challenges of the 4IR and training systems

4.3 *Challenges of TVET system*

Figure 6 describes the major challenges of the TVET system in Asian countries. TVET has been implemented in most Asian countries to impart labour market skills. However, TVET systems have low status in the academic setting. The nature of vocational learning is less understood by the policymakers and other stakeholders. TVET is supply-driven without an adequate understanding of labour market demands. Therefore, TVET should be linked to the business sector through robust collaboration. TVET systems should be continuously monitored and evaluated to understand what works and can inform TVET design.

4.4 *The 4IR compatible learning model*

Asian developing countries have relatively low adoption of new technologies, lack of awareness regarding benefits of reskilling, inability to implement retraining programs, and lack of effective lifelong learning to meet the new skills of labour market. Education and training systems are unable to respond quickly to digital and technological transformation for the future of work. Therefore, there is an urgent need to design, plan, and deliver new educational and training programs to complement digital learning strategies. Figure 7 describes a new 4IR compatible learning model in a digital age to be applied in Asian developing countries.

The students should be able to regularly update their skills or learn new skills in the school system by using new technologies in highly interactive and online mode within schools and outside the schools as lifelong learning. Soft skills should be embedded into learning and cultivated in students. Curriculum and learning in converging technologies should be integrated to promote lifelong learning. Teachers should act as mentors and guide in skill development and learning. TVET should actively collaborate with the industry to supply the required skills. Digital educational platforms and cloud-based solutions should be developed to provide skills in new technologies.

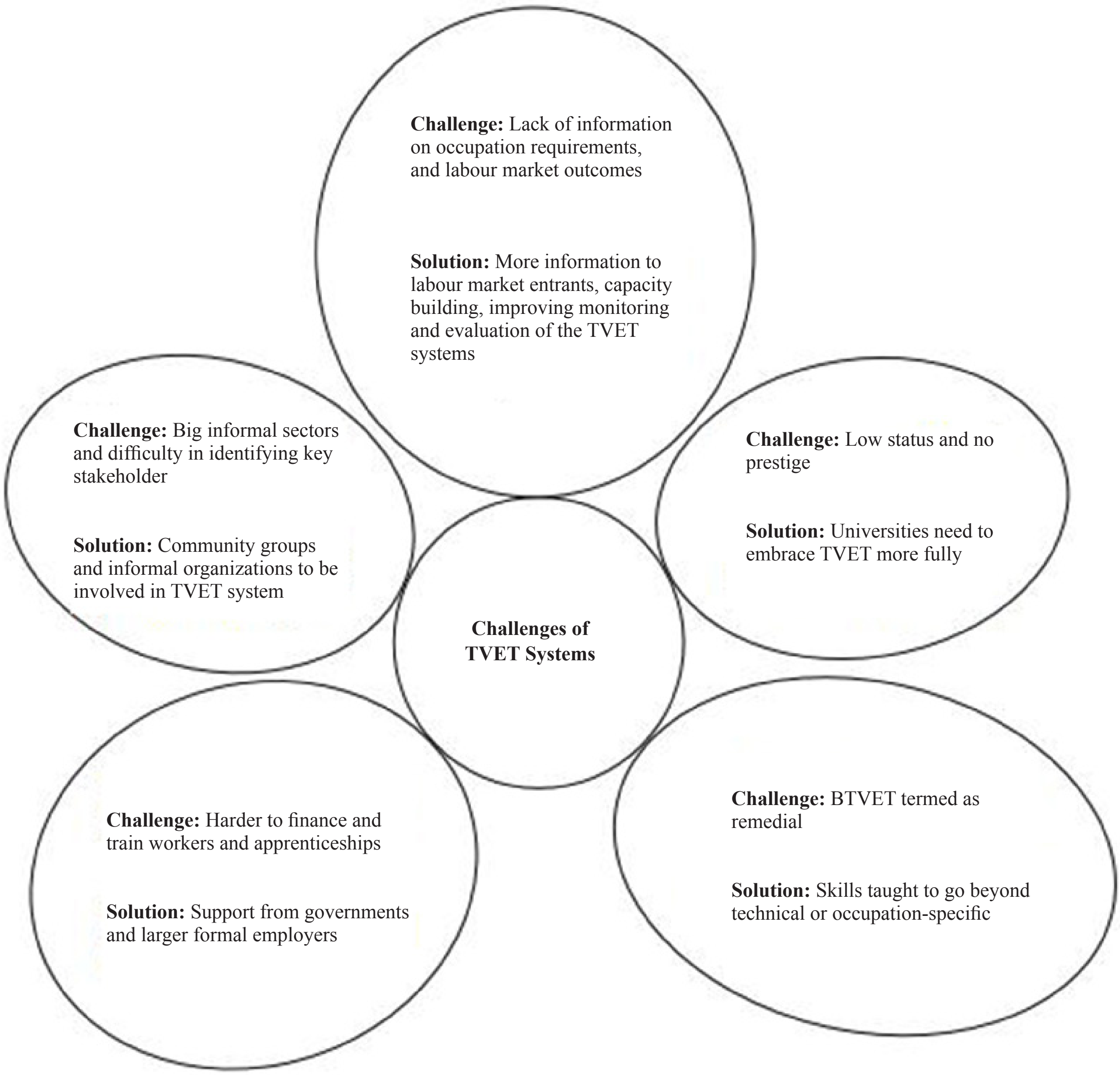

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Figure 6. Challenges of the TVET system

5. Discussion

The 4IR is a technological revolution embracing AI, IoT, big data and other digital platforms, which has led to innovative industrial practices and new skills challenges in Asian economies. In the COVID-19 period, the importance of reliable digital services has been widely recognized throughout the world and Asia is no exception. However, poor digital accessibility has been reported even in digitally advanced economies. This calls for improving digital services for greater future resilience to such crises, speedier economic recovery, and sustainable supply chains including education and services.

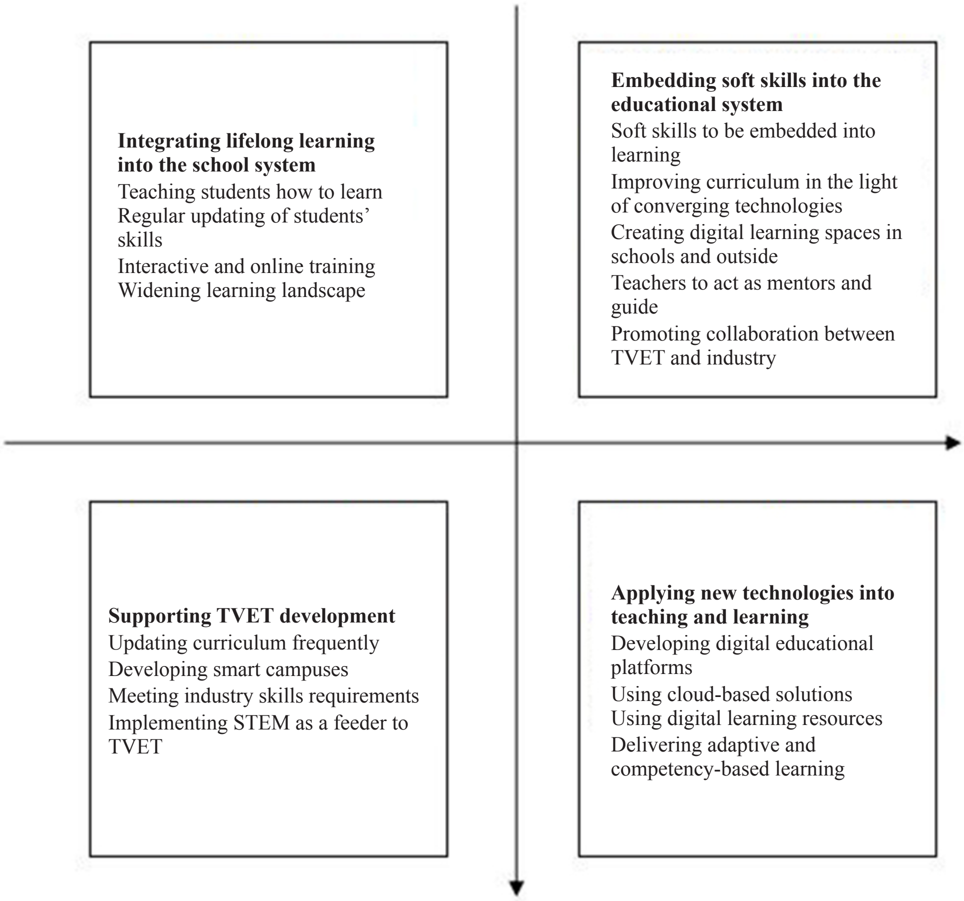

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Figure 7. 4IR compatible learning model

Many Asian governments have developed the 4IR compatible plans for improved productivity and economic resilience. Internet connectivity and the 4IR solutions have improved significantly in many economies. For instance, India has worked for interconnection, information transparency, decentralized planning, and technological transformations through substantial investment in digital infrastructure. Indonesia has developed plans to integrate the 4IR in the manufacturing sector and international trade through robust collaboration with relevant stakeholders. Japan plans to integrate the 4IR to the vision of Society 5.0 covering demography, health, fintech and logistics. Pakistan has focused on AI, IoT, big data, robotics, fintech and cloud computing through collaboration. Singapore plans for substantial investment in the R&D sector and improving the 4IR compatible skills of the workforce. South Korea targets to achieve people-centric 4IR through public-private collaboration. Thailand plans to capitalize the 4IR for economic development, social upliftment, human wellbeing, and climate resilience. Vietnam focuses on institutional development and investment to embrace the 4IR.

Despite numerous initiatives, many people faced significant risks of exclusion. For instance, in India and Pakistan, rural students have faced immense difficulties to access online educational activities during the COVID-19 induced closure of educational institutions. Therefore, governments should drastically improve digital infrastructure for greater resilience to future crises. The 4IR will cause huge job losses in the future. Therefore, the governments should invest heavily in improving the 4IR compatible skills of the youth for gainful employment and reskill the technology-affected workers for their reintegration to jobs market, which will ensure speedier economic recovery. TVET system should play a vital role in smoother transitions to the 4IR and to bridge the emergent skills gaps in manufacturing and services through public-private collaboration in the diversification of the curriculums focusing on both the technical and soft skills and renewed research avenues.

6. Conclusion

The paper has analyzed how the 4IR is changing the jobs demand and drawn the implications of the 4IR on the future of the workforce in Asia. The challenges and opportunities of the 4IR and Asia's experiences in new technologies and skills mismatches vis-à-vis the TVET system and their impact on the jobs market have been discussed. Two new models viz. the 4IR compatible skill development model and the 4IR compatible learning model have been developed. In the following concluding paragraph, the policy and practice implications of the study for the future workforce have also been drawn.

Automation-induced massive job losses call for adequate skills development or retraining of displaced workforce and new entrants in foundational skills to enable them to tap the opportunities of new technologies. The 4IR provides ample opportunities to increase the demand for workers to perform non-routine cognitive, social, and information and communications technology (ICT) tasks, which can be met through the supply of agile and competent workers (ADB, 2018) with high skills (Khatiwada & Veloso, 2019). This requires robust TVET systems to equip workers with new skills for emerging jobs, which can be possible by increasing the quality of program structure to meet the needs of labour market. The technical training should be integrated into with the secondary education through education reforms to impart skills to thrive in the knowledge economy. The system of quality apprenticeships should be evolved with the active collaboration of potential employers in the curriculum development of TVET programs. ICT should be integrated into with TVET programs to increase its outreach and flexibility to quickly respond to the needs of the emerging labour market. An increasing mismatch between workers' skills and the skills required in labour market makes it intricate to find a suitably skilled workforce. Therefore, training institutes should evolve a more agile and resilient approach to close skill gaps to address labour market dynamism (OECD, 2017) based on adequate data and information. Public employment services should be strengthened to provide adequate labour market information for skill development and training. Career counseling centers should facilitate the prospective trainees in finding the right training courses to enable them to enter labour markets after course completion. There should be active collaboration between employers and skill development institutes to achieve better outcomes.

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