

A Fourth Industrial Revolution that empowers SDG 2030: Exploring the Development-Technology Nexus in quest for Inclusivity

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ABSTRACT

From a development perspective, combinations of high internet penetration, low education levels, and high levels of poverty can result in an environment of technology-driven inequality. The Fourth Industrial Revolution (FIR) is going to fundamentally reshape the way economies operate all around the world. It will affect both developed and developing economies as well as impact achievement of the Sustainable Development Goals (SDGs). This paper looks into various challenges and opportunities which the FIR offers in the path to achievement of the SDGs. One areas of focus is the relationship between education and the ability to access the FIR economy.

With SDGs aspiring for successful integration of excluded members of society into the mainstream economy, FIR is both an opportunity and challenge for integrating these members into the economy. The paper discusses this concept in the context of two countries and the impact that the FIR unleashes in each. Particularly the ways in which FIR is changing the economy in Bangladesh, and the various industries which it is impacting most. Also included is how the implementation of automated processes poses a risk to many vulnerable members of the community. Of relevance is the recent implementation of an automated welfare debt recovery system by the Australian government and the way it placed an undue burden on many vulnerable members in the community. The paper advocates for a proactive rather than reactive approach in the implementation of strategies to address the changes wrought by the FIR, and the core argument being that educational inequalities may be the most important area of change to be addressed.

Introduction

The Fourth Industrial Revolution (FIR) is redefining how people live in the world today. It has fostered an environment that allows technological advances to be made every day, and then rapidly integrated into society once they have been made. In doing so, the FIR is presenting both opportunities and challenges for global sustainable development and needs to be considered for any projects concerned with inclusivity on a global scale. Whilst there are diverse aspects to the FIR, it is characterized by *pervasive automation*, a sharp rise in the use of *Artificial Intelligence*, *3D printing*, *advanced materials*, *advanced energy exploration and recovery*, increased and new usage of *cloud and supercomputing*, pervasive usage of the *internet of things* and the *ubiquitous use of the internet* to conduct a host of daily activities¹.

By the time the SDGs are scheduled to be met in 2030, technological developments associated with the FIR would have moved the society into an unprecedented space, with each advancement having an impact on the 17 SDGs. For example, the simple use of Uber – the globally popular ride sharing application – has enabled people in cities to travel better, often times at lower cost and has also opened up newer income earning opportunities. Transitions like this will continue to have a substantial impact on the achievement of SDG 8: Decent Work and Economic Growth and SDG 11: Sustainable Cities & Communities. Elsewhere, the ability to use mobile phones to conduct a host of financial activities will bring a large number of the population in the developing world into the formal financial sector, which will impact Goal 4: Quality Education, Goal 5: Gender Equality and Goal 10: Reduced Inequalities. With the achievement of the SDGs by 2030, a key issue of global justice, it is important to ask: ‘*How will the Fourth Industrial Revolution impact the achievement of the Sustainable Development Goals by 2030?*’

To address this question, this paper draws insights from 2 separate examples, each engaging with different aspects of the FIR.

- The 1st example looks into how automation are replacing jobs in established industries and how service sharing technologies can have unambiguous impact on inequality in the Bangladeshi labour market.
- The 2nd highlights ethical issues which have arisen when FIR technologies have been implemented by the Australian Government to recover fraudulent welfare claims

¹ Heiner Lasi et al., “Industry 4.0,” *Business and Information Systems Engineering* 6, no. 4 (2014): 239–42.

What is the Fourth Industrial Revolution (FIR), and what is it changing?

There are various dimensions to the FIR which overall combine to make the FIR represent a fundamental shift in the way people interact with each other, the economy, and with society more generally. These changes are occurring in a variety of sectors and are interacting in ways that make some of the impending changes difficult to predict. Even so, there are some clear shifts which can be made clear, which are briefly outlined here.

Table 1 highlights six specific changes which can be grouped together in the context of the kind of impact which they are likely to have. Various changes from the FIR can be loosely broken up into 3 distinct areas of impact: improving productivity, improving product quality, and improving access. Taken together, these areas provide exciting opportunities and pose unique challenges for achieving the SDGs. Some of these challenges are set aside for this paper, with improvements to materials, and subsequent improvements in product quality being largely unexplored. Instead the focus is on the interaction between increasing access and changes in production which are occurring as a consequence of the FIR.

Change	Area of Impact
Pervasive automation	Productivity
Pervasive usage of the internet of things and the ubiquitous use of the internet	Product/Market Access
Increasing usage of artificial intelligence	Productivity
3D printing, advanced materials,	Product quality
Advanced energy exploration and recovery	Productivity
Pervasive usage of cloud and supercomputing	Productivity Product/Market Access

An important issue which will occur from the changes outlined in Table 1 is the way in which the FIR will change global labour market dynamics. Changes in productivity and access to various markets will impact the way individuals are integrated into the economy and society.

The FIR is fundamentally reshaping the economy and redefining the roles available for many workers. As Table One notes, there are going to be numerous changes to the economy from the FIR, most of which will occur in the areas of productivity and product or market access. As such, the changing elements of market access and increased productivity will reshape the labour market in a way that requires looking towards existing literature on labour market dynamics. This is because if we want to understand the way in which the FIR will impact society overall, then it is worth first considering the area it is likely to have the biggest impact, and what that impact is going to be.

The interaction of educational inequality with changing labour market dynamics in both developed and developing economies is an essential dimension to understanding the impact of the FIR. It is essential because changes to labour market structures as a consequence of the FIR will make education a key factor in the life opportunities which individuals have available to them. Whilst the interaction is somewhat complex, it can be understood through the following straightforward premises:

- 1) The labour market polarization in many economies are currently changing as a consequence of the FIR.

- 2) The FIR will eliminate many middle-income jobs.
- 3) The quality of jobs which are available to individuals are closely tied to the quality of life prospects that individuals have available.
- 4) Education level is increasingly becoming an important driver of the quality of jobs which individuals will have access to as consequence of skill biased technological change.
- 5) Individuals without a good education and complimenting skill sets will not have access to good jobs.

Labour market polarization can be defined as “more rapid growth of employment in jobs at the bottom and top, relative to the middle of the skill distribution”². It has been well established that over the last three decades, there has been increasing labour market polarization across the globe³; with much of the polarization attributed in large part to technological developments⁴.

The most recent literature on labour market change has identified that a large number of established professions and roles will be eliminated in the near future. Notably, many of these roles which are eliminated will be in the middle-income bracket. Already, estimations have suggested that as much as 47% of total US employment is at high risk of automation in the next two decades⁵, and reports evaluating the impact of the FIR expect to see a large decrease in the number of jobs requiring manual labour and basic cognitive skills⁶. Whilst some are hopeful that a new suite of middle-income jobs will emerge, with ‘new’ collar employees⁷, the skill level expertise of this class is expected to be higher than previous middle-class jobs have required.

If current trends in labour market polarization continue, especially the hollowing out of middle skill jobs, it will likely lead to the development of two clusters. One with those employed at the bottom in a market for unskilled labour or low skilled labour, and those at the top in a highly skilled market requiring technical expertise. As summarised in a recent Human Development ⁸ report, “there has never been a worse time to be a worker with only ordinary skills or abilities.” Considering the degree to which increasing labour market polarization has also been linked to a polarization in wages⁹, it is important to consider how this will effect and relate to social mobility in the coming years.

² By David H Autor, Lawrence F Katz, and Melissa S Kearney, “The Polarization of the U.S. Labor Market,” *The American Economic Review* 96, no. 2 (2006): 79.

³ Theo Sparreboom and Alexander Tarvid, “Imbalanced Job Polarization and Skills Mismatch in Europe,” *Journal for Labour Market Research* 49, no. 1 (2016): 15–42; Joanne Lindley and Stephen Machin, “Spatial Changes in Labour Market Inequality,” *Journal of Urban Economics* 79 (2014): 121–38; Autor, Katz, and Kearney, “The Polarization of the U.S. Labor Market”; By David H Autor and David Dorn, “The Growth of Low-Skill Service Jobs and the Polarization of the US Labor Market,” *The American Economic Review* 103, no. 5 (2013): 1553–97; Maarten Goos and Alan Manning, “Lousy and Lovely Jobs: The Rising Polarization of Work in Britain,” *Review of Economics and Statistics* 89, no. 1 (2007): 118–33; Maarten Goos, Alan Manning, and Anna Salomons, “Explaining Job Polarization: Routine-Biased Technological Change and Offshoring,” *The American Economic Review* 104, no. 8 (2017): 2509–26.

⁴ Michael A. Peters, “Technological Unemployment: Educating for the Fourth Industrial Revolution,” *Journal of Self-Governance and Management Economics* 5, no. 1 (2017): 25–33; Elena Deskoska and Jana Vlčková, “The Role of Technological Change in Income Inequality in the United States 1” 26, no. 1 (2018): 47–66; Goos, Manning, and Salomons, “Explaining Job Polarization: Routine-Biased Technological Change and Offshoring”; Goos and Manning, “Lousy and Lovely Jobs: The Rising Polarization of Work in Britain.”

⁵ Carl Benedikt Frey and Michael A Osborne, “The Future of Employment: How Susceptible Are Jobs to Computerisation?,” *Technological Forecasting & Social Change* 114 (2017): 268.

⁶ Jacques Bughin et al., “Skill Shift: Automation and the Future of the Workforce,” 2018; Sparreboom and Tarvid, “Imbalanced Job Polarization and Skills Mismatch in Europe.”

⁷ Bughin et al., “Skill Shift: Automation and the Future of the Workforce.”

⁸ “Human Development Report 2015: Work for Human Development,” 2015, 9.

⁹ Autor and Dorn, “The Growth of Low-Skill Service Jobs and the Polarization of the US Labor Market.”

While education affects opportunities available to individuals in a number of ways, the most direct way that education constrains job opportunities is by limiting the job market which they are qualified to enter ¹⁰.

In high skilled economies, lacking an education substantially limits the scope of jobs which are available to an individual¹¹, in addition, it limits the quality of the jobs which are available to them. Because labour market polarization increases the degree to which education shapes life opportunities, increasing polarization represents an increase in the importance of educational equality for the equality of life opportunities which individuals have.

Within the literature examining social mobility, it is well established that the higher the rate of return¹² on education, the lower the level of social mobility¹³. If this remains true during the FIR, and the relationship between getting a good job and level of education increases through the FIR, we can expect to see those without high levels of education increasingly trapped at the bottom of the income distribution. In turn, this poses a risk to completing a number of the SDGs which are tied to reducing poverty and ensuring that individuals are able to live a good life of their choosing.

Studies illustrating how FIR is affecting existing systems: The Case of Bangladesh

The Ready Made Garments (RMG) industry forms the backbone of Bangladesh's export market with the sector accounting for almost 83% of total export earnings of the country. The sector is a prime contributor to Bangladesh's continued economic growth and today Bangladesh has 5,000 ready-made-garments factories employing 4 million workers¹⁴.

It was previously thought that the garments manufacturing sector would not be impacted by automation because of the difficulty in emulating the quality of hand stitched garments with machines. However, in Bangladesh today large factories have gradually started to incorporate semi and fully automated machines in their production processes. Mohammadi Fashion Sweaters Ltd with a workforce of 720¹⁵ have fully automated their knitting process since 2012. The factory has up to this point replaced 500 workers, with more such changes expected in the future. Another factory in Bangladesh's port city of Chittagong has identified that laser machines cut better holes into denim than manual workers¹⁶.

The impact of job loss in the RMG sector will be severe since these low-skilled workers have only a few industries to transition to. While other industries like ceramic, leather, and agricultural products are picking up they are not yet large enough to incorporate the expected loss in jobs in

¹⁰ Rolf Van Der Velden and Ineke Bijlsma, "College Wage Premiums and Skills: A Cross-Country Analysis," *Oxford Review of Economic Policy* 32, no. 4 (2016): 497–513.

¹¹ OECD, "The NEET Challenge: What Can Be Done for Jobless and Disengaged Youth?," *Society at a Glance*, 2016.

¹² The rate of return is the amount of income gained by attaining an additional year of education.

¹³ Corak, "Income Inequality, Equality of Opportunity, and Intergenerational Mobility"; Solon, "Intergenerational Mobility over Time and Place"; John Jerrim and Lindsey Macmillan, "Income Inequality, Intergenerational Mobility, and the Great Gatsby Curve: Is Education the Key?," *Social Forces* 94, no. 2 (2015): 505–33; Meir Yaish and Robert Andersen, "Social Mobility in 20 Modern Societies: The Role of Economic and Political Context," *Social Science Research* 41, no. 3 (2012): 527–38; Christopher Rauh, "Voting, Education, and the Great Gatsby Curve," *Journal of Public Economics* 146, no. 1 (2017): 1–14.

¹⁴ World Bank. "Creating Jobs and Diversifying Exports in Bangladesh". <http://www.worldbank.org/en/news/feature/2017/11/14/creating-jobs-and-diversifying-exports-in-bangladesh> (accessed June 25, 2018).

¹⁵ Mohammadi Fashion Sweaters Limited. <http://www.mohammadigroup.com/companies/sweater-manufacturing/mohammadi-fashion-sweaters-limited/>. (accessed May 31, 2018).

¹⁶ Emont, Jon. "The Robots Are Coming for Garment Workers. That's Good for the U.S., Bad for Poor Countries." *The Wall Street Journal*. February 16, 2018.

RMG. The social cost of mass layoff from automation will also be severe in Bangladesh. With weak law enforcement and unavailability of industries to take in low-skilled workers, severe unemployment will result in a rise in crime, poverty, and illegal migration.

Uber which came to Bangladesh in 2016 and other local ride sharing services like 'Pathao' are having an impact on the capital city, Dhaka's transport sector. But the higher than average cost of such ride-sharing services and their digital operability means the services have only so far remained 'middle class urban' solutions which require the users to have internet access and basic digital literacy. Dhaka is a sprawling metropolis with 18 million inhabitants but only 5,000 buses, 40,000 CNG auto-rickshaws and 400,000 rickshaws to cater to the demand.¹⁷ Both Uber and Pathao have opened up more transportation options for Dhaka city commuters. Providing affordable, safe and quality transportation is key to building sustainable cities and is crucial for reaching many of the targets under SDG 11: Sustainable Cities and Communities. But since operating sharing-services requires internet access and some level of digital literacy, they cannot be utilized by those living below the poverty line and those without access to quality internet and basic digital literacy. With only 35% Bangladeshis accessing the internet every day and with only 40 million active internet users in a country of 163 million, ride sharing services have yet to become an inclusive technology to have.

Australia

The FIR presents interesting ethical challenges as a consequence of the implementation of new technologies. An instance where ethical issues have already arisen as a consequence of the FIR was in Australia when the Government recently implemented a new automated debt collection scheme. There are two distinct aspects to the way that the Online Compliance Intervention (OCI) was conducted which make it emblematic of the FIR. The first was that it represented an instance of *pervasive automation*, the second being that it represented an instance of using big data to replace human analysis.

The OCI was a controversial¹⁸ policy implemented by the Australian Federal Government in 2016 to recollect welfare overpayments made as a consequence of incorrect welfare claims and payments. The policy changed previously manual data matching from human workers with automated processes. The OCI matched the earnings recorded on a customer's Centrelink¹⁹ record with historical income data from the Australian Taxation Office (ATO), with discrepancies identified being then used to identify people with potentially outstanding debts to the government²⁰. Centrelink customers were required to identify if there were any discrepancies in the data matching calculations and report those discrepancies back to Centrelink. Failure to do so would result in a debt notice being generated, and Centrelink customers would be required to repay the debt. Delays in repayment would also result in customers incurring an interest charge of 10%.

With welfare payments existing for the purposes of keeping recipients out of risk of poverty, and ensuring that they can afford to live in society, we can regard those issued with notices as belonging to an at-risk group in the community. Any process which is likely to marginalise them poses an issue to the achievement of SDGs 1: No Poverty, SDG 2: Zero Hunger, SDG 3: Good Health and Well-Being, and SDG 10: Reduced Inequalities.

The implementation of the 'robo-debt' collection system represents a nexus of issues present in the FIR. The first issue is the automation of collection processes which results in the loss of the usage of discretion by former workers on the frontline. With no people making decisions and assessments with the process being undertaken, it reduces the quality of oversight internal to

¹⁷ Syed Mafiz Kamal and Noor A Ahsan. "Uber-Pathao' ride-share's impact on Dhaka." The Financial Express. April 28, 2018.

¹⁸ Peter Martin, "Centrelink's Robo-Debt Is a Litany of Inhuman Errors," *The Age*, January 4, 2017.

¹⁹ Centrelink is the name given to a key part of the Australian Department of Human Services, which generally acts as the interface between the government and citizens when processing welfare support.

²⁰ Richard Glenn, "Centrelink's Automated Debt Raising and Recovery System," vol. 2, 2017.

the process. This will be an issue across a number of automated processes which come about as a consequence of the FIR. The second issue which arose during the 'robo-debt' policy was the lack of public interfacing available after the debts were assigned. In removing the public interfacing, pressure was placed on customers to understand the processes and adequately address the issues raised by the OCI. This increased stress for those already at risk of financial hardship, and ultimately resulted in a policy which negatively impacted many already in precarious economic situations.

FIR induced Benefits for Achieving the SDGs and the Negative Disruptions

The Benefits

Digitization and the subsequent high penetration of the internet into everyday life has enabled a number of direct improvements for those who are disadvantaged in the community. E-commerce and mobile phone based financial applications have enabled a large number of people in developing countries previously outside of the banking network to gain access to financial accounts and use them for financial services like paying and transferring money online. China's rural economy has been transformed through spread of e-commerce giving rise to 'Taobao villages' where almost 10% of the households in villages are engaged in e-commerce²¹. According to the World Bank's World Development Report (WDR), the ability of people to communicate and conduct business online has created inclusion, efficiency and innovation.

One core benefit generated by the FIR is that digital technologies assist in job creation through the facilitation of access to new employment markets. For example, China's State Information Centre estimates that the recent boom in the country's e-commerce sector has created 10 million jobs in online stores and related services, about 1.3 percent of the country's employment (The World Bank 2016).

As was mentioned in the discussion of Bangladesh, mobile financial services have radically changed the financial service sector in Bangladesh, particularly rural Bangladesh with 15.8 million²² active mobile users in the country. Mobile money is key to financial inclusion where any mobile phone owner can now make person to person money transfers without having to pay exorbitant fees to middle men, travelling long distances to make payments physically or pay more due to asymmetric price information²³.

Technology has helped shape healthcare for centuries and the availability of personalized and more accurate health data and statistics will create healthier human beings and societies. Emerging technologies like mobile-based healthcare applications are shifting healthcare systems in developing economies. Mayes and White²⁴ show that more people are using smart phones and taking an active interest in personalized healthcare. They show communication technology has greatly increased the volume and quality of doctor-patient information sharing at low cost in developing countries. The Public Health Foundation of India has created a "Health Tablet" locally termed as the 'Swasthya Slate' to monitor vital signs and communicate those signs to a central server creating a reliable record of patients' health and enabling download of recommended therapies.²⁵

²¹ World Bank Group. *World Development Report: Digital Dividend*. Washington, DC. The World Bank.2016. Accessed May 25, 2018.

²² USAID.2015.

²³ World Bank Group. *World Development Report: Digital Dividend*. Washington, DC. The World Bank.2016. Accessed May 25, 2018.

²⁴ Mayes, Jonathan; White, Andrew. *How Smartphone Technology Is Changing Healthcare In Developing Countries*. The Journal of Global Health. 2016. Accessed May 25, 2018.

²⁵ Wunker, Stephen. *How The Swasthya Slate Is Revolutionizing Healthcare, And Why It Steers Clear Of The US*. Forbes. 2014. Accessed May 25, 2018.

Digitization, mobile technology and the internet has also greatly impacted traditional education systems by making courses and degrees available online. Massive Open Online Courses (MOOCs) have become widely available making it possible for individuals from any country with certain levels of literacy skills complete these courses at considerably lower prices than offered by traditional institutions. According to West²⁶ mobile technology offers particular assistance to women and the disadvantaged by broadening their access to information and connecting them with other people. Mobile applications like ALISON enable people in rural communities' access free online courses. Eneza Education with is a virtual tutor, that provides universal access to affordable, quality, lifelong learning to its 4.6 million registered learners. For the benefits of the FIR to accrue to those most in need, it will be important to ensure that these digital platforms remain accessible to all, both in terms of connectivity, and in terms of price.

By making available large parts of the economy previously inaccessible to poorer individuals, the FIR is creating greater potential for overall inclusion in the economy. If the FIR continues to open up previously closed economic and social spaces, it will improve the life prospects of those who are the least well off around the world. Furthermore, by changing the way in which education and information is disseminated, the FIR is creating a whole new mechanism through which individuals can gain access to life changing education²⁷. If these opportunities are harnessed, and FIR is used to generate economic inclusivity, then from the perspective of providing welfare to all, it may be the most important change to human society which has occurred in the world to date.

Benefits from the FIR	SDGs to be affected
Access to more information	SDG 10: Reduced Inequalities
Access to markets from E-Commerce	SDG1: No Poverty; SDG 5: Gender Equality; SDG 8: Decent Work and Economic Growth; SDG 9: Industry, Innovation and Infrastructure; SDG 10: Reduced Inequalities
Healthcare applications	SDG 3: Good Health and Well-Being
Mobile Financial Services	SDG 8: Decent Work and Economic Growth; SDG 10: Reduced Inequalities
Bio-Engineering, wearable health monitors, gene editing, gene engineering	SDG 3: Good Health and Well-Being
Massive Open Online Courses	SDG 4: Quality Education
Service Sharing Mobile Applications	SDG1: No Poverty; SDG 8: Decent Work and Economic Growth; SDG 10: Reduced Inequalities

The Negative Disruptions

Most emerging technologies are not inherently inclusive and are neither affordable, accessible nor usable by all. Some technologies are designed in ways that do not make them accessible to people from all socio-economic backgrounds and levels of education, and some expensive technologies possess the capacity to exclude those who do not have the means to afford them.

²⁶ West, Darrell M. *Connected learning: How mobile technology*. Brookings Institution. 2015

²⁷ Richard Breen and Inkwan Chung, "Income Inequality and Education," *Sociological Science* 2 (2015): 454–77.

As the example of the OCI demonstrated, many emergent technologies are placing an increasing demand on the labour of customers, who must now directly interact with automated services and processes. Whilst this is not inherently problematic, there are structural pressures to implement these technologies at face-to-face points of interaction. When this occurs at high-stress points of contact, the loss of an intermediary to assist with the process can shift the stress onto the individual. As was discussed in the context of the OCI, for many individuals, the debt which they were told they held was one which placed them into circumstances of extreme financial hardship.

Using mobile phones and accessing information from the internet requires one to have basic literacy and numeracy skills- denying internet access to nearly one-fifth of the world's population who are illiterate.²⁸ While basic mobile applications like making calls can be utilized by those even without any literacy or numeracy skills, applications that facilitate texting, mobile banking, ride-sharing, and online shopping can only be utilized by those with medium levels of literacy and numeracy skills. Complicated technologies that utilize currently developing concepts like block chain and the internet of things will require advanced degrees and higher cognitive skill sets barring developing countries with a population having moderate to low levels of technological knowledge and literacy.

The existing digital divide among regions, countries, localities, and demographic is also a rising concern. Nearly 60 percent of the world's people are still offline and nearly two billion people in the world do not own a mobile phone and can't fully participate in the digital economy. According to the report, while internet penetration and mobile phone usage has gone up rapidly even in the developing world, only 31 percent of the population in developing countries had access in 2014, against 80 percent in high-income countries. Worldwide, nearly 21 percent of households in the bottom 40 percent of their countries' income distribution don't have access to a mobile phone, and 71 percent don't have access to the internet.²⁹

Ubiquitous mobile and internet connectivity is obligatory for most technologies under FIR to function inclusively. However, on average not even 1 in 2 people have mobile phones in Africa and mobile signals are not available everywhere. In countries like Niger, Burundi and South Sudan, less than 5% of the population have access to mobile internet. The International Telecommunications Union (ITU) says that under one in 100 people in Africa has cable internet, compared with about a quarter in rich countries³⁰. The ITU calculates that in poor countries the average cost in 2016 of the smallest mobile-internet package was equal to 14% of the average national income per person, putting it out of most people's reach³¹.

AI, robots, machine learning and automation are innovations that have characterized this industrial revolution and each of these technologies can lead to job loss and massive replacements. With each successive industrial revolution, the number of jobs that cannot be performed by robots is shrinking. In turn, labour market dynamics are rapidly changing due to technologies that require minimal human contribution to operate. One clear distinction between the previous and this Industrial Revolution is the extent of human involvement required in operating machines and processes. The third came up with programs, instruments and processes which all required some degree of human involvement to function fully. However FIR has given rise to technologies like machine learning, block chains, AI and self-driven cars that may require minimal to zero involvement of humans to become fully functional. For example, the Company Rethinks Robotics have come up with a robot named Baxter, which it claims can

²⁸ World Bank Group. World Development Report: Digital Dividend. Washington, DC. The World Bank.2016. Accessed May 25, 2018.

²⁹ World Bank Group. World Development Report: Digital Dividend. Washington, DC. The World Bank.2016. Accessed May 25, 2018.

³⁰ The Economist. Why half of Africans still don't have mobile phones. The Economist. 2016. Accessed May 25, 2018.

³¹ The Economist. Why half of Africans still don't have mobile phones. The Economist. 2016. Accessed May 25, 2018.

replace all humans in routine manufacturing tasks, such as “material handling, line loading and unloading, product inspection, light assembly, sorting, and packaging.”³²

A McKinsey Global Institute (MGI) discussion paper on automation and the future of the workforce³³ shows the estimated change in hours worked between 2016 and 2030 in 5 categories of skills: 1) physical and manual skills 2) basic cognitive skills 3) higher cognitive skills 4) social and emotional skills 5) technological skills. Estimated calculation in change in hours spent under each of these categories show that physical and manual skills will see a decrease of 14% while jobs that require high cognitive skills, social & emotional skills and technological skills will see rise of 8 %, 24% and 55% respectively. Fastest rises will be seen in demand for IT and programming skills, which could grow as much as 90 percent between 2016 and 2030. The demand for workers using only basic cognitive skills is expected to dramatically decline. This will impact emerging economies where these jobs make up the majority of the workforce. Emerging economies relying on the availability of cheap manual labour will see their comparative advantage vanish as industries in the future will require more and people with higher cognitive skills. As discussed above, many low-skilled individuals are likely to become trapped because of unemployment, or poor employment options.

In addition to inequality stemming from labour market transformation, there are risks of inequality stemming from technology access. For the next few decades some FIR technologies will continue to remain very expensive for the world’s poorest but affordable for the high earners creating space for inequality. Financial inequalities may create biological inequalities which in turn may create further financial inequalities. We may see a differentiation based upon access to high-end products which greatly increase ease of living. It will thus be important to pay attention to how the gains made from the FIR are distributed amongst society. Health technologies, for example, should be monitored to ensure there is not two tiered systems which are tied to economic inequalities.

Negative Externalities from the FIR	SDGs to be affected
Machines unable to follow ethical guidelines	SDG1: No Poverty; SDG 8: Decent Work and Economic Growth;
Gap in digital literacy	SDG1: No Poverty; SDG 4: Quality Education; SDG 8: Decent Work and Economic Growth; SDG 10: Reduced Inequalities
Expensive healthcare services and products	SDG3: Good Health and Well-Being
Low levels of internet penetration and usage	SDG1: No Poverty; SDG 5: Gender Equality; SDG 8: Decent Work and Economic Growth; SDG 9: Industry, Innovation and Infrastructure; SDG 10: Reduced Inequalities
Job loss from automation	SDG1: No Poverty; SDG 8: Decent Work and Economic Growth; SDG 10: Reduced Inequalities
Job loss from Artificial Intelligence (AI)	SDG1: No Poverty; SDG 8: Decent Work and Economic Growth; SDG 9: Industry,

³² Naudé, Wim; Nuger, Paula. *Is Technological Innovation Making Society More Unequal?* United Nations University. 2016.

³³ Jacques Bughin; Hazan, Eric; Lund, Susan; Peter, Dahlstrom; Wiesinger , Anna; Subramanian, Anna. *Skill shift: Automation and the future of the workforce*. McKinsey Global Institute. Accessed May 25, 2018.

Recommendations to Overcome Negative Externalities and Enhance Benefits

Considering the various changes which will occur as a consequence of the FIR, there are a number of areas which policy makers will need to address if they want to ensure that the FIR does not negatively impact the achievement of the SDGs. Returning to the areas of change outlined in Table One, there are three key issues of impact which will need to be addressed by policy makers. The first issue which policy makers will need to address is the changing labour dynamics which will arise as a consequence of the FIR. The speed of these changes makes them unique. The second change, which presents an opportunity, is the degree to which the FIR is opening new points of access for many previously excluded individuals. The third change which FIR is bringing about that will require careful attention from policy makers is the way that the FIR is changing interaction with government.

The example of Bangladesh highlighted some of the speed of the transitions which FIR is causing in existing markets, and the new markets which it is opening up. Policy makers will need to rapidly adapt to the changes which arise to ensure the SDGs can be met. To that end, the identification of at risk industries has been an important component of research on the FIR up to now³⁴. Even so, the changes occurring are such that it remains unclear which industries might be at risk by the time the SDG targets are meant to be met. To ensure adequate protection for those who do lose their jobs, it is important to increase the availability and range of training options for individuals at risk of losing their jobs. It is important that training and skill transitions occur in a proactive rather than reactive manner, and that these transitions are accessible for those at risk of losing their employment in the medium term.

Increasing product and market access will provide the greatest opportunity for the achievement of the SDGs. Services which were previously unavailable to disadvantaged members of the community are increasingly become accessible. If they are properly utilised then new technologies from FIR will continue to increase the integration of these disadvantaged members of the community into the economy in a way that will help with the achievement of various SDGs.

As noted in the negative externalities section, many of the benefits which will accrue from the FIR require access to the internet, and minimum basic literacy and numeracy skills. Those who are unable to use the technologies generated by the FIR are likely to face exclusion and marginalisation from the economy. In that sense, achieving basic levels of education for all is a fundamental issue moving forward. Whereas there have historically been low-skill jobs and industries where literacy and numeracy skills are not required, these jobs are now almost universally at risk of automation or from other kinds of replacement. Moreover, in conjunction with the fact that increasing returns on education in a society translate into lower social mobility in that society, it will be important to protect those with lower levels of education from becoming trapped in poverty.

The FIR is accelerating many aspects of the economy, either through more efficient processes, or through providing access to previously inaccessible markets. In such a rapid world, it will be important to ensure that no one is left behind. The negative externalities explored above highlight that there are many ways in which individuals may be left behind, and consequently, it will be important for policy makers and development practitioners to manage these risks.

³⁴ Bughin et al., "Skill Shift: Automation and the Future of the Workforce."

Conclusion

The FIR is fundamentally changing the world around us. Some of the changes present opportunities, by increasing the access to information, education, and previously closed spaces of the economy. At the same time, the FIR will generate many challenges for contemporary societies to overcome.

The potential for automation to eliminate whole sectors of jobs presents a unique challenge for the successful achievement of the SDGs by 2030. We recommend preparing for the changes that are occurring before they occur. In making these preparations, we have advised providing adequate training for the new economy. We also note that there are high levels of risk associated with automating services for the most vulnerable members of the community. The example of OCI was used to highlight how this increases pressure and stress on already at-risk members of the community, and may represent an undue burden upon the most disadvantaged members of the community. Ensuring that automated processes have adequate oversight will thus be crucial for achieving the SDGs, as failure to do so will result in greater inequality (SDG 10).

The opportunities which the FIR presents for achieving the SDGs are numerous. Improving access to the economy for those currently excluded will help with the achievement of multiple SDGs. The increased access to education services through online delivery and peer-to-peer interaction has the potential to greatly increase social mobility, and in doing so, ensure that many previously trapped in poverty are now able to learn valuable skills.

A proactive rather than reactive strategy will be required to ensure that the FIR does not negatively impact the achievement of the SDGs. A key issue for achieving the SDGs is that policy makers will need to ensure every citizen is able to participate in the economy, by ensuring everyone has the required literacy and numeracy skills. The integration of new technologies as a learning mechanism for all will be crucial to doing this. Ensuring access to the technology required to participate in the economy will also be a key issue, and mobile technologies will be an important feature of bringing in previously excluded people into the global economy. In summation, policy makers will need to be planning ahead, rather than reacting to crises as they occur.

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