



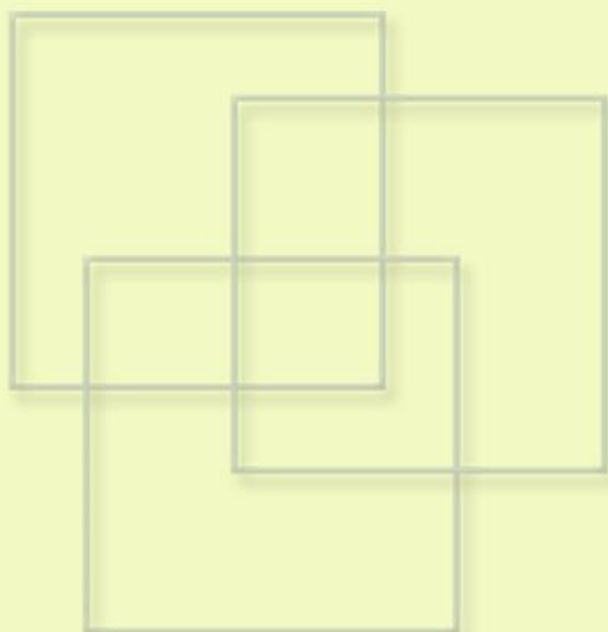
International  
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# Emerging technologies and the future of work in India



TANDEM  
RESEARCH

June 2018





## **ILO Asia-Pacific Working Paper Series**

# Emerging technologies and the future of work in India

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Tandem research  
June 2018

ILO Decent Work Team for South Asia and Country Office for India

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First published 2018

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ISSN: 2227-4391 (print); 2227-4405 (web pdf)

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Printed in India

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# Abbreviations

AI	Artificial Intelligence
4IR	Fourth Industrial Revolution
3IR	Third Industrial Revolution
ASI	Annual Survey of Industries
BCG	Boston Consultancy Group
BPO	Business Process Outsourcing
BPS	Business Process Sourcing
CAIR	Centre for Artificial Intelligence and Robotics
DGET	Directorate General of Employment and Training
DRDO	Defence Research and Development Organisation
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
ICT	Information, Communication, Technology
IoT	Internet of Things
M2M	Machine-to-machine
MNE	Multinational Enterprise
NASSCOM	National Association of Software and Service Companies
NCEUS	National Commission of Enterprises in the Unorganised Sector
NiTi Aayog	National Institution for Transforming India
NSS	National Sample Survey
OEM	Original Equipment Manufacturers
OWSDW	Organization for Women in Science for the Developing World
RPA	Robotic Process Automation
TFG	Technology Foresight Group
TNN	Times News Network
UNDP	United Nations Development Programme





# Acknowledgements

This paper has been prepared with funding from the International Labour Organization (ILO). Responsibility for its content lies with the author, Tandem Research and publication. It does not constitute an endorsement by the International Labour Office of the opinions expressed in it.

The authors acknowledge and are grateful to all interviewees, members of the Tandem's Technology Foresight Group, and a number of colleagues, and Dr Nomaan Majid, Senior Employment Specialist, ILO DWT New Delhi for their knowledge, insights, and guidance.



# Executive summary

## I. Enquiry

The Fourth Industrial Revolution (4IR), characterized by the convergence of a cluster of technologies cutting across the physical, digital, and biological worlds - machine learning and artificial intelligence, advanced robotics and autonomous transport, cloud computing and the IoTs, among others, is expected to profoundly transform the future of work. Many jobs and ways of working will become redundant while many others will be created anew. Production processes, business models, service delivery mechanisms along with employment relationships and social protection frameworks are likely to be reconfigured. Anxiety about the world of work is not new, but it is claimed that this time around, the speed and spread of technological change will be unprecedented.

Global narratives on the impact of 4IR need to be localized and re-examined. While new technologies will be developed and deployed globally, the impact on the future of work will be mediated through local political, legal and socio-economic structures. This study examines the likely impact of 4IR on the Future of Work in India, with specific focus on job displacement, employment conditions, and labour market inequities.

The Third Industrial Revolution (3IR), linked to the invention of computing, telecommunications, and electronics, is still unfolding in India. Approximately 300 million Indians live without electricity and only 35 per cent of the population has access to the internet. The two distinctive features of India's structural transformation have been disconnect between the gross domestic product (GDP) and employment growth and a shift straight from agriculture to service-led growth, without an expansion in manufacturing. This is reflected in the overwhelming contribution of the services sector to GDP growth (63 per cent) over the last decade, but a significantly smaller share in employment (about 25 per cent) during the same period. Over 80 per cent of the workforce is engaged in the unorganized sector. Fewer than two million jobs are being created annually, even while the number of people joining the workforce exceeds 8 million every year. India is also one of the few countries in the world where women's participation in the labour force is declining. It is therefore imminently clear that the future of work in India will be shaped by the interactions that exist between technological trajectories and such socio-economic trends.

With official labour data largely limited to the organized sector and 4IR still at an emergent stage, this study presents its findings in terms of propositions about the likely impact of 4IR over the next 5-10 years. It would be pertinent to note that propositions are statements of high likelihood and plausibility, not predictions. In so far as the adoption of 4IR tech will be shaped by India's particular socio-economic and political context, it follows that technology trajectories are not a neutral force. The study accordingly emphasizes the socio-political dimensions of technological trajectories and their impact.

It would be important to make a distinction between automation potential and automation adoption. While a high number of tasks might be technically automatable, the adoption of particular technologies will depend on a complex interplay of factors including the cost of labour; levels of education and skilling; legal frameworks for innovation; labour protection policies; availability of supporting infrastructure; and social and cultural norms that shape attitudes towards technological change and innovation.

## II. Propositions

### Automation and Displacement

Advanced automation is already disrupting job futures around the world. Recent studies estimate that India has high automation potential, calculated in terms of the task content of various occupations. In many industrialized economies, 4IR technologies are expected to contribute to a hollowing out of labour markets, as many routine and rule-based jobs that typically involve low to medium skills are automated. Cashiers, receptionists, legal aids, and travel agents are thus most vulnerable to the impact of automation.

In India, however, the bulk of the labour force is engaged in unskilled or low-skilled and low-income jobs within the unorganized sector. The category of low-medium skilled jobs within the organized sector, such as those of a cashier, is still very small. India is thus unlikely to experience a hollowing out of the labour market in terms that may be similar to other industrialized economies. However, these low-medium skill level jobs within the organized sector are what millions within the unorganized sector, particularly youth, aspire toward. As businesses within the organized sector realign to new technological possibilities, a critical pathway for upward labour mobility and income mobility is likely to shrink. This can pose a significant challenge in the Indian context as middle skill jobs have served as a pathway out of poverty.

Adoption of 4IR technologies will be in niches within the organized manufacturing and service sectors, primarily because of the relative cost of labour and infrastructural constraints. Capital intensive manufacturing industries, such as the automobile industry, are more likely to adopt 4IR solutions. Work processes within the service sector, particularly those that involve routine and repetitive tasks, have high automation potential. Adoption rates will be higher in some sectors, such as financial and legal services, and IT services. In some cases, this may result in the creation of newer higher value jobs such as that of a bank teller, which could become redundant, for example, while increasing the value of a financial counsellor. However, the overall impact on employment numbers is likely to be limited, as these industries and services are traditionally not large-scale employers.

Largest employers happen to be from the construction and agriculture sectors wherein they are both likely to experience incremental mechanization rather than advanced automation. The adoption of select 4IR technologies could provide solutions to improve low productivity and output in the agricultural sector, but low growth combined with the decreasing size of land-holdings makes widespread adoption of these technologies unlikely. The relative cost and abundant supply of labour is likely to make the construction sector a slow adopter since many, much older machines are yet to be adopted in the sector.

With most of India's work-force engaged in the unorganized sector, the impact on India's dual economy structure is a crucial concern. Comprised of small enterprises, daily wage and self-employed workers, the unorganized sector lacks the financial capital and necessary skills to support adoption of advanced technologies. Micro-technologies such as those for digital banking, alongside ecosystem upgrades in transport and connectivity services, could however improve labour productivity.

## Employment conditions

Assessing the impact of emerging technologies on the future of work requires an enquiry into not just job displacement but also changing employment conditions. Employment conditions refer to issues such as job security, social protection, and a safe working environment. The question is particularly important in the Indian context where a majority of workers are without a formal employment contract or access to formal social protection mechanisms. In India, it will be important to see how technological advancements influence the movement of workers across the prevailing structure of employment, across the organized and unorganized sectors and across forms of formal and informal employment.

India, along with the United States and China, is expected to lead the platform economy by 2020, creating new economic opportunities for both service and white-collar workers. Industry experts note that digital platforms will enable new forms of micro-entrepreneurship, enabling opportunities for self-directed wage growth and financial planning along with flexible working arrangements. Platforms will also enable women to avail new employment opportunities, circumventing barriers of physical mobility and domestic commitments. Platforms could potentially be beneficial for migrant workers, who may not have strong social networks in their new place of residence.

However, leveraging these opportunities will require workers to have technical skills along with entrepreneurial and soft skills. The platform economy is also likely to create more precarious work conditions than formal employment, in terms of job security and social protection. While these concerns about the platform economy have been voiced in industrialized economies as well, they are particularly significant in the context of the bulk of India's labour force being unskilled or low-skilled and weak state sponsored social security systems.

Of particular significance in India is the growth in digital platforms targeted at service workers, many of whom fall under the purview of informal employment, such as drivers, plumbers, and delivery men, among others. This trend is likely to accelerate, particularly as urban consumers get increasingly accustomed to an on-demand economy. Gig-work or piece-work, however, is not new to India. Most workers already work multiple jobs for multiple employers and lack access to formal social protection mechanisms. In this sense, the platform economy can be seen as reproducing informality in India. Employment conditions for these workers may improve, but this will be reflective mostly of poor employment conditions in the unorganized sector. Yet, the platform economy does offer a degree of formalization to many service workers through, for example, access to the formal banking system or opportunities for training. In other words, growth of the platform economy offers an opportunity to rearrange informality. Moreover, this potential can be harnessed to facilitate the delivery of social protection mechanisms, skilling and other opportunities.

A rapidly changing technological landscape will make skilling and labour demands unpredictable and variable. This is likely to increase the preference for hiring contractual rather than permanent labour. There is already a clear increase in the hiring of contractual workers, across organized manufacturing and government services. Contractual labour is cheaper and does not incur any extra costs (insurance, social benefits etc), keeping employer obligations to a minimum. It follows that employment conditions for contract work are likely to be worse than for regular employees.

Emerging technologies will create new opportunities for entrepreneurial ventures, whether by enabling more efficient access to suppliers and markets through the platform economy or enabling new opportunities for dispersed manufacturing and remote working. A shift from wage employment

to self-employment can accordingly be expected. The start-up ecosystem will be profitable primarily to those who have access to financial and social capital along with the necessary skills to leverage 4IR technologies. For many others however, self-employment will be associated with a loss of social protection and income guarantee. It is important to note that a large part of the workforce in the unorganized sector is already self-employed, not out of choice, but because of the lack of meaningful job opportunities.

## **Labour market inequities**

Labour mobility and welfare is as much a social question as it an economic one. Access to gainful employment for women and marginalized groups is hindered by both a lack of suitable work opportunities and prevailing socio-cultural norms that restrict access to education and employment. Current technology and work trajectories are likely to further entrench labour market inequities along gender, caste, class, and religious lines.

Women have relatively limited access to technology gains, with less than 30 per cent of India's internet users being women. Lower levels of education and skilling combined with socio-cultural norms inhibit their capacity to leverage new digital opportunities. The platform economy will create new economic opportunities for women, allowing them to circumvent barriers of physical mobility and domestic responsibilities. At the same time, compared to formal employment, the platform economy could also increase vulnerability of women while reproducing the gendered division of labour.

The marginalization of certain communities is likely to become more entrenched due to technological skill-bias. Digital access and fluency are rapidly becoming essential for approaching a variety of public goods and services, including suitable work opportunities. Low levels of education among marginalized social groups will limit their capacity to access technology gains and adapt to technology-led disruptions with respect to the future of work.

## **III. Policy pathways**

Emerging technologies will undoubtedly disrupt labour markets in India. These impacts, however, will be felt in niches. The broad structure of Indian labour markets is unlikely to change in any significant way in the next decade. Net employment numbers will not be drastically transformed as a result of 4IR technologies, though businesses and workers will nonetheless have to adapt existing processes and competencies. While large-scale displacement is unlikely to occur in the coming decade, opportunities for decent work will continue to be limited. Cyber security, data analysis and cloud computing are expected to be some of emerging, highly specialized areas of work, but these opportunities will only be available to those with requisite skills. Entrepreneurship may not be a feasible option for many, particularly those without a financial and social support system. Technology trends will perpetuate and even aggravate the macro trends around informalization, multiple forms of labour inequity and service-led growth that are already underway. The political and social consequences of having a workforce that is young and aspirational but unable to move across the fissures that separate the informal from the formal, urban from the rural, manual from the mechanized, and high-caste from low-caste work, are likely to be serious.

A relevant question would be to see what kind of strategies can help shape how emerging technologies play out in the complex socio-economic and cultural context of work in India. Ways of shaping and coping with the impact of emerging technologies can broadly be organized around four sets or portfolios of strategies, namely, labour protection, redistribution of technology gains, coping and adapting, and shaping technological trajectories.

### **Labour protection strategies**

With the rise in contractual work and self-employment, there is a need to find new avenues for the delivery of social protection mechanisms and to strengthen working conditions in non-standard jobs. Policy measures will be needed to improve working conditions across the employment structure, including access to formal social protection mechanisms, facilitating collective bargaining opportunities for workers and smoothening labour market transitions and care support. Digital technologies can potentially offer workers a virtual space for information sharing and grievance redressal. Organization and standardization through the platform economy can be instrumental in establishing social protection mechanisms and collective bargaining opportunities.

### **Redistributive strategies**

Technology gains can be redirected at the state level, through universal social security and basic income provisions. A robot tax, levied on companies that use robots, or the provision of labour subsidies, encouraging businesses to increase their hiring, are a few possible redistributive measures available to the state. Other alternatives could include providing labour subsidies, rather than capital subsidies, which can be used to skill the workforce, or a redistribution of existing jobs by reducing the hours worked per worker.

### **Coping strategies**

India's existing labour force and demographic dividend is woefully underprepared and under-skilled for work within the 4IR landscape. Though it will be hard to re-skill the present-day average worker (above 45 years of age), skilling initiatives can support the youth in working towards gainful employment. Particularly, digital skills, humanistic and interpersonal skills (especially relevant in the service sector) along with learnability (ability to adapt through lifelong learning and acquiring of new skills), will be central to accessing decent work opportunities.

### **Technology strategies**

These include strategies to manage and regulate technologies by incentivizing and incubating certain technologies while regulating, limiting or jettisoning others. Innovation left to market forces alone will not be adequate in leveraging emerging technologies for development solutions suited to the Indian context. Technology, research and development policies can be used to drive technological trajectories, to develop applications of emerging technologies for the bottom of the pyramid and to incubate technologies for employment generation in new sectors.

These strategies will need to be deployed simultaneously and iteratively, for a comprehensive yet proactive response, to leverage 4IR for decent work in India.



# 1. Introduction

Anxiety about the impact of technology on the world of work is not new. Since the beginning of the Industrial Revolution in the 18th century, the question of how technology shapes work and labour and, in turn, how society should shape technology through technological choices and policies, has fuelled intense public debate. In England, textile workers known as Luddites destroyed and smashed automated looms, concerned that they would lose their jobs. While jobs in mass manufacturing and new industries, such as coal, iron and steel were subsequently created, the Luddites did lose work.

In the middle of the 20th century, the 3IR, linked to the invention of computing, telecommunication and electronics, vastly improved our ability to process and communicate information.<sup>1</sup> Building on these advancements, we are now at the cusp of the so-called (4IR), underpinned by the convergence of technologies cutting across the physical, digital and biological worlds where there is machine learning and artificial intelligence, advanced robotics and autonomous transport, cloud computing and the Internet of Things (IoT), among others. These technologies are expected to profoundly transform the world of work. It is claimed that this time around, the speed and spread of technological change will be dramatic and unprecedented. The technologization of society will be ubiquitous, reconfiguring not just work but also underlying social, economic and political systems.

The notion of ‘creative destruction’ articulated in the Schumpeter Formula<sup>2</sup> is often used in the dominant discourse on the impact of technological change on employment. The argument is that markets evolve through technological disruptions. In other words, this happens when destruction of some jobs is compensated by the creation of new employment opportunities. Suggesting a ‘churn’, economists argue that emerging technologies will erode certain jobs but also create new ones in their place. Public anxiety about robots taking over human operations, they argue, is based on a faulty assumption that the amount of work is fixed in any given economy.

Be that as it may, ‘churning’ in the world of work will create both winners and losers. Sociologists of technology argue that it reflects dominant social interests wherein technologies are often shaped in ways that serve and reinforce existing power structures and hierarchies rather than disrupting them. (*Law J, 2017*). Technological trajectories can reproduce social inequities such as technologies of the pre-computer print trade which it was argued had reproduced both class and gender interests.

Moreover, globally, there are indications that many new technologies are replacing labour rather than improving productivity. Robert Solow famously remarked that we see computers everywhere but productivity statistics (*Robert, 1987*). In fact, labour productivity growth has not been significant since the 1960s, even more so after 1990, despite the spread of digital technologies in India and abroad (*The Wire, 2017*).

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<sup>1</sup> First Industrial Revolution began in England in early 18th century with improved steam power and mechanized production. Factories with assembly lines emerged and under colonial influence, Industrial Revolution in Europe turned India into a source of raw materials/market while ensuring destruction of its artisanal systems of production and agricultural practices. Second Industrial Revolution began in Western Europe and North America in late 19th century. Growth of factories was followed by dramatic expansion of transportation and communication with application of internal combustion engine, flight, electricity, telegraph and telephone.

<sup>2</sup> Noted economist Joseph Schumpeter observed that innovation and technology works through a process of ‘creative destruction’ by shifting economic structures internally and displacing ‘old’ market forms with new ones. It follows that technological disruptions destroy traditional jobs, they create new ones.

The Future of Work has been a topic of conversation among policy makers and other stakeholders in industrialized economies for the past decade. A series of influential books, which happen to be New York Times bestsellers, have precipitated wider public discourse in both developed and emerging economies. In his book *The Fourth Industrial Revolution*, Klaus Schwab, the founder and chairman of the World Economic Forum, announced, ‘We are on the brink of the Fourth Industrial Revolution. And this one will be unlike any other in human history.’ In *The second machine age*, MIT professors Erik Brynjolfsson and Andrew McAfee dwell on ‘work, progress and prosperity in a time of brilliant technologies.’ Martin Ford, in *The rise of the robots*, talks about ‘technology and the threat of mass unemployment.’ Similarly, in his book *Superintelligence*, Nick Bostrom speaks of the ‘paths and dangers’ of super artificial intelligence and the challenge of ‘control.’

None of these efforts explicitly deal with the question of how these technological trajectories or their social impacts will be unique or different in emerging economies. While analysts in India are engaging with global narratives there is paucity of research and evidence focused on the specificities of the Indian context.<sup>3</sup> What is likely to be the fate of 4IR in India? Undoubtedly, global narratives will need to be localized and re-examined. While the disruptive impact of technology on the future of work will be experienced globally, the exact nature of the impact will be mediated through local political, legal and socioeconomic structures.

The 3IR digital revolution is still unfolding in India, as it is in many others parts of the world. Here, the poor have limited access to electricity, let alone high speed Internet. Approximately 300 million Indians live without power while only 25 per cent have access to the internet.<sup>4</sup> There is an urgent need for indepth sectoral analysis within the country to understand the impact of technology on the future of work and to develop context-specific policy responses.

Decent work is a key policy objective, as highlighted in Goal 8 of the 2030 Sustainable Development Agenda. The ILO defines ‘Decent work’ as ‘opportunities for work that are productive and which deliver a fair income, security in the workplace and social protection for families. It comes with better prospects for personal development and social integration, freedom for people to express their concerns, organize and participate in decisions that affect their lives and equality of opportunity and treatment for all women and men.’<sup>5</sup>

## 1.1 Future of work in India: Enquiry and method

How will technology transform job futures and ways of working in the next five to ten years is a key question that job analysts are trying to find answers to. Will technology aggravate or ameliorate persistent inequities and the different forms of marginalization in the labour markets? What is likely to be the impact of technological change in employment opportunities for different social groups?

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<sup>3</sup> Notable exceptions include Vigneswara, I’s “Automation and workforce in India: Terrible consequences or impossible?,” as part of the publication *Future of Work in the Global South*, and Pankaj Vashisht’s (ICRIER) sector-specific working paper on “Destruction or polarization: Estimating the impact of technology on Indian manufacturing”. Global consultancy firms have conducted studies on the impact of automation on employment, globally and in India. They include “India: Growth and jobs in the new globalization” by Boston Consultancy Group and Confederation of Indian Industry; McKinsey Global Institute’s “A future that works: Automation, employment and productivity” and “Jobs lost, jobs gained: Workforce transitions in a time of automation”; along with World Bank’s recent working draft, “The changing nature of work”, as part of the *2019 World Development Report*.

<sup>4</sup> World Bank. 2017. “Access to electricity,” Available online at [www.worldbank.org](http://www.worldbank.org). [accessed 15 May 2018].

<sup>5</sup> ILO. 2017. “Decent work”.

Technology trajectories will be mediated through (and shaped by) socioeconomic contexts, producing unique and diverse challenges and possibilities. The story in India is unlikely to follow the script written in industrialized economies.

While the future of work will be shaped by the complex interplay of a number of factors, this study interrogates the impact of emerging technologies on the future of work in India, with a specific focus on automation and job displacement, employment conditions (including labour welfare and social protection), and various forms of inequities in labour markets. The paper also identifies and unpacks new opportunities that can be leveraged through emerging technologies that range from new mechanisms for social protection to the organization of the informal sector. The objective is to generate a set of strategies to steer the impact of 4IR technologies towards socially beneficial and economically equitable outcomes. What are the prospects of providing decent work in India, as it copes with the disruptive effects of technological change, and seizes new opportunities?

The report is organized into five sections. Section 1 presents the problem context, research questions, methods of enquiry and background information on both the structure of labour markets and 4IR technologies in India. Sections 2, 3 and 4 present the propositions related to automation and displacement, employment conditions, and labour market inequities, respectively. Section 5 focuses on strategies for coping with the consequences of emerging technologies on the world of work.

There is a paucity of data, empirical observations and analysis of how these trajectories will play out in India. Existing evidence tends to be anecdotal or relies on macro analysis that uses patchy employment and economic data to generate broad estimates of displacement and identify major trends (*Ghose, 2016*). Moreover, many changes related to 4IR are emergent and have not yet unfolded.

The approach adopted in this study emphasizes the social dimensions of technology. The social choice or shaping of technology is central to its evolution. Multidisciplinary framing that combines insights from sociology and economics is, therefore, critical. The data from different National Sample Survey (NSS) rounds and the Annual Survey of Industries (ASI), along with the Indian Employment Report, is used as a basis for assessing job displacement. (*Ghose, 2016*). Data on the impact of technology is sparse, largely because the effect of these systems is yet to be seen. In addition, the available survey data is not designed to assess the wellbeing of the workforce or the extent of change in the quality of work.

For a more comprehensive and ‘social’ view of the impact of technological change, a two-step process of qualitative enquiry was followed. A Technology Foresight Group (TFG), comprised of stakeholders from the domains of policy-making, industry, and civil society, as well as a community of domain experts, that was convened to guide the study. A policy laboratory with the TFG was assembled to identify sectors, enterprises and industries linked to the three themes of automation and jobs, employment conditions, and labour market inequities. Next, semi-structured, in-depth qualitative interviews were conducted with key informants across industry, academia and civil society. Purposeful sampling was used to identify these informants, all individuals in positions of authority, business leaders and recognized experts.

Much of the likely impacts of technologies associated with 4IR are still unfolding and cannot be examined as traditional case studies. Rather, foresight and anticipatory knowledge was developed by weaving together available macro-economic data and existing evidence of digital adoption and impact trends with expert judgments solicited through the TFG and key informant interviews. These insights have been presented in the form of ‘propositions’ about the likely impact of technologies on labour.

The propositions speak to expected changes over the next five to ten years; limited data on current labour trends and conditions, combined with the complex interplay of factors involved, restricts possibilities for more long-term analysis. Propositions are not predictions, rather they are reflective of plausibility, likelihood and expected scenarios.

## 1.2 Growth and employment in a dual economy

The two distinctive features of India's structural transformation have been a disconnect between gross domestic product (GDP) and employment growth and a shift from agriculture to service-led growth, without an expansion in manufacturing. This is reflected in the overwhelming contribution of the services sector to GDP growth (63 per cent) over the last decade, but a significantly smaller share in employment (about 25 per cent) during the same period. Growth has been capital rather than labour intensive (*Ghose 2016*).

Further, data from India's Labour Bureau suggests that fewer than two million jobs are being created annually, a seemingly dire situation in a country where the working age population grows by some 16 million every year. The rate of labour force participation among women is amongst the lowest in the world and has been declining since 2004-05. Participation rates are also lower in urban areas among educated women, indicating a lack of meaningful work opportunities (*The Wire, 2017*). Average wages for urban workers are significantly higher than those of rural workers as rural wage growth has stagnated (*Business Today, 2015*).

However, employment numbers do not tell the entire story in a dual economy like India's, where unemployment can be said to reflect 'queuing for good jobs in the organized sector by educated youth from relatively well-off households' (*Ghose, 2016*). Over 80 per cent of the work-force is engaged in the unorganized sector<sup>6</sup> and more than 90 per cent is in informal employment. There are significant disparities in employment conditions between urban and rural workers. The National Sample Survey (NSS) data from 2011-12 reveals that of all non- agriculture labour, nearly 75 per cent of rural workers are engaged in the unorganized sector and 85 per cent have no job contract. Additionally, while 69 per cent urban workers are occupied in the unorganized sector, 73 per cent are without a job contract (*The Hindu, 2017*). Majority of workers in India have to work to survive, even though it may generate an income that is below subsistence level. The unorganized sector contributes almost 50 per cent of the national income. Small and medium enterprises contribute an estimated 8-9 per cent of GDP, providing employment to a vast majority of the workforce in the informal economy while representing more than 60 million jobs (*ILO, 2015*).

Wage growth also does not indicate a tightening of the labour markets as the total supply of labour far exceeds jobs that are available in the organized sector. Even within the organized sector, 68 per cent of workers do not have a written contract and 57 per cent do not have access to any formal social security benefits (*Centre for Equity Studies, 2016*). Considerations of employment conditions must therefore accompany assessments of employment growth. Recent studies show that there has been a notable increase in contractual employment within the organized sector and that the slowest growth has been with respect to regular formal employment.<sup>7</sup> These trends suggest a deterioration of employment conditions in terms of access to social protection and job security.

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<sup>6</sup> Referred to as 'informal sector' comprising of all unincorporated private enterprises owned by individuals or households engaged in sale and production of goods and services operated on proprietary or partnership basis and with less than 10 total workers.

Education is a key determinant of lifelong access to decent work. The education system is geared towards higher education that is by far most easily accessible to the elite. Moreover, despite increasing rates of enrolment in schools, results on learning outcomes have been dismal. (Pratham, 2016). Skilling, through programmes such as the Skill India Initiative, can be helpful, but cannot be a substitute for education itself (Scroll, 2017). The Skill Certification and Reward Scheme, facilitating youth training and employment, trained over 18 lakh individuals in 2015. However, only 12.4 per cent or 2.23 lakh trainees got actually placed in jobs (Ministry of Skill Development and Entrepreneurship, 2016). Every year up to eight million youth are expected to enter the labour force in the country, although on an average only 30 per cent of these are highly skilled while the remaining have low or medium levels of skills (Ghose, 2016).

### 1.3 Innovation and adoption: The state of 4IR in India

What will be the fate of 4IR in the country? In India, public sector research and development of AI is spearheaded by the Centre for Artificial Intelligence and Robotics (CAIR) at the Defence Research and Development Organization (DRDO) and the Indian Institutes of Technology (IIT). The AI research and deployment within the private sector is led by Infosys, one of India's largest IT companies. Intel, an American multinational corporation and technology company, has also committed to training 15,000 engineers in the sphere of machine learning in the country (Hindu Business Line, 2017). Large companies such as e-commerce giant Flipkart and taxi aggregator Ola, along with a number of other start-ups, are beginning to use machine learning-based applications. Conversations around AI in India are at a nascent stage, including in the government. In early 2018, the government announced that Niti Aayog, the government's policy think tank, will spearhead a national programme on AI research (Livemint, 2018). It is likely that both government and industry, particularly in the start-up space, are likely to significantly increase investments in 4IR over the next decade.

Simple industrial robots have been in use for a few decades, particularly in the automotive industries. The new generation of robots powered by machine learning will be more agile, dexterous and cognitive. The size of the industrial robotics market in India is still very small with about 11,800 operational robots in the year 2014 (Roehricht, 2016). In comparison, industrial robot sales in China reached 68,600 in 2015, a large share of which were domestically produced. China is expected to become the leading manufacturers and supplier of low-cost robots by 2025 (Asian Robotics Review, 2017). The automotive industry leads in the use of industrial robotics, with 58 robots per 10,000 workers in 2014 (Roehricht, 2016). Established automobile manufacturers are increasingly employing robotics as a substitute for manual labour (Scroll, 2017).

#### **Box 1** **Robotics and cognitive automation**

Class 1: Basic Process Automation addresses transactional work activities that are rule-based and primarily repetitive.

Class 2: Enhance Process Automation enables the recognition of unstructured data and aids in adapting to the business environment.

Class 3: Cognitive Automation enables decision support with the help of advanced decision algorithms. The evolution of these tools are generally interlinked with machine learning, natural language processing, and big data analytics.

Source: KPMG, 2017

In India, usage and implementation of 3D printing is maturing with indigenous manufacturers selling 3D printers locally. The 3D printing as a service is most popular, especially with automobile manufacturers, such as Nissan and Renault (The News Minute, 2017). However, large-scale deployment requires software sophistication and awareness around the technology, both of which are currently lacking in India (FactorDaily, 2017). Government reports state that the Indian IoT service sector already owns about 40 per cent of the global market through companies like the Tata Consultancy

Services (TCS), Wipro, Infosys and other major IT and Business Process Outsourcing (BPO) companies (*J Group Robotics, 2018*). The processing of large amounts of data with cloud computing underlies and fuels these technologies. Companies such as Microsoft and Sales Force are setting up data centres in India with local companies such as Airtel and Tata, thereby increasing cloud computing capacities. The cloud computing industry is expected to generate approximately 10 billion USD in 2020, up from 2 billion in 2015 (*Forbes India, 2017*).

However, the adoption of 4IR technologies will not be contingent on technological feasibility alone. Rather, technological adoption will depend on a complex interplay of factors including labour market dynamics and the relative cost of labour; relevant education and skilling to operate and leverage 4IR; legal frameworks for innovation and labour protection; availability of supporting infrastructure; and social and cultural norms that shape attitudes towards technological change and innovation.

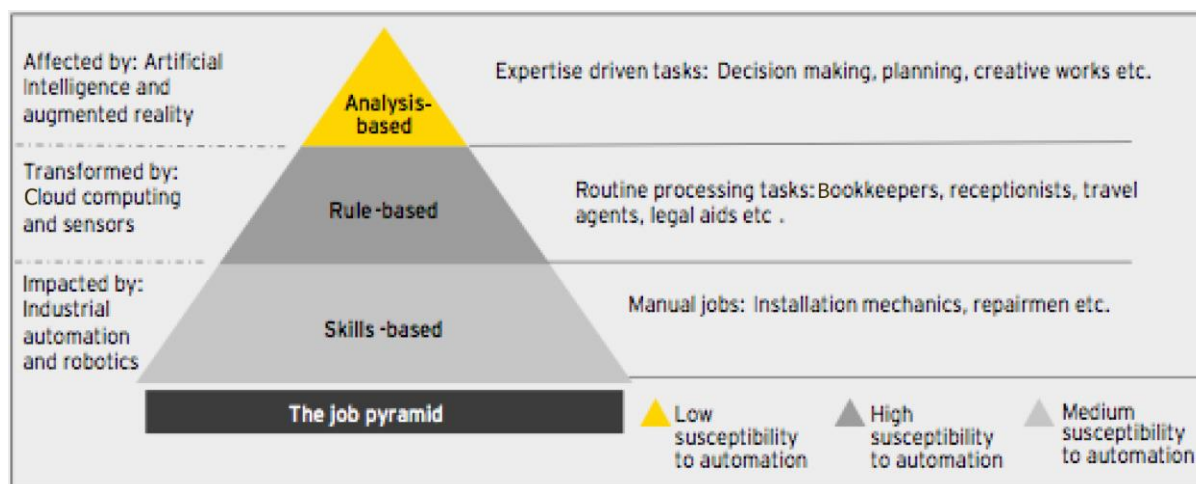
For instance, India is yet to articulate a legal framework for data protection. Indian start-ups are already facing challenges in realigning their businesses to accommodate new European Union regulations for privacy (*Livemint, 2018*). Moreover, the ecosystem and basic infrastructure required for Industry 4.0 technologies is weak in India, whether in terms of stable electricity and water supply or digital connectivity. An overwhelming majority of the informants interviewed for the study were of the view that these technologies were unlikely to proliferate in the next five years or so and that it would take another 10 years, if not more, for them to move out of niche applications and begin to have systemic significance. Without broader ecosystem updates, systemic impact will be limited and fragmented. Much of the disruption will be caused by a wider spread of digital technologies from the previous industrial revolution.

## **2. Automation and job displacement**

Advanced automation is already disrupting job futures across the globe. In India, however, many industries still have limited access to power and other basic infrastructure and a large portion of manufacturing and services are concentrated in small and medium enterprises. In this context, it is particularly important to make a distinction between automation potential and automation adoption. While a large number of tasks might increasingly be technically automatable, their adoption will depend on a wider range of socio-economic factors, including relative cost of labour and availability of skilled labour. Therefore, adoption of advanced robotics and related technologies over the next decade will be in specific niches and job displacement will thus be concentrated in specific industries and work processes.

## 2.1 High automation potential of routine tasks will reduce labour mobility

**Figure 1**  
Future of jobs and its implications on Indian higher education



Source: The Federation of Indian Chambers of Commerce and Industry, November, 2016

Occupations and jobs are made up of numerous tasks, each of which requires a combination of specific competencies and skills. Automation potential must be assessed accordingly, i.e. in terms of technical feasibility of automating certain kinds of tasks.<sup>8</sup> The ease and scope of automating routine and rule-based tasks, both manual and cognitive, will increase rapidly with 4IR technologies. It will continue to be difficult to automate non-routine tasks, as in cognitive tasks that require intuition and judgment and manual tasks electing variable responses and/or in unpredictable environments.

Recent studies estimate automation potential in India ranging between 52 and 62 per cent, based on the task content of various occupations (*McKinsey & Company, 2017*). The impact of automation on jobs could be even greater if considered in terms of skill levels. The NSSO data reveals that less than 20 per cent of the population is engaged in high-skill occupations that typically require advanced analytical skills and are thus less vulnerable to the impacts of automation (*Social Science Research Network, 2017*).

In many industrialized economies, 4IR technologies are expected to contribute to a further hollowing out of the labour market, as many routine and rule-based jobs that typically involving low to medium skills get automated. Cashiers, receptionists, legal aids, and travel agents are thus most vulnerable to the impact of automation (*Mark Muro and Jacob Whiton, 2017*). In India, however, bulk of the labour force is engaged in unskilled or low-skilled, low-income jobs, within the unorganized sector. The category of low-medium skilled jobs within the organized sector, such as those of a cashier, is still very small. India is thus unlikely to experience a hollowing out of the labour market in terms that could be similar to other industrialized economies. However, these low-medium skilled level jobs within the organized sector are what millions within the unorganized sector, particularly youth, aspire

<sup>8</sup> Carl Benedikt Frey, economist, and Martin Osborne categorized different tasks on the basis of their difficulties for automation in a 2013 study “The future of employment: How susceptible are jobs to computerisation?”. A recent report, “A future that works”, by *McKinsey Global Institute* assesses automation potential on basis of a set of capability requirements across sensory perception, cognitive capabilities, natural language processing, social and emotional capabilities, and physical capabilities.



towards. As businesses within the organized sector realign to new technological possibilities, a critical pathway for upward labour mobility and income mobility is likely to shrink. This can pose a significant challenge in the Indian context as middle-skilled jobs have typically been the pathway out of poverty.

This trend is already observable in the organized manufacturing sector. The share of high-skilled occupations such as managers, professionals and associates in total manufacturing employment has increased by more than three percentage points, while the share of machine operators, clerks and craft-related occupations, which fall under the middle-skilled category, has come down from 76.5 per cent in 1993-94 to 70.2 per cent in 2011-12. Their wage share, too, has come down from 70 per cent in 1993-94 to 59.4 per cent in 2011-12 (*Vashisht P, 2017*). This reflects the diminishing size of mid-level jobs in organized manufacturing. Similarly, the IT sector has offered an aspirational career path for many of India's youth. In 2016, almost 40 per cent of New Delhi's youth population (between 14-18 age group), aspired to become software engineers (*The Economic Times, 2017*). Many of these software jobs in the IT industry have high automation potential and job availability is likely to stagnate, if not reduce, in the years to come. The automation of middle skilled jobs in the organized sector is thus likely to impact the mobility of low-skilled labour to higher income and skilled jobs.

## 2.2 Automation adoption in organized manufacturing and services in niches

The manufacturing sector has high automation potential with a recent study estimating that 69 per cent of tasks within organized manufacturing in India have the potential to be automated (*World Bank Group Foresight Report, 2016*). Automation adoption, however will be shaped by the cost of technological upgradation and the relative cost of labour, amongst other variables. Representatives within the field are of the view that for many existing factories, the cost of switching to new machines is likely to be expensive and thus, this shift will be gradual.<sup>9</sup> Manufacturing wages adjusted for productivity stand at an average of \$5.25, which is substantially less than the cost of robots (*Sirkin, Harold L et al. 2015*). It is in this context that a recent study has categorized India as a 'slow adopter' (*Deccan Chronicle, 2017*). In addition, the manufacturing sector is increasingly hiring contractual rather than permanent workers, mostly at half the wage (*Kapoor R, 2016*).

The cost of adoption could reduce if India becomes a manufacturer of advanced robotics. The government is in the process of formulating a National Policy for Advanced Manufacturing, aimed at increasing technological depth for global competitiveness, but this is yet to culminate in a set of policy directives or industry guidelines (*The Economic Times, 2016*). The few existing private sector initiatives include TAL Manufacturing Solution, a subsidiary of auto major Tata Motors (*Deccan Herald, 2017*) and warehousing and logistics start-up Gray Orange, which manufactures and supplies robots to retail giants Flipkart and Pepperfry (*Livemint, 2014*).

### Box 2

"Rising labour costs of permanent workers and labour demands for better working conditions has accelerated the shift to automation. This is both easier to manage and does not require the company to think of any benefits or protection."

Employee and Union Member, of a leading car manufacturer

<sup>9</sup> Financial consulting services expert. 2017 in a telephonic interview.



Within the manufacturing sector, capital-intensive manufacturing industries are more likely to adopt advanced automation and robotic s. Industry 4.0 technologies are likely to lead to further deepening of capital, productivity improvements and labour replacement. This trend is already observable in the automobile sector, which is estimated to buy 60 per cent of all industrial robots sold in India (*ET Auto. 2015*). Nearly, 550 robots are at work in the Ford plant, 400 at Hyundai, and another 4200 in the factories of Honda and Suzuki (*Robotics Business Review, 2015*).

Across various production units (i.e., weld and paint shop) in automobile manufacturing plants, the labour force has shrunk from 32 to 4 people. High adoption is partly because of the high number of routine tasks for welding, polishing and painting. This trend is expected to grow, providing further incentive for manufacturers to move toward the contractualization of labour.<sup>10</sup> It is important to note that even while the automobile industry is capital-intensive, it has seen the highest growth in employment within the manufacturing sector over the last decade. As the adoption of advanced robotics accelerates, employment within the sector will be negatively impacted.

Labour-intensive industries such as textile, apparel, leather and footwear, and paper manufacturers are unlikely to be rapid or large-scale adopters of Industry 4.0 technologies. Materials such as textile, paper, wood and leather require higher levels of dexterity. Even if routine tasks become automatable, this will require high capital investments making it unlikely because of slow growth across the aforementioned labour intensive industries. Certain work processes are, however, experiencing increasing automation, though at present these seem to build on earlier technological advances rather than Industry 4.0 technologies in particular. In the textile and apparel sectors, for example, the spinning, auto-comer and auto-splicer divisions have replaced a job of 20 workers with two workers. As a result of such ongoing and incremental automation, the textile business is expected to create only 29 lakh jobs compared to the government's target of one crore (*The Hindu, 2016*). Industry leaders are more likely to adopt advanced robotics. Leading textile house, Raymond, for example has announced that it will replace 10,000 of its 33,000 work-force with robots in the next three years (*The Economic Times, 2016*).

Post the 2009 global recession, outsourcing and offshoring functions have experienced a slowdown. While various manufacturing plants in China are re-shoring due to increasing wages of Chinese labour and declining costs of automating routine work processes, India is unlikely to face this challenge as yet as Indian labour costs remain low. Existing businesses are unlikely to transform their production processes to use 4IR because of the high costs associated with switching over and the abundant supply of low cost labour. In many cases, re-shoring certain business processes will be more cost-effective than adopting advanced automation in Indian plants.

The services end of the manufacturing sector will experience technological transformation more rapidly. Information

### Box 3

"The little automation we have experienced is largely concentrated in logistics and warehousing. An end-to-end backend processing software has been adopted, but this has been primarily productivity enhancing rather than labour replacing. We expect these technologies will result in displacement of 10 per cent of our work-force in the next 5-10 years. Robotics will take 10-15 years to be adopted in India, if not longer.

CEO of a large export-oriented apparel manufacturing company with 25,000 permanent employees.

### Box 4

Digital marketing firms increasingly claim to offer algorithm-based 'marketing automation technologies' to position themselves as leaders in digital space. Digital analysts in some of these firms however tell a different story. "The tech-team is still working on these 'automation technologies.' Our marketing team, which consists of 10 digital marketing analysts, mostly work on the back-end data analysis that is supposed to be already automated. Chances are that within the next couple of years, most of the advanced marketing processes will be automated. But, the job displacement this could potentially create will be harder to measure, as their work has already been rendered invisible."

Digital marketing startup employee

<sup>10</sup> Industry informant and automobile manufacturer union member. 2017 in a telephonic interview.

systems, accounting and human resources, and logistics, transport and warehousing are all sectors that will leverage data analytics and IoT technologies. Industry experts note the growing interest among large manufacturing units in leveraging Industry 4.0 technologies for factory floor management, safety and security, and environmental management.<sup>11</sup>

Certain work processes within the services sector are also likely to be impacted, particularly those that involve routine and repetitive tasks such as processing transactions or other tasks involving large amounts of data.

However, many tasks and operations in the services sector rely on ‘affective labour’ i.e. labour that is geared towards producing feelings of satisfaction, contentment and reassurance. Such labour necessarily requires emotional, social, and interpersonal skills that are particularly relevant in sectors such as education, health and the care economy. These sectors will continue to rely on human inputs and can provide a potential avenue for job creation. In other words, the job of a bank teller or risk analyst might become increasingly redundant but that of a financial adviser could become increasingly valuable.

Automation potential within services is a double-edged sword. On the one hand, it will create new economic opportunities for data-driven businesses and on the other hand, these opportunities are likely to be seized and maximized by large and well-established players in the retail space or new capital-backed start-ups. These will potentially displace numerous other small and medium enterprises and individual micro-entrepreneurs.

The retail space provides an instructive example. Estimates indicate that with the rapid growth of the e-commerce sector (from USD 23 billion in 2016 to 68.8 million by 2020), employment in ‘e-tail’ (retail for e-commerce) and allied industries (warehousing, transport etc.) is expected to create 1.45 million jobs by 2021 (*Vellody, et al. 2015*). Yet, this is already displacing many small to medium retail enterprises and the shop floor salespeople they employ. New jobs will be created in the e-retail space but not necessarily for those who have been displaced. Jobs could also dwindle over a period of time as processes are increasingly automated such as the growing use of customer-service chats bots which is a pertinent example. The bulk of advertising and promotion will rely on data analysis and social media platforms, tasks that are vulnerable to algorithmic automation and cloud computing solutions. Importantly, the new jobs being created will require a different set of skills from the jobs displaced.

The impact of emerging technologies is already visible in the BPO and IT industries. Over the past two decades, India has established itself as a leading location for offshoring operations, currently employing 3.9 million people (*NASSCOM, 2017*). The application of machine learning and cloud computing technologies will contribute to job displacement as routine and backend tasks are

**Box 5**  
**Differing views on IT sector lay-offs & future prospects**

The National Association of Software and Service Companies (NASSCOM) recognizes that job losses in the IT sector are likely, but argues that this will be offset by creation of multiple, new and more productive opportunities. Many current lay-offs have been a result of poor performance.

IT union representatives argue that current lay-offs reflect a slow-down in the industry at a global level rather than tech-led job displacement. Contractualization of labour can be expected to continue. With rapid technological change disincentives, hiring of permanent staff while easing employee management being a case in point.

Industry leaders see a new opportunity in re-orienting IT and BPO sectors towards delivery of knowledge-based solutions, repositioning India from a back-end service provider to leader in data-driven product solutions.

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<sup>11</sup> Organized manufacturing sector worker. 2017 in a telephonic interview.

increasingly automated. Industry experts are optimistic that the sector will revamp itself, transforming from a backend service provider to a product-based solution industry, leveraging big data and machine learning for data-driven solutions. However, this shift is likely to be technology driven and unlikely to create widespread employment opportunities.<sup>12</sup>

The Hfs Future Workforce Impact Model (dividing workers into three categories based on skill levels, whether low, medium or high) indicates that 640,000 low-skilled service jobs in the IT sector are at risk to automation while only 160,000 mid to high-skilled positions will be created in the Indian IT and BPO service sector.<sup>13</sup> Out of all the main countries offering IT services (i.e. the Philippines, the US the UK, and India) India is expected to suffer the greatest negative impact with a 14 per cent decline in the workforce by 2021(*HFS Research, 2016*). Key informants from the industry note a significant slowdown in hiring, a trend that is expected to continue, if not accelerate. While IT sector workers will need to rapidly up-skill, fewer jobs will be created in the medium-long run.<sup>14</sup>

The financial sector, particularly private sector banks, is increasingly adopting Robotic Process Automation technologies. Financial analysis services especially in terms of trade, investments and risk assessment follow an internal pattern and logic that lends itself to algorithmic and robotic process automation. Industry informants are quick to point out that algorithms have been in place in trading processes for the past decade and they continue to be developed.<sup>15</sup> At the customer services end, there is already widespread use of chatbots and Internet banking. In the case of the former, leading private bank HDFC's AI chatbot has reportedly boosted transactions by 160 per cent (*Financial Express, 2017*). In addition, in 2015-16, the share of mobile and internet transactions went up to 71 per cent in FY '16 from 63 per cent in FY '15, as a share of total transactions (*Moneycontrol, 2016*). As banks become digitally enabled, the relationship manager will be required to assist customers with online banking transactions, essentially paving the way for their own replacement.

**Box 6**  
**Leveraging 4IR for logistics & warehousing: Startup**

"New logistics and warehousing startups are looking to leverage AI for inventory management and order fulfillment. New technological applications could overcome inefficiencies and delays in India's supply chain. As warehousing gets aggregated and centralized, robotic solutions will become economically more viable. These technologies will displace unskilled manual labour that is currently used for loading and unloading and organizing warehouses."

Industry representative

Yet financial services are also fundamentally about trust. Human intervention will thus be required alongside algorithmic processes. As an industry informant noted, 'Customers enjoy using chatbots and other digital facilities for basic, non-risky transactions. But when it comes to investing money, they are unlikely to trust robots since the robot will be unable to calm their fears.'<sup>16</sup> Human complementarity will thus continue to be necessary to ensure customer trust and avoid unmitigated risks. A recent study on consumer behaviour in India corroborates this, arguing that financial service agents, particularly those visible and active within the community, are critical to inspire trust (*Omidyar Network, 2015*). Recent industry reports suggest that 21 million new jobs will be created on

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<sup>12, 14</sup> IT & BPO industry worker. 2017 in a telephonic interview.

<sup>13</sup> The Hfs model assesses job immunity to automation based on tasks/skill level where routine tasks reflect lower skill level; occupying entry level positions (application systems managers; server maintenance; back-end customer support). These are mostly business process sourcing activities, under threat of automation from robotic process automation.

<sup>15, 16</sup> Banking and financial service worker. 2017 in a telephonic interview.

the back of digital finance by 2025 (*Manyika, James et al*). While there is little evidence for this at the moment, job creation will ultimately depend on a broader ecosystem in which digital finance is but one service. It is worth noting that the recent job cuts in the banking sector are only partially attributable to technological innovation (*The Economic Times, 2017*); Government policy to merge public banks across the country has been a significant driving factor (*Reuters. 2017*).

## **2.3 Largest employers, construction and agriculture, will experience incremental mechanization rather than advanced automation**

While the agricultural sector remains the largest employer, engaging a substantial section of India's low-skill workforce (48.9 per cent employment share in 2011-12), it contributes less than 15 per cent in output (*ILO, 2016*). More than three lakh farmers have committed suicide over the last 20 years (*Sainath P, 2015*). Most tasks in agriculture can be classified as manual and routine, from planting crops, applying pesticides and fertilizers to harvesting. Automation potential is accordingly high. Applications of IoT and data analytics also have the potential to improve productivity. They are currently in the R&D phase and widespread adoption will require significant capital investments. Start-ups like EM3 agri-services are also leveraging digital platform solutions to provide agricultural equipment and services on a pay-for-use basis.

While there is a clear need for a productivity boost in the agricultural sector, which could be achieved with the deployment of advanced automation and digital technologies, low growth in the sector combined with the decreasing size of land-holdings makes widespread adoption of these technologies unviable. Progressive mechanization rather than adoption of Industry 4.0 solutions will characterize technological transformation in the agricultural sector. Most importantly, while productivity boosts are urgently needed in the field, the application of such technologies will be labour displacing.

The construction sector, which currently offers seasonal employment to 29 million workers (the estimate is expected to be larger for indirect employment) is said to need 38-40 million workers within the next five to ten years, particularly to support the expansion of public infrastructure (*Construct India, 2017*). The bulk of the work-force requires little skill, performing routine and predictable tasks. Global developments around construction technologies indicate that various manual processes have high automation potential. A Perth-based robotics company has developed a robot bricklayer, easily 50 to 60 times faster and more efficient than a manual labourer. Similarly, Hadrian, a robot designed by an Australian engineer in 2015, is reportedly capable of building a house in just two days (*Scroll.in. 2017*).

However, the likelihood of India adopting these bricklayers and other automated technologies within the next decade is low given that labour is both cheap and available in abundance and many parts of India continue to lack the basic infrastructure to support Industry 4.0 technologies. New skill capabilities will also be required to support the application of such advanced equipment. Incremental mechanization and subsequent labour displacement in the construction sector will largely be due to the adoption of older machines.

## 2.4 Unorganized sector will benefit from micro-technology, but the ecosystem will not support large-scale adoption of industry 4.0 technologies

Over 80 per cent of the labour force works in the unorganized sector while 92.2 per cent is reportedly engaged in informal employment, signalling low earnings with limited or no social protection (*Sharma, et al, 2014*). Almost 50 per cent of the national income is from this sector (*Srija and Shrinivas V. Shirke, 2014*). Nearly two-thirds of the workforce are employed in small enterprises within the unorganized sector, 58 per cent of which have less than six to ten workers (*Vigneswara I, 2017, 2017*). The other one-third is primarily engaged in some form of casual wage employment<sup>17</sup> or self-employment (*ILO Country Office for India, 2016*) In the unorganized sector, limited data on employment numbers and quality, prevent robust analysis around informal employment.

The cost of Industry 4.0 technologies, particularly in relation to the cost of labour, will make adoption unlikely in the near future. For example, in contrast to the advanced robotics being employed by automobile manufacturers in the organized sector, automobile component manufacturers<sup>18</sup> are mostly concentrated in the unorganized sector and likely to continue relying on manual labour (*Sabnavis, et al, 2017*). Moreover, most enterprises within the unorganized sector still have limited access to basic, older technologies and two-thirds of the workforce are employed in enterprises without electricity, relying heavily on manual labour.

Micro-technologies could, however, be increasingly relevant and beneficial for the informal sector. Here, investments in ‘new’ technologies are often steps up ‘technology ladders’ such as improved stoves, improved carts or improved sewing machines (*Jonathan Casey and Kendra Hughes, 2016*). A recent study found, for example, that tailors desired the efficiency-enhancing Juki sewing machine, one that has in-built programmes for designs, patterns and buttons and costs INR10,000 (about US\$ 150) in the market (*Sabina Dewan and Gregory Randolph, 2016*). There are also technologies that are low-cost and have low-energy consumption such as mobile applications related to banking and financial transactions. Their impact is likely to be concentrated in the specific enterprise that is using them rather than a large-scale disruption to the structure of work and employment. The focus on ‘high-tech’ innovations that target large industrial machines can end up obscuring the more affordable, smaller technology inputs that can revolutionize micro-enterprises. Moreover, broader eco-system upgrades such as smart transport systems or improved digital connectivity could indirectly improve labour productivity within the unorganized sector.

Government policy can, however, impact this outlook. Increasing foreign direct investment (FDI), particularly in the consumer goods segment, could have the effect of wiping out many small-scale enterprises. These large, new firms will be increasingly reliant on new technological applications, many of which will be labour displacing. The plausibility of this scenario is enhanced in light of recent policy changes. As recently as January 2018, the central government has issued a notice that full FDI will be allowed in retail and that trade unions will be expecting this move to result in significant job losses (*Vigneswara I, 2017*).

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<sup>17</sup> Negative employment growth in agricultural sector led to increase in casual wage employment, largely in construction sector where employment rose from 14.4 per cent (1990-2000) to 30 per cent (2011-12).

<sup>18</sup> While 400 companies belong to Original Equipment Manufacturers in the organized sector, 10,000 auto part companies operate in unorganized sector, as per *Automobile Components and Spares* data, on “Spare part and accessories”.

## 2.5 Conclusion

Adoption of 4IR technologies will be in niches within the organized manufacturing and service sectors, primarily because of the relative cost of labour and infrastructural constraints. Capital intensive manufacturing industries, such as the automobile industry, are more likely to adopt 4IR solutions. Work processes within the service sector, particularly those that involve routine and repetitive tasks, have high automation potential. Adoption rates will be higher in some sectors, such as financial and legal services, and IT services. However, the overall impact on employment numbers is likely to be limited as these industries and services are traditionally not large-scale employers. Moreover, the bulk of the labour force is concentrated in agriculture, construction, and the unorganized sector. These sectors are likely to experience the adoption of micro-technologies and incremental mechanization, rather than the large-scale adoption of 4IR. The high automation potential of routine and rule-based tasks will nonetheless shrink opportunities for labour mobility, particularly from low-skill work in the unorganized sector to medium-skill work in the organized sector.

## 3. Employment conditions

Assessing the impact of emerging technologies on the future of work requires an enquiry into not just job displacement but also changing employment conditions. This is particularly relevant in India where a majority of workers do not have a formal employment contract or access to formal social protection mechanisms. For decent work, employment conditions can be assessed in terms of income, access to social protection, working hours, safety and security. In India, it will also be important to assess the influence of technological advancements on the movement of workers across the prevailing structure of employment, across the organized and unorganized sectors and across forms of formal and informal employment. The adoption of emerging technologies will improve employment conditions for individual workers but this will not drastically alter economy-wide employment conditions.

### 3.1 Growth in the platform economy will rearrange informality

The digital platform economy encompasses a growing number of digitally enabled activities in business, political and social interaction. India, along with the US and China, is projected to lead the platform economy by 2020, creating new economic opportunities for both service workers and white collar workers (*Livemint*, 2016). Industry experts note that digital platforms will enable new forms of micro-entrepreneurship, enabling opportunities for self-directed wage growth and financial planning along with flexible working hours.<sup>19</sup> Platforms will also enable women to avail new employment opportunities, circumventing barriers of physical mobility and

#### Box 7

"In many cases, income of service providers on our platform has risen from INR 10,000 to 50,000 a month. This has allowed many of them to move to safer parts of the city and start sending their children to better schools. We help service providers obtain bank loan, providing lending institutions with a statement of average income. Training and equipment is also provided. Many service providers on our platform say they feel a sense of pride and belongingness in being associated with a formal organization such as ours."

Representative, home service, on demand platform

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<sup>19</sup> Service aggregator in digital platforms. 2017 in a telephonic interview.



domestic commitments.<sup>20</sup> Platforms could potentially be beneficial for migrant workers, who may not have strong social networks in their new place of residence.

Freelancers or independent professionals already comprise 20 per cent of the skilled workforce in India with categories of specialization ranging from content writers and web designers to management consultants and programmers. This number is likely to increase significantly in urban areas. While this movement will create new entrepreneurial opportunities, leveraging them will require workers to have technical skills along with entrepreneurial and soft skills. The platform economy is also likely to create more precarious work conditions than formal employment, in terms of job security and social protection. While these concerns about the platform economy have been voiced in industrialized economies as well, they are particularly significant in the context of the bulk of India's labour force being unskilled or low-skilled and weak state-sponsored social security systems. While for many, the shift from formal employment to gig work will be voluntary, for many others, engagement on the platform economy might will be driven by the unavailability of alternative secure and gainful work opportunities.<sup>21</sup>

Of particular significance in India is growth in “on demand” digital platforms targeted at service workers, many of whom fall under the purview of informal employment. In the last five years, 270 new home-based on- demand platforms have been set-up in India (*Livemint*, 2017). Babajobs, a job-posting platform, has 8.5 million registered users and over 5,00,000 customers (*YourStory*, 2017); Urban Clap, a popular home services aggregator, has over 650,000 registered service providers (*Livemint*, 2017); and Uber has 400,000 registered drivers (*The Economic Times*, 2016).

Participation on digital platforms can indeed improve employment conditions for a number of service workers, be it in terms of higher income or better working conditions, flexible work hours or access to banking. While some of these gains will reflect the strengths of a platform economy, it is also reflective of poor employment conditions in the unorganized sector. Gig work is not new to India. Most workers already work multiple jobs for multiple employers on a piece-rate basis, and lack access to formal social protection mechanisms. Over 90 per cent of casual workers do not have a formal employment contract. Even among salaried employees within the organized sector, over 60 per cent are reported to be working without written agreements (*Center for Equity Studies*, 2016). In this sense, the platform economy can be seen as reproducing an existing system of informal piecework in India.<sup>22</sup> It will facilitate some movement of workers across the structure of employment that ranges from the unorganized to the organized sector – but this movement in itself will not enable access to formal social protection mechanisms or job security.

Work will continue to be precarious, albeit in new ways. Interviewed service workers report an initial increase in income. Over time, earnings have stabilized, and in some cases, reduced significantly. The platform economy risks catalysing a race to the bottom in terms of wages (*Mark Graham, et al.* 2017). As this happens, workers will need to ensure they are pursuing multiple opportunities. Most Uber drivers interviewed for this study, for example, were also registered with other taxi aggregator companies as a way to boost their earnings.<sup>23</sup> Since workers are likely to also invest their time, labour and personal capital, they are therefore vulnerable to external shocks. Many Uber drivers had taken a loan to purchase their cars. But as supply outpaced demand, the income of many Uber drivers dropped, leaving them in debt. While many digital platforms see themselves as technology

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<sup>20</sup> A number of women registered on Gharkamai were professionals who left jobs due to home-related care duties.

<sup>21</sup> Truelancer. 2016. “Freelance job opportunities in India, trends and future.”

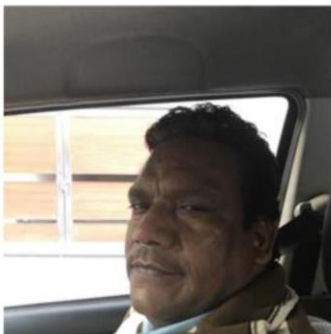
<sup>22</sup> Development economist. 2017. In a telephonic interview.

<sup>23</sup> Service workers on digital platforms. 2017. In a personal interview.

companies, this disguises the power they assert in setting the terms and conditions governing worker engagement. Many privilege the needs of the customer over those of workers, operating through a system of incentives and penalties. One of the platforms interviewed for this study pointed out that, ‘If the rating of a service provider falls below four or five, the platform automatically stops sending jobs to the service provider. You are only as good as your last 20 jobs’.<sup>24</sup> In these ways, the platform economy will contribute to the degradation of labour, reproducing informality and precarity, even while creating new economic opportunities.

**Box 8**  
**Cab driver on demand platform**

<p><b>Name:</b> Soban Singh      <b>Age:</b> 44      <b>OLA</b></p> <p><b>Education:</b> Grade 12 (graduated)      <b>Born:</b> Almora district U.P</p> <p><b>What did you do before?</b> I was a driver at someone's house for 16 years.</p> <p><b>Why did you switch?</b> The other driver in the house switched to Uber and I saw how much money he was making and I got greedy. I have three daughters and I thought it was important to earn more.</p> <p><b>How long with Ola / Uber?</b> 2 years.</p> <p><b>Do you own your car? If loan, what is loan amount; how did you manage to secure it; whats progress on repayment?</b> Yes I own the car. I took a loan from Mahindra Finance @ 16.5% for 3.85 lakhs with a 2.06 lakh down payment. I pay Rs.12,100 every month.</p> <p><b>How much do you make? How does it compare to earlier job? How does it compare to when joined?</b> I earn around Rs.30,000- Rs.35,000. I used to earn Rs.16,500 plus roughly Rs. 6000 in overtime. When I Initially joined Uber I earned upto Rs.90,000 a month.</p> <p><b>What are your working hours / how does it compare to earlier?</b> I work around 16 hours a day. In my earlier job I worked around 10 hours but had a few outstation trips a month.</p>	<p><b>How do customers treat you?</b> I've had some trouble but only with women passengers. They shout a lot and sometimes refuse to pay.</p> <p><b>What do your friends and family think of your job?</b> They are understanding and are happy I can make ends meet.</p> <p><b>Are you able to save? Plan for the future?</b> I can't really save. I did save a little initially but when I was earning more I spent more as well. I want to go back to having a salaried job, not necessarily as a driver.</p> <p><b>Does this feel like a secure job?</b> I think our earning potential will go down as time goes on.</p>
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The platform economy does however have the potential to reorganize informality in India. For many service workers, digital platforms have enabled access to the formal banking system along with opportunities for training and skilling (*Livemint*, 2017). Platforms can enable the standardization of services and payment, providing a certain degree of predictability to both service providers and customers. Babajobs, for instance, uses data available on its platform to create a digital map of average driver salaries across different neighbourhoods in Bangalore (*Economic Times*, 2016). Access to such information improves the ability of drivers to negotiate fair pay in an otherwise unregulated market. By aggregating service providers, platforms can help build a sense of community that can be mobilized for collective bargaining. Yet, as noted above, in most cases where there is a shift from informal to formal employment, it is largely in terms of ‘registration’, through taxation and banking services, lacking in transformative aspects such as access to greater social protection, job and income security. Regulatory steering will be required to secure worker wellbeing in a platform economy, for registration to become a means of transforming the precariousness of informal work.

<sup>24</sup> Service aggregator of digital platform



## 3.2 Increasing contractual work within the organized sector

As the capital intensity of production in organized manufacturing increases with the adoption of advanced robotics and other Industry 4.0 technologies, the reliance on contractual workers can be expected to increase. Rising capital intensity implicates an increasing use of technology in the process of production, as the share of fixed assets per output rises and that of labour decreases. India, in fact, uses more capital-intensive technologies in manufacturing than other countries at a similar level of development (*Kapoor R, 2016*).

Contractualization of work is particularly likely in capital intensive industries, such as automobile manufacturing and telecommunication related production (i.e., optic fibre networks, mobile phone production and so forth). Use of contractual work will allow firms to have a swifter and more efficient response to technology-led transformation in business products and processes while minimizing their labour costs. As skills requirements evolve swiftly, businesses are likely to prefer a more nimble work-force that can be hired on a project basis. While new jobs might be created, employment conditions will deteriorate insofar as contractual workers can be easily dismissed, receive a much lower wage than permanent workers, and do not have access to social protection mechanisms (*A. Sood, et al. 2014*). It is important to note that approximately 68 per cent of contractual workers currently do not have a formal contract and can thus be classified as informal employees (*Center for Equity Studies. 2016*).

The manufacturing sector is already experiencing a sharp increase in contractual labour, particularly in capital intensive industries (*Kapoor R, 2016*). The share of contract workers in total employment rose from 15.7 percent in 2000-01 to 26.47 per cent in 2010-11, while that of directly employed workers fell from 61.12 per cent to 51.53 per cent in the same period. More significantly, the increase in contract workers has accounted for about 47 per cent of the total increase in employment in the organized manufacturing sector over the last decade.<sup>25</sup> The share of worker wages has also fallen significantly. Estimates made from unit-level data of the National Sample Survey (NSS) in 2004-05 suggest that the average wage earned per day by regular wage workers in organized manufacturing was about INR169 while that earned by contractual workers was only about INR55.<sup>26</sup> While rigidity of labour laws contributes to the hiring of contract workers (*Dutta, et al, 2003*), firms also hire contractual workers to reduce the bargaining power of regular, unionized workers (*Kapoor R and Krishnapriya PP, 2016*).

Contract-based work is also increasing across the services sector. Digital platforms and new communication and data sharing solutions are making it easier to break down work into smaller tasks and then outsource it to the most cost-effective bidder across multiple geographies. This allows businesses to maintain agility and adaptability while simultaneously reducing the responsibilities that come with a formal employment relationship.<sup>27</sup>

This trend can already be observed in IT services. A member of the recently formed IT union discussed an increasing trend towards the subcontracting of work. This was attributed to the global slowdown of the IT industry, facilitated by the rapid technology-led changes to business processes.<sup>28</sup> Facing an unpredictable market and dwindling investment, Indian IT firms have shown a preference to reduce their permanent manpower and the additional costs of labour welfare. Leading consultancy

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<sup>25</sup> Ibid.

<sup>26</sup> Service workers on digital platforms. 2017. In a personal interview

<sup>27</sup> Industry experts. 2017 in a telephonic interview.

<sup>28</sup> IT Union Member. 2017 in a telephonic interview.

firms interviewed for the study also indicate a growing preference for project-based teams that shift with skill and competency requirements. ‘We could up-skill existing employees but that takes a lot of time.’<sup>29</sup> Similarly, in the financial sector, consultants are increasingly being hired across medium and high-skilled jobs as an alternative to full-time employees (*Truelancer, 2018*). The Indian Staffing Association has also projected that 50,000 jobs will be created in the flexible staffing space, driven primarily by consumption-focused sectors such as retail and consumer good firms.<sup>30</sup> The share of permanent employees in government services is also on the decline. As of 2014, 12.3 million people are engaged in temporary jobs with the government and 10.5 million casual workers are without any formal job contract (*Indian Staffing Federation, 2014*).

### 3.3 Increasing shift from wage employment to self-employment

Emerging technologies will create new opportunities for entrepreneurial ventures whether by enabling more efficient access to suppliers and markets through the platform economy or enabling new opportunities for dispersed manufacturing and remote working. Some analysts argue that India will lead the start-up universe by 2020 (*Financial Express, 2016*). Industry body NASSCOM projects that 10,5000 start-ups will be established by 2020, creating 250,000 jobs (*NASSCOM, 2016*).

Current government policy is also directed towards promoting self-employment and entrepreneurship, in particular to counter slow growth in job-creation.<sup>31</sup> The present financial and policy environment however has not been supportive of start-ups. According to the start-up media platform Inc, as of 2016, 42, 500 start-ups shut down within 20 months of their being set up (*Inc42, 2016*). In the first nine months of 2017, 800 new start-ups were established as opposed to the 6000 in 2016 (*Livemint, 2017*). Moreover, the start-up ecosystem is only penetrable by those who have access to financial and social capital since for many small businesses, access to seed funding remains a huge impediment.<sup>32</sup>

It is also essential to recognize that self-employment is not necessarily the product of choice for many workers and that they have chosen this route essentially because they have been unable to find regular employment in the organized sector. Over 80 per cent of the workforce in the unorganized sector is already classified as self-employed. Many of these businesses are not productive enough to make ends meet and have little access to capital or formal safety nets. A recent study refers to them as ‘reluctant entrepreneurs’ (*Abhijit Banerjee and Esther Duflo, 2012*). Self-employment, in other words, does not necessarily reflect an upward movement across the structure of employment or an improvement in employment conditions.

Without adequate social security nets, access to capital and market opportunities, self-employment will signify lower employment conditions than wage employment for many workers. Self-employment, in other words, will not mean the same thing across the labour market. For the economic elite, it could represent a welcome and voluntary trade-off between autonomy and job security while for a daily wage, casual labourer, struggling to make ends meet, it could be a more precarious and insecure option, being less desirable than wage work.

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<sup>29</sup> IT & BPO industry worker. 2017. In a telephonic interview.

<sup>30</sup> Economic journalist. 2017 in a personal interview.

<sup>31</sup> StartupIndia, under the Department of Ministry of Commerce and Industry was initiated by the NDA-led central government to promote India’s startup culture and generate employment through increased funding and other initiatives.

<sup>32</sup> In terms of financial assets to invest in the startup and/or social networks to support the firm, financially or otherwise.

### 3.4 Conclusion

The spread of 4IR in India is likely to reproduce rather than transform existing trends pertaining to employment conditions. Job security and related access to formal social protection mechanisms risk becoming more precarious with the growing contractualization of work. The platform economy will create new economic opportunities, and enable the organization with respect to some aspects of informal work through enabling access to formal banking services or insurance. Yet, in so far as workers continue to lack access to formal social protection mechanisms, the platform economy will also reproduce informality in India. With adequate regulatory steering, the platform economy can nonetheless be harnessed to deliver social protection and training, enabling the formalization of service work in India. Self-employment is likely to increase but this in itself does not signify an improvement in employment conditions.

## 4. Labour market inequities

Labour mobility and welfare is as much a social question as it an economic one. India has one of the highest rates of income inequality in the world, having risen steadily post economic liberalization in the 1990s (*The Hindu*, 2017). Access to gainful employment for women and marginalized groups is hindered by both lack of suitable work opportunities and prevailing socio-cultural norms that restrict access to education and employment. Economic poverty in India is highest amongst groups who have been socially and culturally marginalized including religious minorities, lower, vulnerable castes and tribal communities. Socially marginalized communities have restricted access to education, health and other public services, low levels of capital ownership and face discrimination while seeking employment. Women's access to remunerative work and economic opportunities continues to be restricted due to norms that discriminate on the basis of gender. Current technology and work trajectories are likely to further entrench labour market inequities along gender, caste, and religious lines.

### 4.1 Gender inequities will persist, even as women avail new opportunities

Gender inequities in the world of work are likely to become further entrenched due to low levels of education and skilling and socio-cultural norms and belief systems. India has one of the lowest labour participation rates for women (*Verik, Sher, 2014*). Between 2011-12, 19.6 million women have dropped out of the workforce, of which 53 per cent were rural women.<sup>33</sup> 'Family reasons' are cited as one of the main factors for women quitting their jobs (*Harvard Kennedy School, 2017*).

Recent studies show that there is a significant digital gender divide in terms of access to mobile technologies and the internet. In 2017, less than 30 per cent of India's Internet users were women (*The Economic Times, 2017*). Women are also 23 per cent less likely to own a mobile phone as compared to men, and only 14 per cent of women in rural India own a mobile phone (*GSMA, 2018*). Women's access to digital technologies is likely to increase as the affordability and penetration of internet services and devices increases. However, access alone is an inadequate measure. Low levels of literacy, education, and skilling combined with, and reinforced by, socio-cultural norms are likely to restrict the capacity of women to leverage new technologies for their economic empowerment.

About 65 per cent of women are literate as compared with 82 per cent men (*Census 2011*) and 23 per cent girls drop out of school before they reach puberty (*The Guardian. 2013*). A recent study found that the engagement of girls in housework and domestic chores was the largest contributor to a gender gap in secondary education (*Renu Singh and Protap Mukherjee, 2017*). Education is not leading to jobs either as shown in a 2015 report by the United Nations Development Programme (UNDP) that disclosed over 67 per cent female graduates in rural areas going without work while 68.3 per cent in urban areas not having paid jobs (*Ernst and Young LLP and UNDP. 2015*). Some of the reasons for this scenario were attributed to patriarchal attitudes that restrict women's access to public spaces, including community Internet centres and skilling and training facilities (*Kovacs A, 2017*). Unless these deeper issues are addressed, the digital world is likely to reproduce, and further entrench, current gender inequities.

Women are less likely to have the digital fluency skills required to succeed in the digital economy. Moreover, they are more likely to occupy low-medium skill level jobs, that are most vulnerable to the effects of automation. A well-known economist has argued that the first casualties of the mechanization of agriculture were women, both because they occupied lower-skill jobs and because of social norms that perceived operating heavy machinery to be a 'man's job.'<sup>34</sup> A similar trend may repeat itself with 4IR. In the IT and BPO sector, for example, women tend to occupy low-skill, back-end jobs, which are likely to be automated first in terms of technical feasibility. Managerial, high-skilled, positions, that are less susceptible to automation, are typically occupied by men (*The Wire, 2017*). Studies also find that social beliefs around women's capabilities govern their participation in the workforce where women are often perceived as ill-suited to jobs that require advanced technological skills (*OSDW, 2012*). The ICT enabled interventions can help address some of these issues, but only if located within a broader set of social and policy interventions.

#### Box 9

Our platform, catering specifically to women, allowed them to access good quality work from home, but it also reinforced the gendered division of labour. If women can access paid work remotely from home, they are further constricted in the 'private' sphere and simultaneously expected to accomplish unpaid household tasks. Lack of social protection is also particularly worrying for women who are the primary care givers, but have no job security when they need it the most."

Representative, Gig economy

The platform economy has the potential to facilitate women's employment as work requirements are 'flexible,' allowing women to juggle their domestic and professional roles. Home service providers report an increasing demand for women workers, even in traditionally male dominated professions such as plumbing, carpentry and other house repair work.<sup>35</sup> Yet, platforms also reproduce the gendered division of labour. Moreover, access to social protection mechanisms is particularly important for women, who are structurally and socially more vulnerable to external shocks. In their current form, platforms do not provide this access and thus can be said to reproduce the precarity women face in the future of work.

## 4.2 Marginalized communities will be further marginalized

The marginalization of certain communities is likely to become more entrenched due to technological skill-bias. A high incidence of poverty combined with low levels of education among marginalized social groups will limit their access to technology gains (see Table 1 and 2). The literacy levels for

<sup>34</sup> Gender anthropologist and economist. 2017. In a telephonic interview. See also: Radhika Balakrishnan, et al. "Transforming women's work: Policies for an inclusive economic agenda." *Solidarity Center*, 2016.

<sup>35</sup> Industry informant. 2017 in a telephonic interview.

scheduled tribe women are the lowest in the country at 49.35 per cent, followed by Muslim women at 51.9 per cent, both well below the national average of 72 per cent. Information, Communication and Technology (ICT) and digital access are rapidly becoming essential for approaching a variety of public goods and services including suitable work opportunities. Furthermore, as more business and industrial processes are digitized and partially automated, technological knowledge is becoming a crucial skill in itself. Consequently, low levels of education and skilling will constrain the capacity of marginalized communities to access technology gains. Moreover, as many medium-skill jobs are automated, economic mobility opportunities will be further restricted.

The low cost of labour in the unorganized sector reduces the possibility of technological adoption in the next decade. Therefore, automation may not directly replace work within the unorganized sector. Yet, much of what is known as ‘dirty, dangerous, and demeaning work’ is predominantly carried out by marginalized communities. Social norms make their labour cheap, thereby reducing the incentive for adopting automation technologies, and further entrenching their minimal access to technology gains. Manual scavenging is a relevant case and while technology to automate manual scavenging exists, and the practise itself has been illegal since 1993, it still continues due to the availability of cheap labour and caste-based discriminatory practices.<sup>36</sup>

While there is a vast urban-rural divide in terms of access to technology gains, the hierarch-ization of labour is equally, if not more, entrenched within urban areas. Urban areas have extreme incidences of poverty, especially among new migrants who are typically landless rural communities. In urban areas these communities often live in marginal informal settlements and without access to public services, work and digital technologies. These inequities are likely to be reproduced and exacerbated without adequate policy steering.

## 4.3 Conclusion

Labour data differentiated by gender, caste, religion and other socio-economic markers, particularly within the unorganized sector, is limited. Current trends suggest that technology led disruptions to the future of work are likely to reproduce and entrench labour market inequities along gender, caste, and religious lines. Low levels of education and skilling combined with socio-cultural norms and beliefs will restrict the capacity of women and marginalized groups to leverage new technologies for their economic empowerment. Innovative opportunities for circumventing these barriers can be created through the adoption of new technologies that include a range of scenarios, from the growth of the platform economy to remote learning opportunities. However, their effectiveness will depend on how well they are integrated with broader social and policy interventions.

**Table 1. Literacy levels as a percentage of population**

Category	National average	Schedule castes (SC)	Scheduled tribes (ST)	Muslim backward communities
<b>BPL people in urban areas</b>	13.7	21.8	27.3	26.5

<sup>36</sup> Development economist. 2017 in a telephonic interview.

<b>(per cent)</b>				
<b>BPL people in rural areas (per cent)</b>	25.7	33.8	44.8	30.8

Source: Ministry of Tribal Affairs, Statistical Division. 2013, *Statistical profile of Scheduled Tribes in India*

**Table 2. Percentage of people below poverty line**

Category	Percentage
Men	80.89%
Women	64.64%
Scheduled castes, men	75.17 %
SC, women	56.46 %
Scheduled tribes, men	68.53%
ST, women	49.35%
Muslim men	62.41%
Muslim women	51.9%

Source: Ministry of Minority Affairs, 2013. Post Sachar Evaluation Committee, "Final Report of Kundu Committee"

## 5. Conclusion: Portfolio of strategies

In the novel *Frankenstein: or, The Modern Prometheus*, author Mary Wollstonecraft created the enduring image of Frankenstein's Monster who is a mechanical but sapient creature, a product of an uncontrolled scientific experiment who destroys its own creator. *Frankenstein* reflects the social implications of technology as something uncontrollable and with a life of its own. What frames public narratives on technology and work are, on the one hand, deep-seated public anxiety about the loss of control over unknown and emerging technologies and, on the other, the dominant economic discourse of technological change and work as a form of creative destruction and inevitable churn.

Emerging technologies will undoubtedly disrupt labour markets in India. These impacts, however, will be felt in niches. The broad structure of Indian labour markets is unlikely to change in any significant way in the next decade. Technology trends will perpetuate and even aggravate the macro trends around informalization, multiple forms of labour segmentation and service-led growth that are already underway. Technology could both induce and reproduce more inequality. Opportunities for labour and income mobility are likely to be restricted for large sections of the population due to low levels of education and skilling. The political and social consequences of having a workforce that is young and aspirational but unable to move across the fissures that separate the informal from the formal, urban from the rural, manual from the mechanized, and high-caste from low-caste work, are likely to be serious.

Are there ways out of this? What kind of strategies can help shape how emerging technologies play out in the complex socio-economic and cultural context of work in India? Technology and future work belong to a class of public policy problems that are persistently insoluble and are referred to as ‘wicked problems.’ There is no silver bullet or a discrete set of solutions to address these challenges. Public discourse is framed by ethical and value conflicts among stakeholders, often involving deeply entrenched world-views, interests and attitudes to future risk. There is no right or correct solution that we can all agree on, only better or worse ways for coping and managing.

While studies on the potential impact of technology on the world of work are beginning to emerge, there is little analysis of how to manage these disruptions. Ways of shaping and coping with the impact of emerging technologies can be broadly organized around four sets or portfolios of strategies, namely, labour protection strategies; policies for the redistribution of technology gains; coping and adapting strategies; and policies for shaping technological trajectories. Much more empirical research, analysis and stakeholder consultation will be required to develop this suite of policy responses.

**Labour protection strategies:** As the number of contracted and self-employed workers increases and employment relationships transform, new frameworks will be needed to protect workers. Strengthening working conditions in non-standard jobs and ensuring that all workers have access to minimum working conditions, regardless of their contractual status, will be critical. Policy measures will be needed to improve working conditions across the employment structure, including access to formal social protection mechanisms, facilitating collective bargaining opportunities for workers and smoothening labour market transitions and care support. Digital technologies can potentially offer workers a virtual space for information sharing, grievance redressal and collective bargaining. The expansion of the platform economy can provide opportunities to formalize the unorganized sector in India. This can be done through a range of systems from the delivery of training and skilling programmes to the provision of social protection benefits, both via the platform.

**Redistributive strategies:** Productivity gains can be redistributed at the level of the State to provide universal social security, universal basic income and social services (free health, education, food rations etc) and minimum employment guarantee schemes. There are numerous proposals for the redistribution of technology-led productivity gains of large companies. Bill Gates has argued that governments should tax companies that use robots by charging a robot tax to fund other types of employment (*Fortune*, 2017). Technology-led productivity gains can also allow for the redistribution of existing jobs wherein the number of hours worked per worker could be attenuated, offering employment opportunities to a much larger percentage of workers (*Pedro S. Raposo and Jan C. Our Van*, 2008). Nevertheless, many of these conversations are abstract and theoretical in the Indian context at this stage and require fundamental social reorganization and restructuring. The Vice-Chairman of the federal think tank NITI Aayog recently suggested that rather than provide capital subsidies to industries, the government should consider labour subsidies instead. This could be done by setting up a labour utilization fund that could be used for making the workforce ‘more skilled and cost competitive’ to encourage businesses to hire more when automation and deployment of AI is likely to make low -skilled labour redundant (*Livemint*, 2017).

**Coping strategies:** These include strategies to help people cope and adapt to the changing world of work. These could include skilling and re-skilling initiatives to stay relevant in current jobs, availing opportunities in new sectors, and launching entrepreneurial ventures. However, we cannot skill our way out of disruptions of technological change (*Ghose AK*, 2017). Without foundational knowledge and good education, skilling on its own can be an ineffective coping mechanism. The Indian education system has been heavily biased towards the upper echelons given that illiteracy is high and thousands of people do not even have access to primary education. The quality of education is fraught

with an entire set of challenges but, at a minimum, the initial emphasis needs to be on the provision of universal education and addressing the questions of exclusion of marginal groups from schools and universities.

Digital literacy and ICT have been recognized as the basic skills required in the current environment for work and, increasingly, to access public goods and services. In the face of rapidly changing technologies, the skill landscape is constantly evolving. Education and vocational training can no longer follow a linear trajectory and workers will need to regularly up-skill as new and improved technologies continuously disrupt the labour market. Lifelong learning is integral to building resilience and remaining relevant in the context of work. Humanistic skills, including creative and critical problem solving, are important means to adapt to change. Interpersonal skills, along with leadership abilities, are essential in navigating the various spheres of work. In the service sector, for example, they are vital in engaging with customers and clients as well as for internal interactions.

**Technology strategies:** These include strategies to manage and regulate technologies by incentivizing and incubating certain technologies while regulating, limiting or jettisoning others. Technology, research and development policies can be used to drive technological trajectories, to develop applications of emerging technologies for the bottom of the pyramid and incubate technologies for employment generation in new sectors. Policy steering will be required since innovation, if left to market forces alone will not be adequate in leveraging emerging technologies for development solutions suited to the Indian context. For example, the Indian Institute of Technology (IIT) Guwahati is developing AI technologies for breast cancer detection, reducing the chance of error and unnecessary surgeries through pattern recognition and data analysis. In the agricultural sector, AI has multiple applications, from developing intelligent environment control mechanisms to monitoring crop conditions (weather and soil analysis). Microsoft has powered a Sowing Advisory app to help farmers make informed decisions on sowing dates and land preparation. Combined with AI, IOT is also relevant in the agricultural sector to help farmers maximize and safeguard their crop yields. A connected network of sensors in agricultural objects used by farmers can help them control and manage equipment based on real-time information. IOT devices have also been proposed to exchange information between farmers. These plural strategies will need to be deployed iteratively and reflexively, learning from experiments proactively and anticipating issues rather than just cleaning up.

A buckshot approach that includes a portfolio of strategies rolled-out across different sectors and domains will be essential, but which also needs to be built on a normative framework for addressing the interface of technology and the world of work. The normative framework should draw on the concepts of Decent work to inform the ethical framework that steers policies and strategies. Economic growth on its own will not be enough; despite almost two decades of high growth in India, the workforce remains vulnerable. Citizens need to be empowered through the provision of Decent work. Social protection is a central feature of this and the provision of basic social security guarantees needs to be at the centre of a normative framework for the future of work.

In the wake of the First Industrial Revolution, philosophers, artists and economists from Marx to Adam Smith were concerned about the de-humanizing effects of work. Here, factories with assembly lines and a strict social division of labour, with the lowest rung of people were doing repetitive and routine jobs. At the cusp of the 4IRn, there was also anxiety about the de-humanizing effects of non-work. Economist, John Keynes worried about non-work/forced leisure way back in the 1930s and wondered how society would use its time once freed from the struggle of existence. Yet, in the present-day context, most of the Indian workforce is unlikely to face this dilemma in the next 10 to 15 years as they continue to struggle with the age-old challenge of finding enough work to make a living.



# Bibliography

- Banerjee, A. et al. 2012. "Poor economics: A radical rethinking of the way to fight global poverty. (United States, Public Affairs, Peresus Book Group)
- Alkhatib A, et al. 2017. "Examining crowd work and gig work through the historical lens of piecework". Stanford University, 2017. Available online at <http://hci.stanford.edu/publications/2017/piecework/pn4226.pdf> [accessed 15 May 2018].
- Asian Robotics Review.2017. "Asian outlook 2017: Robots, automation & industry". Available online at <https://www.linkedin.com/pulse/asian-outlook-2017-robots-automation-industry-tom-green>. [accessed 17 May 2018].
- Automobiles maps of India. 2012. "Automobile components and spares" Available online at <https://automobiles.mapsofindia.com/automobile-components-and-spares/>[accessed 15 May 2018]
- Bhattacharya, et al. 2017. "India: Growth and jobs in the new globalization". (BCG-CII India future of jobs publication, 2017)
- The Business Standard. 2018:"More joblessness: ILO sees India's unemployment rate rising to 3.5% in 2018." Available online at [http://www.business-standard.com/article/economy-policy/more-joblessness-ilo-sees-india-s-unemployment-rate-rising-to-3-5-in-2018-118012300389\\_1.html](http://www.business-standard.com/article/economy-policy/more-joblessness-ilo-sees-india-s-unemployment-rate-rising-to-3-5-in-2018-118012300389_1.html) [accessed 15 May 2018].
- Business Today. 2015: "Not so 'Achhe Din' for rural wages." Available online at <http://www.businesstoday.in/current/economy-politics/not-so-acche-din-for-rural-wages-in-india/story/214378.html>. [accessed 15 May 2018]
- Casey, et al. 2016. "Technology and the Future of Work". (Women in Informal Employment Globalizing and Organizing Practical Action Publication, 2016).
- Census 2011. State of literacy. (Government of India, Chapter 6, 2011.
- Center for Equity Studies. 2016. "India Exclusion Report," (New Delhi: Yoda Press, 2016).
- Construct India. 2017. "India Builds Big." Available online at <https://www.thebig5constructindia.com/industry-updates/blog/india-builds-big/>. [accessed 15 May 2018].
- Deccan Chronicle.2017: "Universal robots eyes Indian market for future growth." Available online at <https://www.deccanchronicle.com/technology/in-other-news/260417/universal-robots-eyes-indian-market-for-future-growth.html>. [accessed 17 May 2018].
- Deccan Herald. 2017:"TAL to create market for robots in India." Available online at <https://www.deccanherald.com/content/593654/tal-create-mkt-robots-india.html> [accessed 15 May 2018]
- S Dewan and G Randolph. 2016. "Transformations in technology, transformation in work," *JustJobs Network Inc.*
- Dutta, et al. 2003 2008; Ahsan and Pagés,
- ET Auto. 2015: "Robots are no hazard but beneficial, say auto industry experts." Available online at <https://auto.economictimes.indiatimes.com/news/industry/robots-are-no-hazard-but-beneficial-say-auto-industry-experts/48008181>. [accessed 15 May 2018]
- The Economic Times. 2016a. "Government formulating national policy for advanced manufacturing." Available online at <https://economictimes.indiatimes.com/news/economy/policy/government->

- formulating-national-policy-for-advanced-manufacturing/articleshow/56124416.cms. [accessed 15 May 2018].
- , 2016b. “India will be home to 10,500 start-ups by 2020: NASSCOM.” Available online at <https://economictimes.indiatimes.com/small-biz/start-ups/india-will-be-home-to-10500-start-ups-by-2020-nasscom/articleshow/55068274.cms>. [accessed 15 May 2018].
  - , 2016c. “Raymond to replace 10,000 jobs with robots in next three years.” Available online at <https://economictimes.indiatimes.com/jobs/raymond-to-replace-10000-jobs-with-robots-in-next-3-years/articleshow/54358700.cms>. [accessed 15 May 2018].
  - , 2016d: “BabaJobs introduces location specific salary estimates on its site.” Available online at <https://economictimes.indiatimes.com/small-biz/start-ups/babajobs-introduces-location-specific-salary-estimates-on-its-site/articleshow/53866906.cms>[accessed 19 May 2018].
  - , 2017a. “About 39% of youth in NCR aspire to become software engineers: Survey.” Available online at <https://economictimes.indiatimes.com/jobs/about-39-of-youth-in-ncr-aspire-to-become-software-engineers-survey/articleshow/57518235.cms>. [accessed 15 May 2018]
  - , 2017b. “SBI cuts staff strength, looks to redeploy 10,000.” Available online at <https://economictimes.indiatimes.com/industry/banking/finance/banking/sbi-cuts-staff-strength-looks-to-redeploy-10000/articleshow/60051905.cms>. [accessed 15 May 2018].
  - , 2017c. “Only 29% female internet users in India: UNICEF Report.” Available online at <https://economictimes.indiatimes.com/tech/internet/only-29-female-internet-users-in-india-unicef-report/articleshow/62027590.cms>. [accessed 15 May 2018].
- Elan, Susan: “Study: Women encounter inequality in science & technology fields.” (Elsevier, October, 2012)
- Ernst and Young LLP and UNDP. 2015. “Women’s Voices: Employment and entrepreneurship in India”. (United Nations Development Programme, July 2015).
- Erbe, Thom. “Automation to impact 14 million global services jobs by 2021 with India the most affected”. (HFS Research, July 5, 2016).
- FactorDaily. 2017: “Here is why India is likely to lose the AI race.” Available online at <https://factordaily.com/artificial-intelligence-india/> [accessed 15 May 2018].
- Financial Express. 2016: “Start-up deadpool: Government says it’s only a lean phase.” Available online at <https://www.financialexpress.com/industry/sme/start-up-deadpool-government-says-its-only-a-lean-phase/368744/> [accessed 15 May 2018].
- , 2017: “HDFC bank’s Onchat records 160 per cent month-on-month growth in transactions.” Available online at <https://www.financialexpress.com/industry/hdfc-banks-onchat-records-160-month-on-month-growth-in-transactions/863443/>. [accessed 17 May 2018]
- Forbes India. 2017: “Mapping the landscape of the cloud computing industry in India,” Available online at <http://www.forbesindia.com/article/special/mapping-the-landscape-of-the-cloud-computing-industry-in-india/48031/1> [accessed 15 May 2018].
- Fortune. 2017: “Bill Gates says robots should be taxed like workers.” Available online at <http://fortune.com/2017/02/18/bill-gates-robot-taxes-automation/> [accessed 15 May 2018].
- Ghose AK. 2016. “Challenges and the imperative of manufacturing-led growth,” India Employment Report 2016 (Oxford University Press, New Delhi
- , 2017. “The future of work in India, Technology Foresight Group” in the *Goa: Tandem Research*, September 2017.
- Mark Graham, et al. 2017: “Digital labour and development: impact of global digital labour platforms and the gig economy on worker livelihoods”, *Sage Journals*, March 16, 2017

- The Guardian. 2011: “India’s official poverty Line doesn’t measure up.” Available online at <https://www.theguardian.com/global-development/poverty-matters/2011/oct/04/india-measuring-poverty-line> [accessed 15 May 2018].
- . 2013: “The unsanitary truth about gender inequality in India.” Available online at <https://www.theguardian.com/global-development-professionals-network/2013/jun/06/unsanitary-truth-gender-india>. [accessed 15 May 2018].
- Harvard Kennedy School. 2017. “Evidence for policy design: Identifying the key constraints to young Indian women’s labour force participation”.
- HFS Research. 2016. “Automation to impact 14 million global services Jobs by 2021 with India the most affected.” Available online at <https://www.hfsresearch.com/press-releases/automation-to-impact-14-million-global-services-jobs-by-2021-with-india-the-most-affected>. [accessed 18 May 2018].
- The Hindu Business Line. 2017: “Intel India trains 9,500 developers in AI technology.” Available online at <http://www.thehindubusinessline.com/info-tech/intel-india-trains-9500-developers-in-ai-technology/article9895527.ece>. [accessed 15 May 2018].
- The Hindu. 2017a: “Govt sets up expert group for suggestions of artificial intelligence policy.” Available online at <https://www.hindustantimes.com/india-news/govt-sets-up-expert-group-for-suggestions-on-artificial-intelligence-policy/story-R4VnrCufgm7xhh1fVlz9IL.html>. [accessed 15 May 2018].
- . 2017b: “Income inequality in India at its highest level since 1922, says Lucal Chanel.” Available online at <http://www.thehindu.com/opinion/interview/income-inequality-in-india-at-its-highest-level-since-1922/article19645881.ece>. [accessed 15 May 2018].
- . 2017c: “India’s informal economy.” Available online at <http://www.thehindu.com/opinion/columns/Chandrasekhar/indias-informal-economy/article11119085.ece>. [accessed 17 May 2018].
- ILO. 2015a. “Research department briefing, re-shoring in Europe: Trends and policy issues.” (September, 2015). Available online at [http://www.ilo.org/wcmsp5/groups/public/---europe/---ro-geneva/---ilo-brussels/documents/genericdocument/wcms\\_409031.pdf](http://www.ilo.org/wcmsp5/groups/public/---europe/---ro-geneva/---ilo-brussels/documents/genericdocument/wcms_409031.pdf). [accessed 15 May 2018].
- . 2015b. “Small and medium-sized enterprises and decent and productive employment” creation. Report presented at the *International Labour Conference, 104th Session*, 2015
- . 2015c. “What is a minimum wage. 1.7 Piece rate pay”. (Chapter 1, G. Billikopf, piece-rate pay design, ILO, Forthcoming (2015), and on K. Sankaran, piece rated minimum wages, ILO, Forthcoming).
- . 2016. “India labour market update” in the Report on India labour market update, (India, July, 2016 and July 2017).
- . 2017. “Decent work”. Available online at <http://www.ilo.org/global/topics/decent-work/lang-en/index.htm>. [accessed 15 May 2018].
- Inc42. 2016. “The 500 Indian start-ups shutdowns of the past 20 months.” Available online at <https://inc42.com/datalab/100-indian-start-ups-shut-down/> [accessed 15 May 2018].
- Indian Staffing Federation Presentation. 2014. “Indian staffing industry research 2014; Flexi staffing in government and public sector.” (Presentation on flexi-staffing in government, 2014). Available online at <http://www.indianstaffingfederation.org/wp-content/uploads/2015/05/Flexi-Staffing-in-Govt.-Public-Sector.pdf>. [accessed 15 May 2018].
- Internet Democracy Project. 2017. “Chupke, Chupke: Going behind the mobile phone bans in North India.” Available online at: [https://genderingsurveillance.internetdemocracy.in/phone\\_ban/](https://genderingsurveillance.internetdemocracy.in/phone_ban/) [accessed 15 May 2018].

- John L. 2017. "STS as method". Ulrike Felt et al ed. *The Handbook of Science and Technology Studies, Fourth Edition*. (Cambridge, Massachusetts: MIT Press, 2017).
- Jonathan Casey and Kendra Hughes. 2016. "Technology and the future of work," *WIEGO – Women in Informal Employment Globalizing and Organizing Practical Action Publication*.
- J. Robotics Private Limited. 2016. "Global 3D printing market overview". (Investor relations, J. Group Robotics, 2016).
- Karin R. 2016. "Study on emerging markets with special focus on Asia." (RockEU, August 16, 2016).
- Kapoor R and PP Krishnapriya. 2016. "The contracutalization of India's workforce: Explanations and implications," *International Growth Centre Project*
- Kapoor R, et al 2016. "The contracutalization of India's workforce: Explanations and implications". (International Growth Centre Project), November 1, 2016
- Kovacs A. 2017. Chupke, chupke: Going behind the mobile phone bans in North India," *Internet Democracy Project*.
- Labour glossary. 2013. Dictionary of occupational titles, 2003. Available online at [https://occupationalinfo.org/labor\\_glossary.html#W](https://occupationalinfo.org/labor_glossary.html#W) [accessed 15 May 2018]
- Livemint. 2014: "India-made robots deliver for e-commerce firms." Available online at <https://www.livemint.com/Specials/LKRruDG4V701hkaEyx53N/Indiamade-robots-deliver-for-ecommerce-firms.html>. [accessed 15 May 2018].
- . 2016: "China, India to dominate global Indian platform economy: Accenture Report." Available online at <http://www.livemint.com/Industry/E8L0nrfpAQwU33BOYafGP/China-India-to-dominate-global-digital-platform-economy-Ac.html>. [accessed 15 May 2018].
- . 2017a: "NITI Aayog proposes scheme for saving jobs from automation." Available online at <http://www.livemint.com/Politics/X02BkYjgt76mstRasNrEiI/NITI-Aayog-proposes-scheme-for-saving-jobs-from-automation.html>. [accessed 15 May 2018]
- . 2017b: "Just 800 start-ups launched in 2017 so far, compared to 6000 in 2016." Available online at <https://www.livemint.com/Companies/tgLTcS74hTVj8Cj6nKiEDM/Just-800-start-ups-launched-in-2017-so-far-compared-to-6000.html>. [accessed 18 May 2018]
- . 2018a: "Indian tech start-ups may struggle to comply with new EU data law." Available online at <https://www.livemint.com/Companies/XSfwu0XEFQyegRwQPVjThN/Indian-tech-start-ups-may-struggle-to-comply-with-new-EU-dat.html>. [accessed 15 May 2018].
- . 2018b: "Budget 2018: Niti Aayog takes centre stage in new policy moves." Available online at <https://www.livemint.com/Politics/dkFJ3sTUHG0XoruYMwpGeP/Niti-Ayog-takes-centre-stage-in-new-policy-moves.html>. [accessed 15 May 2018]
- Mark Muro and Jacob Whiton. 2017. "Beneath the US job numbers: Tech's influence on the workforce continues to hollow out the labor market" in *The Brookings Institution*. Available online at <https://www.brookings.edu/blog/the-avenue/2017/12/06/beneath-the-u-s-job-numbers-techs-influence-on-the-workforce-continues-to-hollow-out-the-labor-market/> [accessed 18 May 2018]
- Manyika, James et al. 2016. "How digital finance could boost growth in emerging economics". (Report by McKinsey Global Institute, 2016).
- . 2017. "Jobs lost, jobs gained: Workforce transitions in a time of automation". (Report by McKinsey Global Institute, December, 2017).
- McKinsey & Company. 2015. "The power of parity: Advancing women's equality in India". (Report by McKinsey Global Institute, November 2015).
- . 2017. "A future that works: Automation, employment and productivity". (McKinsey Global Institute, January, 2017).

- Moneycontrol. 2016. “HDFC Bank Exec – This is how future of digital banking looks like.” Available online at <http://www.moneycontrol.com/news/business/companies/hdfc-bank-exec-this-is-how-futuredigital-banking-looks-like-1000015.html> [accessed 15 May 2018].
- McCraw, K., Thomas. Cambridge. 2010. “Prophet of Innovation: Joseph Schumpeter and Creative Destruction” (Cambridge: Harvard University Press, 2010).
- Ministry of Commerce and Industry. 2017. Start-up India. (Website of start-upindia by the Government of India). Available at: <https://www.start-upindia.gov.in/>. [accessed 15 May 2018].
- Ministry of Skill Development and Entrepreneurship. 2016. “Report of the Committee for rationalization & optimization of the functioning of the sector skill councils.” (Report by Government of India, December, 2016).
- Ministry of Tribal Affairs, Statistical Division. 2013. Statistical profile of Scheduled Tribes in India.”
- NASSCOM. 2016. “Indian Start-up Ecosystem Maturing, Edition 2016.” (The National Association of Software and Services Companies, 2016).
- . 2017. “Jobs and skills: The imperative to re-invent and disrupt.” (The National Association of Software and Services Companies, May, 2017).
- NCEUS. “Report of definitional and statistical issues relating to informal economy.” (National Commission for Enterprises in the Unorganized Sector, November, 2008).
- The New York Times. 1987: “We'd better watch out”. Available online at <http://www.standupeconomist.com/pdf/misc/solow-computer-productivity.pdf>. [accessed 15 May 2018].
- . 2017: “Indian technology workers worry about a job threat: Technology.” Available online at <https://www.nytimes.com/2017/06/25/business/india-outsourcing-layoffs-automation-artificial-intelligence.html>. [accessed 15 May 2018].
- The News Minute. 2017: “3D printing lacks awareness in India, but can the few start-ups in this space change that?” Available online at <https://www.thenewsminute.com/article/3d-printing-lacks-awareness-india-can-few-start-ups-space-change-64447>. [accessed 15 May 2018].
- OECD. 2013. “‘Offshoring’: Glossary of statistical terms.” (OECD June, 2013).
- Rowntree, Oliver. 2018. “The mobile gender gap Report.” (Report by GSMA, 2018).
- Omidyar Network. 2015. “Currency of Trust: Consumer behaviours and attitudes toward digital financial services in India”.
- Online Tech. “Cloud computing definition by McKinsey&Company.” (Community of IT Professionals, April, 2009).
- Pratham. 2016. “Annual Status of Education Report (ASER) 2016”, (New Delhi: ASER Centre).
- Pedro S. Rapaso and Jan C. Our Van. 2008. “How working time reduction affects employment and earnings.” *Institute for the Study of Labour, September, 2008*.
- Reuters. 2017: “India to speed up State Bank merger for broader economic revival.” Available online at <https://in.reuters.com/article/india-banks-m-a/india-to-speed-up-state-bank-mergers-for-broader-economic-revival-idINKCN1B31VT>. [accessed 15 May 2018].
- Robotics Business Review. 2015: “India’s Asian dilemma: How best to grow robotics industry?” Available online at [https://www.roboticsbusinessreview.com/manufacturing/indias\\_asian\\_dilemma\\_how\\_best\\_to\\_grow\\_robotics\\_industry/](https://www.roboticsbusinessreview.com/manufacturing/indias_asian_dilemma_how_best_to_grow_robotics_industry/). [accessed 15 May 2018]
- Sabnavis, et al, “Automobile components: Structure and prospects.” (CARE ratings professional risk options, May 27, 2017).

- Sainath P. et al. 2014. "Deregulating capital, regulating labour: The dynamics in the manufacturing sector in India." (Economic and Political Weekly, Volume XLVIX, 2014).
- . 2015. "The slaughter of suicide date," *PARI – People's Archive of Rural India*.
- Schmidt, Marty. 2018. "Capital Intensive Industries and Companies." (Business case analysis, 2018). Available online at <https://www.business-case-analysis.com/capital-intensive.html>. [accessed 15 May 2018].
- Schwab, Klaus. 2016. *The Fourth Industrial Revolution*. (London: Penguin, 2016).
- Scroll.in. 2017a: "Maruti Suzuki partially replaces manpower with robots at its Manesar and Gurugram plants." Available online at <https://scroll.in/latest/837078/maruti-suzuki-partially-replaces-manpower-with-robots-at-its-manesar-and-gurugram-plants>. [accessed 15 May 2018].
- . 2017b: "Watch: Robot bricklayers are here. Could they replace manual construction workers in India too?" Available online at <https://video.scroll.in/836159/watch-robot-bricklayers-are-here-could-they-replace-manual-construction-workers-in-india-too>. [accessed 15 May 2018].
- . "High targets and wasted funds: Problems with the Skill India Programme," Available online at <https://scroll.in/article/844871/high-targets-and-wasted-funds-the-problems-in-the-skill-india-programme>. [accessed 15 May 2018].
- Renu Singh and Protap Mukherjee. 2017. "Whatever she may study, she can't escape from washing dishes: Gender inequity in secondary education". *Taylor & Francis Online*.
- Sharma, et al: "India Labour and Employment Report 2014: Workers in the era of globalization." (Institute of Human Development, 2014). Available online at <http://www.ihdindia.org/ILERpdf/Highlights%20of%20the%20Report.pdf>. [accessed 15 May 2018].
- De Stefano, Valerio. 2016. "The rise of the just- in- time workforce: On- demand work, crowd work and labour protection in the gig economy" (ILO, 2016) Available online at [http://www.ilo.org/wcmsp5/groups/public/---ed\\_protect/---protrav/---travail/documents/publication/wcms\\_443267.pdf](http://www.ilo.org/wcmsp5/groups/public/---ed_protect/---protrav/---travail/documents/publication/wcms_443267.pdf) [accessed 15 May 2018].
- Sirkin, Harold L et al. "The robotics revolution." (Boston Consultancy Group (BCG), September, 2015). Available online at [https://circabc.europa.eu/sd/a/b3067f4e-ea5e-4864-9693-0645e5cbc053/BCG\\_The\\_Robotics\\_Revolution\\_Sep\\_2015\\_tcm80-197133.pdf](https://circabc.europa.eu/sd/a/b3067f4e-ea5e-4864-9693-0645e5cbc053/BCG_The_Robotics_Revolution_Sep_2015_tcm80-197133.pdf).
- Sood, A, et al. 2014: "Deregulating capital, regulating labour: The dynamics in the manufacturing sector in India," *Economic and Political Weekly*, Volume XLVIX, 2014
- Srija, A. and Shirke, Shrinivas V. "An analysis of the informal labor market in India." Confederation of Indian Industry, October 2014. <<http://www.ies.gov.in/pdfs/CII%20EM-october-2014.pdf>>
- Taylor&Francis Online. 2017. "Whatever she may study, she can't escape from washing dishes: Gender inequity in secondary education." Available online at <<https://www.tandfonline.com/doi/abs/10.1080/03057925.2017.1306434>. [accessed 15 May 2018].
- Truelancer. 2018. "Top 10 bank reconciliation bankers of India." Available online at <https://www.truelancer.com/bank-reconciliation-freelancers-in-india>. [accessed 15 May 2018].
- The Wire. 2017a: "India is very much part of the global productivity slowdown". Available online at <https://thewire.in/economy/india-global-productivity-slowdown>. [accessed 15 May 2018].
- . 2017b: "Lost your job? Piyush Goyal thinks that's a 'very good sign.'" Available online at <https://thewire.in/184907/piyush-goyal-india-jobs/>. [accessed 15 May 2018].
- . 2017c. "Why Indian workplaces are losing women," Available online at <https://thewire.in/labour/indian-workplaces-losing-women-nationwide>. [accessed 15 May 2018].

- . 2017d: “Digital India is no country for women.” Available online at <https://thewire.in/economy/digital-india-women-technology>. [accessed 18 May 2018].
- YourStory. 2017: “Quickr acquires BabaJobs, spreads its net wide for bluecollar jobs.” Available online at <https://yourstory.com/2017/06/quikr-acquires-babajob/>. [accessed 15 May 2018].
- Vashisht P. 2017. “Destruction or polarization: Estimating the impact of technology of jobs in Indian manufacturing,” *Indian Council for Research on International Economic Relations*, Working Paper 334, March 2017.
- Vellody, et al.: Impact of e-commerce on employment in India,” (KPMG Report, 2016). [accessed 15 May 2018].
- Verik, Sher: “Women’s labourforce participation in India: Why is it so low?” (ILO, 2014). Available online at [http://www.ilo.org/wcmsp5/groups/public/---asia/---ro-bangkok/---sro-new\\_delhi/documents/genericdocument/wcms\\_342357.pdf](http://www.ilo.org/wcmsp5/groups/public/---asia/---ro-bangkok/---sro-new_delhi/documents/genericdocument/wcms_342357.pdf). [accessed 15 May 2018].
- Vigneswara. I. 2017. “Automation and Workforce in India: Terrible Consequences or Impossible?” (SSRN, September 18, 2017). Available online at [https://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=3038759](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3038759). [accessed 15 May 2018]
- . 2018. “Automation and workforce in India: Terrible consequences or impossible?” (SSRN, September 18, 2017). Available online at [https://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=3038759](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3038759). [accessed 15 May 2018]
- World Bank. 2017. “Access to electricity”. Available online at <https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS> [accessed 15 May, 2018].
- . 2018: “The changing nature of work, 2019 World Development Report, working draft.” Available online at <http://pubdocs.worldbank.org/en/816281518818814423/2019-WDR-Concept-Note.pdf>. [accessed 15 May 2018].
- World Bank Group Foresight Report. 2016: “World Development Report 2016, digital dividends.” Available online at <http://documents.worldbank.org/curated/en/896971468194972881/pdf/102725-PUB-Replacement-PUBLIC.pdf>. [accessed 15 May 2018].
- YourStory. 2017: “Quickr acquires BabaJobs, spreads its net wide for bluecollar jobs.” Available online at <https://yourstory.com/2017/06/quikr-acquires-babajob/>. [accessed 15 May 2018].





# Glossary

## **Unorganized/Informal sector and informal workers**

Varying definitions of the unorganized sector have been utilized by different state bodies in India, from the National Sample Survey Organization (NSSO) to the Directorate General of Employment and Training (DGET).

Based on these variations, and the ILO's conceptualization of the 'informal sector', the National Commission of Enterprises in the Unorganized Sector (NCEUS) in their 'Report on definitional and statistical issues relating to informal economy' has formulated a definition pertaining to the Indian context. The report makes a distinction between both informal/ unorganized sector and informal workers.

Unorganized/informal sector (used interchangeably, as per NCEUS usage): The informal sector consists of all unincorporated private enterprises owned by individuals or households engaged in the sale and production of goods and services operated on a proprietary or partnership basis and with less than ten total workers.

Informal worker/ employment: Informal workers consist of those working in the informal sector or households. They exclude regular workers with social security benefits provided by employers and workers in the formal sector, without any employment and social security benefits provided by employers.

## **Service and white-collar workers**

Service workers: Low to medium-skilled workers are typically engaged in informal work in the unorganized sector. They offer services ranging from driving, domestic work to artisanal services such as carpentry and plumbing.

White-collar workers: These are workers who have office jobs rather than factory, farm, or construction work. In the Indian context, this mainly includes medium to high-skilled workers occupied in the organized sector.

## **Capital and labour-intensive industries**

Capital-intensive industries: Includes those whose major costs result from investments in equipment, machinery and/or other expensive capital assets. For capital-intensive companies, asset structure is represented largely by assets such as land, buildings, plants, equipment, vehicles, or heavy equipment.

Labour-intensive industries: Depends mainly on labour in the production of goods and services.

## **Offshoring, outsourcing, re-shoring, back-shoring, near-shoring**

Offshoring: Used to describe a business (or government) decision to replace domestically supplied service functions with imported services that are produced offshore.

Outsourcing: Acquires services from an outside (unaffiliated) company or an offshore supplier.

Re-shoring, near-shoring and back-shoring: Relocation of all or parts of the production process to (or near) the country of origin of the parent company by a multinational enterprise (MNE).

## **Emerging technologies**

Artificial intelligence: A scientific and engineering discipline devoted to understanding principles that make intelligent behaviour possible in natural or artificial systems. It helps; develop methods for the design and implementation of useful and intelligent artefacts.

Machine learning: Based on algorithms that can learn from data without relying on rules-based programming.

The Internet of Things (IoT): System of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

Machine-to-machine: M2M communications and/or any technology enables networked devices to exchange information and perform actions without the manual assistance of humans.

Robotic Process Automation (RPA): A software automation tool that automates routine tasks such as data extraction and cleaning through existing user interfaces.

## **Piece-work/Gig-work**

Task-based assignments and remuneration. Workers are paid by the unit performed instead of being paid on the basis of time spent on the job. In developing countries, workers relying on piece work wages often constitute a vulnerable section of workers, with many working in the informal economy. Piece work is increasingly being performed through the platform economy, often called gig-work in this context. Such piece or gig-work includes 'crowd work' and 'on-demand work'.

The Fourth Industrial Revolution (4IR), characterized by the convergence of a cluster of technologies — cutting across the physical, digital, and the biological worlds — machine-learning and artificial intelligence, advanced robotics and autonomous transport, cloud computing and the Internet of Things, among others, is expected to profoundly transform the future of work. Many jobs and ways of working will become redundant while many new jobs will be created. Production processes, business models, service delivery mechanisms along with employment relationships and social protection frameworks are likely to be reconfigured. Anxiety about the world of work is not new, but it is claimed that this time around the speed and spread of technological advancement will be unprecedented.

Global narratives on the impact of 4IR need to be localized and re-examined. While new technologies will be developed and deployed globally, the impact on the future of work will be mediated through local political, legal and socio-economic structures. This study examines the likely impact of 4IR on the future of work in India, with a specific focus on job-displacement, employment conditions, and labour market inequities in India.

Automation potential must be distinguished from automation adoption. While a high number of tasks might be technically automatable, the adoption of particular technologies will depend on a complex interplay of factors including the cost of labour; levels of education and skilling; legal frameworks for innovation; labour protection policies; the availability of supporting infrastructure; and the social and cultural norms that shape attitudes towards technological change and innovation.

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India Habitat Centre, Core 4B, 3rd Floor  
Lodi Road New Delhi-110003  
India  
Tel.: +911147509200, Fax: + 911124602111  
Email: [delhi@ilo.org](mailto:delhi@ilo.org)  
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ISSN: 2227-4391 (print)  
22274405 (web pdf)