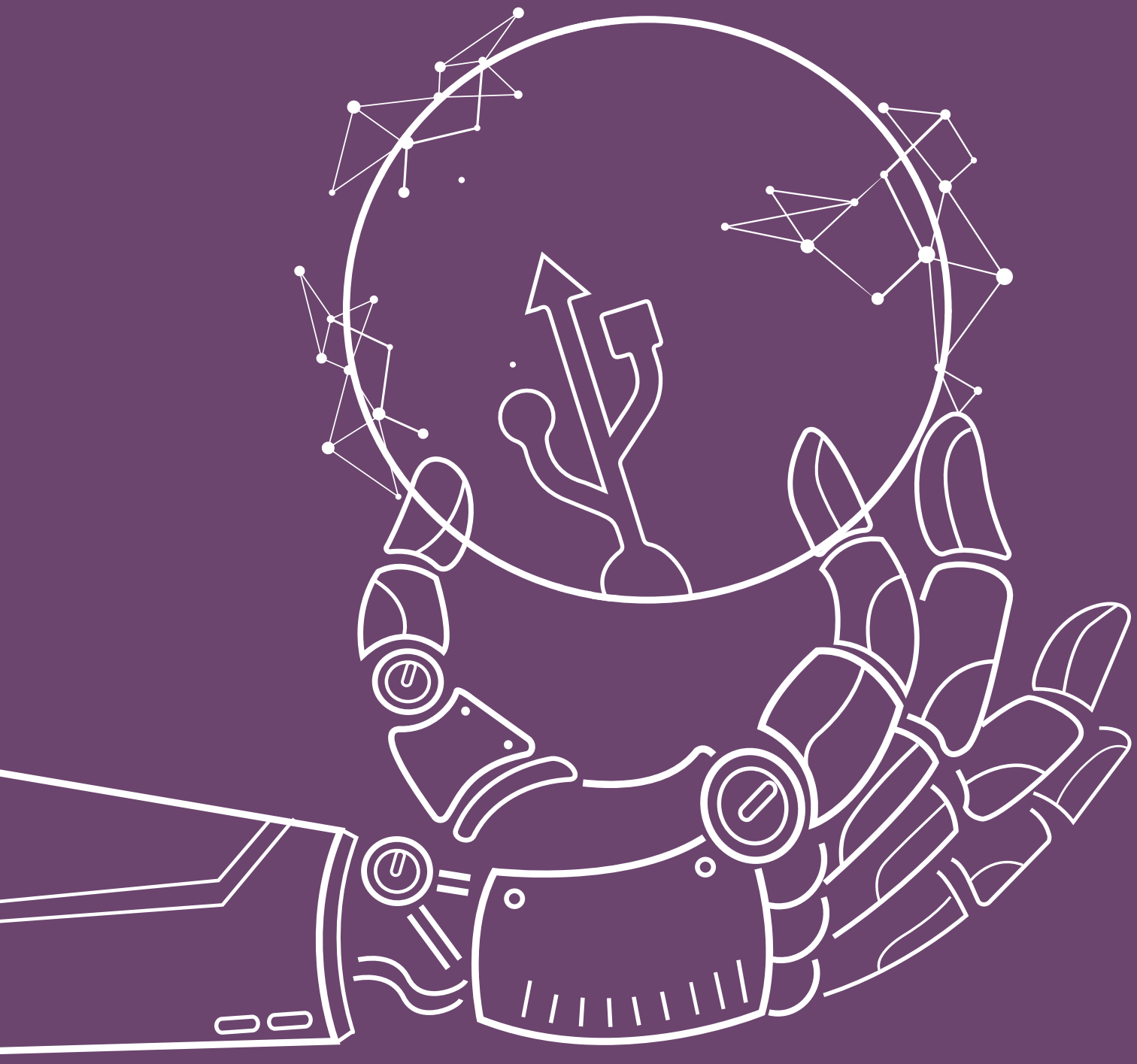
Artificial Intelligence in India - Vol. 9



FRIEDRICH EBERT STIFTUNG

Industrial Revolution 4.0 and the Impact on Information Technology Services Sector

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Preface

"After all, we make ourselves according to the ideas we have of our possibilities."
V.S. Naipaul

There is no doubt that the technological advancement has become the game changer of our times. From the Industry 4.0 discourse launched in Germany in 2011 to the scientific advisory report presented to the former US president Barrack Obama on big data and privacy concerns in 2014, to India's NITI Aayog Artificial Intelligence for All strategy of 2018. A lot of debates have culminated in the questions about the Future of Work in the context of the International Labour Organisation's Centenary in 2019. Triggered by the disruptive forces of technology based start-ups and new business models, a new race for innovations and war for talents has arisen and with it, a new form of global and fierce competition.

Technology has become the holy grail of progress though it did not take long to realise that there is a social dimension attached to it. The platform economy has had severe effects on the bargaining power of suppliers and workers. Data analytics opened a whole array of ethical questions regarding personal tracking and privacy. Further, technological upgrades create productivity gains by efficiency which in turn requires reduced human labour. This poses a particular threat to emerging economies, like India, which need to create new jobs on massive scale for its young and growing population.

The utopia around Artificial Intelligence in the times of jobless growth presents a whole new set of challenges. Is the Indian economy ready to ride the AI wave? Who will benefit from AI: investors, big tech, users, or society as a whole? What is and can be India's role in this global race for innovation? Is tech gender neutral? What about privacy and user protection? How to ensure decent work and social protection in this new age tech revolution? But mostly, how can we turn Artificial Intelligence for All into a reality?

To foster this debate, the FES India Office has teamed up with several experts and organisations across the country to explore ground realities with the objective to understand how technology is already unfolding in selected sectors, draft scenarios of what might happen and to ensure proper safeguards are put in place at the right time.

Artificial Intelligence like any other technology is neither good nor bad. It is what we make out of it - the rules and regulations – which define the outcome of the game. Just like other countries, in India too, a mass scale application of AI is far from being established. It is still in a nascent phase and can be moulded into a success story. A success story in India AND an Indian success story for all.

Patrick Ruether and Mandvi Kulshreshtha
April 2020
Friedrich-Ebert-Stiftung, New Delhi

Note of thanks

Friedrich-Ebert-Stiftung (FES) India office is thankful to its partner The Dialogue for preparing this research paper. The Dialogue is an emerging research and public-policy think-tank with a vision to drive a progressive narrative in India's policy discourse. The Dialogue has prepared two research papers for FES India. The present one is on Industrial Revolution 4.0 and the impact on the IT sector. The second one is on Industrial Revolution 4.0 and the impact on Automotive Sector.

We are grateful to our colleagues at The Dialogue for preparing the research, drafting this paper and refining the manuscript to reflect our joint vision. We have to express our appreciation to all the experts and resources persons who participated in these labs, for their constructive contribution and valuable time during the course of this research.

Contents

List of abbreviations

AI	Artificial Intelligence
ASEAN	Association of Southeast Asian Nations
AR	Augmented Reality
BPO	Business Process Outsourcing
CAD	Computer Aided design and Drafting
CAGR	Compound Annual Growth Rate
CII	Confederation of Indian Industry
CIOs	Chief Information Officer
CKD	Complete Knock Down
ESDM	Electronic System Design and Manufacturing
FDI	Foreign Direct Investment
FICCI	Federation of Indian Chambers of Commerce and Industries
EV	Electric Vehicles
HMSI	Honda Motorcycle and Scooter India
IBM	International Business Machines
IOT	Internet of Things
ILO	International Labour Organization
ITI	Industrial Training Institutes
IT/IT-es	Information Technology and Information Technology enabled services
KPO	Knowledge Process Outsourcing
STP	Software Technology Park
MSIL	Maruti Suzuki India Limited
MSMEs	Micro Small and Medium Enterprises
NATRiP	National Automotive Testing and R&D Infrastructure Project
MTOC	Model, Type, Option and Colour
NEMMP	National Electric Mobility Mission Plan
NLP	Natural Learning Program
NSDA	National Skill Development Agency
NSDC	National Skill Development Corporation
OEMs	Original Equipment Manufacturers
PC	Personal Computers
PwC	PricewaterhouseCoopers
RBC- DSAI	Robert Bosch Centre for Data Science and Artificial Intelligence
R&D	Research and Development
SAARC	South Asian Association of Regional Cooperation
SIAM	Society of Indian Automobile Manufacturers
SSCs	Sectoral Skill Councils
STEM	Science, Technology, Engineering and Mathematics
VR	Virtual Reality

List of Figures

Foreword

In 1963, a committee under the chairmanship of Dr. Homi Bhabha, also known as the driving force of India's nuclear programme, recommended a road map for increasing computerisation across various sectors. The Committee also recommended setting up a dedicated Department of Electronics in the Government of India to increase India's computing prowess through focussed policy interventions.

But in 1969, the Ministry of Labour, Employment and Rehabilitation of the Government of India set up another committee under R. Venkataraman, then a member of the Planning Commission. The Committee was later chaired by V M Dandekar, the then Director of the Pune-based Gokhale Institute of Politics and Economics. Known as the Dandekar Committee on Automation, it recommended strict controls on automation and computers in the government and the industry fearing large scale unemployment. What Dr Bhabha's committee had suggested in 1963 came to a grounding halt in 1972, barely two years after plans to implement computerisation had been drawn up. Till 1978, computerisation was treated a threat rather than an opportunity.

This is an apocryphal story of how policy in India can be at odds with technology, innovation and their impact on economics. Had Dr. Bhabha's recommendations prevailed, India could have switched to developing capacity in computerisation, and emerged as a global leader, leading to greater opportunities rather than mass-scale unemployment. However, the needs of the present became inimical to the aspirations of the future in 1972.

As the world heads into Industrial Revolution 4.0, this is a time of upheaval and great economic challenges. Clearly, this will have a major impact on India's IT/IT-es sectors. As the authors of this study point out, "technological advance under Industrial Revolution 4.0 is a journey, which every organisation will have to undertake." This is true not only for organisations, but also governments and citizens hoping to remain relevant in the 21st century. Machine Learning and its sub-set Artificial Intelligence will pose many challenges to the current global economic order but will inevitably create many opportunities. The study by The Dialogue team supported by Friedrich-Ebert-Stiftung is an important intervention that examines these challenges and opportunities and comes up with clear recommendations. India simply cannot afford to make the mistake of 1972. It is for policy makers to take up the suggested road map and build on it to create a sustainable future.

Saikat Datta
South Asia Editor
Asia Times

Acknowledgements

We would like to thank Centre for Internet Society's contribution and support towards shaping this research paper, from its conception to final execution. We would like to thank Mr. Ayush Rathi and Mr. Sunil Abraham for their regular guidance and support towards helping The Dialogue develop this research study. Our research builds from CIS' own research on this subject and their contribution has played a fundamental role towards guiding The Dialogue's research on this subject. This includes the research outline, methodology, and the stakeholders who helped The Dialogue develop an understanding the role of automation in the IT/IT-es sector in India.

The data presented and analysed in this report was collected during field visits and interviews of stakeholders from Delhi-NCR and Bangalore. The research was conducted from May 2019 to February 2020 and was supported by Friedrich-Ebert-Stiftung, India. We gratefully acknowledge the generous support of these agencies. Our heartfelt thanks to fellow civil society organisations, industry bodies, Government of India and public and private universities for sharing their views. We extend our gratitude to Ms. Shruti Shreya, for her research assistance.

Here is a list of few stakeholders who were interviewed for this study:

Achyuta Ghosh, Research Head, NASSCOM
Biswajit Bhattacharya (Dr.), Partner & Executive Director, IBM
Deepak R, General Secretary, Forum for IT Employees
Devendra Sharma, Control Engineer, General Electric
Goutam Das, Journalist Business Today
Leeladhar Rao, Founder & CEO, Happy Minds
Radhika Radhakrishnan, Programme Officer, The Centre for Internet and Society
Rajesh N, President, Forum for IT Employees
Ravi Kaklasaria, CEO & Co-Founder, SpringPeople
Rohit Gupta, Unit Head, New Product Development Asahi India Glass Limited
Sandhya Chintala, VP NASSCOM and CEO IT/IT-es Sector Skills Council NASSCOM
Sanjay Lakhotia, Co-Founder, Noble House
Santosh Mehrotra (Prof.), Centre for Labour Studies, Jawaharlal Nehru University
Varun Aggarwal, Co-founder, Aspiring Minds

Executive summary

With the advent of Industrial Revolution 4.0 its impact assessment has been a cause celebre. Accordingly, this report analyses the penetration and consequent implications of Industrial Revolution 4.0 on the IT/IT-es sector in India.

The research methodology is qualitative in nature. First an exploratory research was conducted by way of document analysis in and around the issues. Based on the results of stage one, we conducted semi-structured interviews with thought leaders, industry stakeholders-right from the CEOs to the trade union workers and government bodies which was followed by a Focus Group Discussion.

This report lays out the key stakeholders, contextualises the work in the IT/IT-es sector and co-relates it with the factors driving the change in work in the sector. The last section summarises the impact of Industrial Revolution 4.0. on the country, industry and individuals and concludes with policy recommendations.

The report throws light on the labour law reforms being introduced in India which aim to subsume 44 central labour laws into four labour codes in order to strengthen investments and tackle slowdowns in the labour industry. To that end, this report discusses the impact of the Code on Wages Act, the Code on Industrial Relations Bill, the Code on Social Security Bill, and the Code on Occupational Safety, Health and Working Conditions Bill. Development of labour laws which do not take into consideration the technological developments in India is an opportunity missed to resurrect a forward looking labour law regime. The regime so envisaged in the four codes does not take into consideration the rights of gig workers, does not empower them with the right to collective bargaining, fails to clarify ambiguities pertaining to basic criteria for availing social security benefits such as the minimum number of employees in an organisation and the length of service, among other major concerns. The report also maps major central and state government policies that directly or indirectly affect the growth and development of the IT/IT-es sector.

The review of existing literature and interviews with the stakeholders informed that the technological adoption of Industrial Revolution 4.0 technologies in the IT/IT-es sector is still growing. The major impact of the technological disruptions is six-fold. First, the companies are looking forward to hiringup-skilled workforce with foundational knowledge of emerging technologies and that the change in job-roles and intensification of jobs has been witnessed. Second, keeping aside a handful of Indian tech giants, the industry is not ready to invest in Industry 4.0 technology, instead small start-ups which successfully experiment with emerging technologies are acquired or partnered by the established corporations. Third, the skilling agencies have been burdened with the duty to re-skill, up-skill the workforce to leverage India's demographic dividend. Fourth, the technological disruption has impacted various genders, differently. The gendered digital divide in India and the abusive online environment has thwarted the participation of women in the IT/IT-es sector which is further reinforced by the inherent patriarchal biases plaguing India. Fifth, the productivity of the IT/IT-es sector has increased. Sixth, the technological development in the IT/IT-es sector has also led to job creation in allied sectors like medicine, textiles and automobile.

The report concludes with five major suggestions. First, India should diversify the export target countries to make inroads in other major markets such as Japan. The reliance has also stymied India from moving up the value chain and not confining the areas of the IT sector specialisation to services and the BPO sector. Second, owing to the dynamic nature of technological upgradation in the IT/IT-es sector, there is a need to inculcate lifelong learning capabilities at an individual level and is incumbent upon the government, industry and the worker to work together towards this end. Third, the industry should engage with the government and the academic institutions to provide, advanced educational and up-skilling opportunities to the upcoming and the existing workforce. Fourth, there is a need to strengthen social security for the workforce considering that the emergence of non-standard forms of employment in the informal economy is anticipated to only increase in the future. Fifth, there is a need to upgrade the R&D ecosystem in India with institutionalised disruptions in the varsities on emerging technologies. There is a need to develop a cultural shift in the Indian education system by instilling innovation and cross-sectional education at the center.

Introduction

The Fourth Industrial Revolution has touched almost all aspects of human life. With the rapid evolution of emerging technologies, it is pertinent to study its impact on a developing economy like India. While the Global North leads, the Global South is catching up with concerted effort towards developing technological prowess. It is in this context that this report seeks to examine the impact of emerging technologies on the IT/IT-es sector of India. The report ventures to study the sectoral impact of Industrial Revolution 4.0 on the Future of Work by seeking qualitative inputs from the stakeholders in the ecosystem.

Sector context

The Indian IT industry has grown immensely, and its contribution to the global market has been widely acknowledged. Taking off from the software industry's rapid globalisation and increased software demand following the 1970s personal computer (PC) revolution, the Indian IT industry responded to the emerging demand for networking in the 1980s. The internet marketing in the 1990s and the growing demand for Indian IT engineers in the area of customised software development as well as computer machine repair and maintenance prompted the industry's rapid growth.[1]

During the early years of post-independence India, the existence of a burgeoning IT industry could be detected, although it remained an irrelevant field for a long time. The sector had achieved little, even by the early 1990s, to underline its relevance to the process of national industrialisation. This was despite the fact that enormous efforts were made by the State to develop and maintain an information network that allowed the IT sector to flourish after the 1990s. Nonetheless, it was claimed that the State had played a constructive position from the mid-1980s to the mid-1990s, in accordance with the increasing speed of trans-nationalisation of business and trade.[2]

In addition, India's position as the world's preferred Business Process Outsourcing (BPO) and Knowledge Process Outsourcing (KPO) destination had been established with the economic reforms formally in place by the early 1990s. Through capitalising on demand for low-cost yet high-quality programming skills, India joined the global IT industry.[3] During the 1990s (and beyond) the establishment of a series of software technology parks (STPs) across several cities in India was an exemplary State initiative to promote an industry.

India's position as the world's preferred Business Process Outsourcing (BPO) and Knowledge Process Outsourcing (KPO) destination had been established with the economic reforms formally in place by the early 1990s.

Objectives

Considering the need of sectoral research on the impact of the Industrial Revolution 4.0 on the Future of Work in India, the key objectives of this exploratory research is to:

- Decrypt the penetration of the Industrial Revolution 4.0 technologies in the IT/IT-es sector of India;
- Map the existing State policies and initiatives to cater to the needs of the Industrial Revolution 4.0;
- Suggest educational and skilling reforms to keep the Indian workforce industry-ready.

Stakeholders

- **Government Bodies:** Ministry of Labor and Employment, NITI Aayog, Ministry of Skill Development and Entrepreneurship, National Skills Development Corporation, and IT/IT-es Sector Skills Council.
- **Trade Unions:** Forum for IT employees, Information Technology Employees Association (FITE), and IndustriALL, Global Trade Union.
- **Industry Bodies:** National Association of Software and Services Company.
- **Universities and Training Centers:** IIT, Delhi and Northern India Textile Research Association, Ghaziabad, U.P.
- **Employees and Workers**
- **Corporations:** Dell, IBM, Happy Minds, SpringPeople, Noble House, and Aspiring Minds.
- **Civil Society and Academia:** Centre for Internet and Society, Delhi and Indian Council for Research on International Economic Relations, International Labor Organization, and Centre for Labor Studies, Jawaharlal Nehru University.

I. Research methodology

This research was conducted in three stages. First, secondary research of both qualitative and quantitative nature on the existing literature on Industrial Revolution 4.0, Future of Work and IT/IT-es sector of India was conducted. Second, based on the comprehensive review of the existing literature and expert advice, questionnaires were prepared to conduct semi-structured interviews of the stakeholders in the IT/IT-es sector of India. Third, the findings of the first two stages were discussed at a Focus Group Discussion where both the interviewed stakeholders and other leaders in the ecosystem were invited to give further suggestions which were incorporated in the report.

1. Research questions

i. Have the Industrial Revolution 4.0 technologies penetrated in the IT/IT-es sector of India?

ii. How can we keep the Indian workforce indus try-ready for Industrial Revolution 4.0?

iii. What is the role of the State, corporates and individuals in tapping the potential of Industrial Revolution 4.0?

2. Research method

The primary objective of this research is to understand the impact of Industrial Revolution 4.0 in the IT/IT-es sector of India. To gauge the impact, the research team decided to undertake a case-study of a network of stakeholders working in Delhi-N.C.R. and Bangalore. The case-study method was chosen as it allows to undertake an in-depth investigation of a group to explore the causes of underlying disruptions.[4] While endeavoring to collect data the research team had relied on a combination of the following methods.

i. Semi-structured positivist interviews

Based on the literature review in the first stage and expert advice 'Questionnaires' were prepared for each group of stakeholders to guide the research team in conducting 'Semi-Structured Positivist Interviews'.

ii. Documentary analysis

Documents provide evidence of policy directions, legislative intent, understandings of perceived shortcomings and even best practice in the legal system, and agenda for change. Thus, the research team analysed statutes, bills, judgements, government reports, policy papers, etc.

3. Sampling

In order to gauge the perspective of the IT/IT-es ecosystem, the research team mapped the stakeholders from the entire ecosystem. To achieve this end, the 'Snowball' method of sampling was complimented with 'Purposive' sampling. Accordingly, stakeholders from senior and mid-management, trade unions, human resource representatives at software companies and BPOs, skilling agencies, consulting bodies, government agencies, bureaucrats, industry bodies, researchers and academics were interviewed.

4. Limitations

The geographical limitation of this research is Delhi-N.C.R. and Bangalore. While the stakeholders being leaders in the ecosystem represented the general sentiment of the IT/IT-es sector pan India, some of their inputs may be regional. Aligning with the objective of this report, only national trends have been highlighted and wherever deemed necessary regional trends have been mentioned with appropriate caveats.

II. Legal and policy regime in India

1. Legal regime in India

"I believe in the dignity of labour, whether with head or hand; that the world owes no man a living but that it owes every man an opportunity to make a living."
John D. Rockefeller

"Government of India is planning to subsume 44 central labour laws into four labour codes in order to strengthen investments and tackle slowdowns in the labour industry. The Union government also plans to launch a unique 'Santusht' portal for the effective implementation of labour legislations at the grassroot level. The four labour codes include one on wages while the other three are on occupational safety, industrial relations and social safety. All four combinedly are expected to safeguard interest of workers and improvise ease of doing business."

Government of India is planning to subsume 44 central labour laws into four labour codes in order to strengthen investments and tackle slowdowns in the labour industry.

a. Code on Wages Act

The Code on Wages Bill, 2019 was passed by the Lok Sabha in July, 2019 and the Rajya Sabha in August, 2019. It is the first of the four labour codes. This Act replaces four existing acts which related to wages namely, Payment of Wages Act, 1936, the Minimum Wages Act, 1948, the Payment of Bonus Act, 1965, and the Equal Remuneration Act, 1976 into one code. It also expands the definition of 'employer' and 'employee', so that the employees in both the formal and informal sectors can have a range of regulations applicable to them. However, it fails to account for the workers in the gig economy.[5]

The gig economy allows for arrangements to be made where labourers are termed as contractors and not employees. This means that they can do work which doesn't require them to have a fixed-term contract or work under traditional employers. Instead, they can style their own hours of work, earn based on how much time they spend on the job and what kind of feedback they derive from their clients.

The Code on Wages Act could have taken the initiative to delve deeper and understand the nature of work in modern times. However, it fails to account for the fact that gig economy workers are not restricted to any particular platform and there is ambiguity in terms of the enforceability of their contract. It is unclear whether the gig economy workers are entrepreneurs or work for aggregators. This problem is reflective of the fact that the new laws fail to account for changes in the present and in the future.

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b. Code on Industrial Relations

Labour Code on Industrial Relations Bill 2015 proposes to amalgamate three important central labour laws dealing with industrial relations namely The Trade Unions Act, 1926, The Industrial Employment (Standing Orders) Act, 1946 and The Industrial Disputes Act, 1947. The present form of the Draft Code contains 107 sections and 3 schedules, dealing with various industrial relations issues, including registering trade unions, standing orders, notice of change of terms of employment, strikes, lockouts, lay-offs, redundancy and site closures.[6]

However, trade unions argue that the draft code only takes into account employer demands for greater labour market flexibility and labour discipline while ignoring the demands of the trade unions.[7] Considering the rapid technological adoption, it must be incumbent upon the employer to routinely re-skill and up-skill an employee, instead of laying-off and hiring up-skilled labour afresh every time a new technology is adopted.

Trade unions argue that the draft code only takes into account employer demands for greater labour market flexibility and labour discipline while ignoring the demands of the trade unions.

Further, the limit of more than 300 employees to get permission for layoff will reduce the accountability of employers and expose a large number of workers to arbitrary closures and terminations. The code does not mention about collective bargaining and its mandate of registration in trade unions to become office-bearers interferes with the ability of the workers to choose their leaders and stands against the standards in the ILO Convention of Freedom of Association and Protection of the Right to Organise.[8]

c. Code on Social Security

The Code on Social Security, 2019, proposes to amalgamate eight existing labour laws and constitutes a plethora of new initiatives like universal social security for unorganised sector workers with schemes relating to provident fund, employment injury benefit, housing, educational schemes for children and old age and funeral assistance.[9] It also provides for corporatisation of existing organisations like EPFO (Employees Provident Fund Organisation) and ESIC (Employees State Insurance Corporation) and insurance and health benefits for gig workers including life and disability insurance and health and maternity benefits.[10]

However, the code fails to clarify ambiguities pertaining to basic criteria for availing social security benefits such as the minimum number of employees in an organisation and the length of service. Further there is no uniform definition of 'social security' nor is there any centralised fund for providing the same. Also, "workers", "wages" and "principal agents" in a contractual scheme and workers belonging to the "organised" and "unorganised" sectors have not been defined properly making the extension of all social benefits to all sections of the workers difficult.[11]

d. Code on Occupational Safety, Health and Working Conditions

The purpose of this code is to provide "just and humane conditions of work" in a diverse range of economic activities. However, the code is applicable to establishments with more than ten workers and most of the establishments in India have less than ten workers. Furthermore, Second National Commission on Labour had recommended simplification and consolidation of existing health and safety laws. However, the code retains special provisions for various categories of workers without giving any plausible clarification for the same. Additionally, the code puts a bar on the jurisdiction of civil courts with the only judicial recourse for a person aggrieved under the code being to file a writ before the High Court.[12]

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2. Policy regime in India

There has been a concerted effort by the Government of India and the State Governments in the development of policy regime to take India forward. As emerging technologies penetrate the Indian subcontinent, the following figures explicate the policy regime at the national and state level in India, respectively.

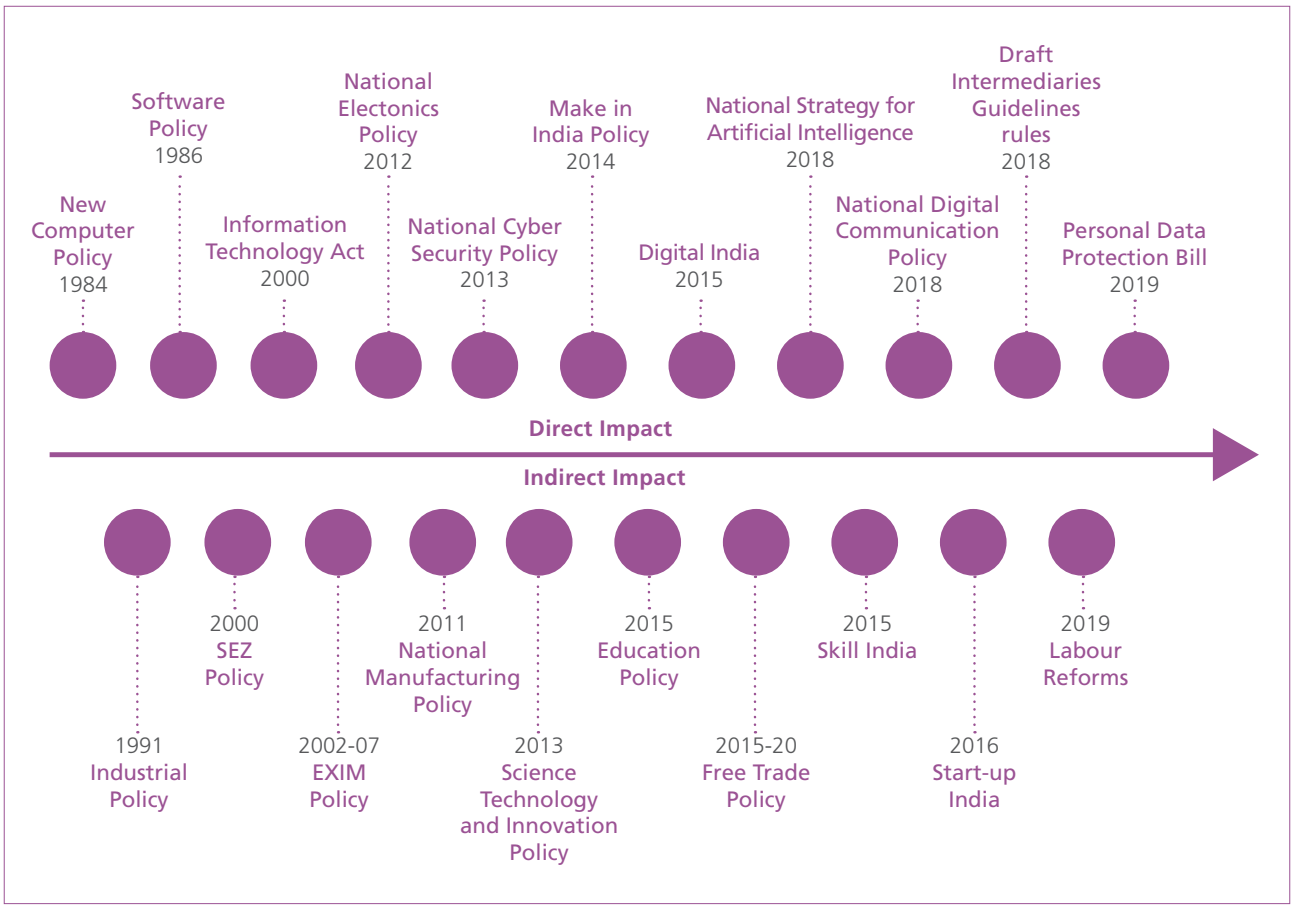

Figure 1: National policy directly and indirectly impacting the IT/IT-es sector of India.[13]

Figure 2: State sectoral policies impacting the IT/IT-es sector of India

III. Mapping Industry 4.0 in the sector

1. Cloud computing

Cloud computing is an IT utilisation and distribution paradigm that enables configurable computer tools such as networks, servers, data, applications and services to be distributed in real time. As the industry progressed, it became evident that cloud computing could provide greater benefits. First is the ability to deliver and eliminate on-demand IT resources through infrastructure, system software, frameworks, software solutions, and protection layers. Second is the opportunity to foster innovation and business partnerships across the global community through creating rich integrated cloud environments.

As the industry progressed, it became evident that cloud computing could provide greater benefits.

Implications in IT/IT-es sector:

- The role of Chief Information Officer (CIOs) is changing from being service operators to service integrators.
- Automation of operational tasks in the cloud will mean IT resources will need to be reskilled to perform service integration tasks.
- The ability to innovate quickly and at scale through the cloud will mean the methods of work will also change.

2. Automation and robotics

The Internet of Things and Artificial Intelligence empowers automation solutions. Such maturing networks allow more stable and safe communications (both in the digital and physical world), thus providing the foundation for more challenging tasks for robots. The processor behind the project, on the other side, is artificial intelligence. The robots will then be tasked with more complex tasks as the programme operating these devices becomes better equipped to understand and perform cerebral basic tasks.

Implications in IT/IT-es sector:

- Automation and robotics provide a powerful opportunity for Indian companies to systematically free their resources from mundane tasks and channel them into building new offerings.
- More engaging prospects for engineers, analysts, coders and other employees, facilitating their migration from repetitive jobs into experimenting with leading-edge technologies and next-generation software.

3. Cognitive computing

Cognitive computing can be defined as systems that learn on a scale, reason for purpose, and naturally interact with people. The programmes learn and interpret their interactions with people and their observations with the world rather than being directly configured. One of the embodiments of the promise of this period took place in February 2011 when Watson, the cognitive processing programme of IBM, beat Jeopardy! champion participants. It was the first commonly used cognitive computing example, and it marked the start of computers making sense of unstructured data, in this case the intelligence needed to play the game show.

Implications in IT/IT-es sector:

- Automation for productivity with cognition for decision support.
- Enabling organisations to provide more accurate and faster decisions and to focus on the issues that need immediate attention.

4. Internet of things

Internet of Things (IoT) is a network of physical objects — devices, cars, structures, and other things embedded with electronics, software, sensors, and network connectivity — that allow these objects to sense or communicate with their internal state or external world.

Implications in IT/IT-es sector:

- IoT can help in consulting processes like governance strategy or strategic planning and business case development.
- IoT aids connectivity by way of Network Engineering, Network Implementation and Network security.
- IoT helps in integration of databases and its design and application modernisation.

5. Virtual and augmented reality

Virtual reality (VR) is the art and science of creating environments where people can either experience their contemporary world in a simulation or a completely different world. Augmented reality (AR) is mentioned in situations where humans are able to experience some capabilities of virtual reality while still present in their normal environment.

Implications in IT/IT-es sector:

- Disrupts any service that is traditionally delivered locally.
- With virtual reality, almost anyone can have access to products and experiences for experimentation, training or enjoyment which are considered expensive today.
- The technology could essentially open up new opportunities for businesses to take risks and innovate.

IV. Impact of Industrial Revolution 4.0 on work in the IT/IT-es sector

The industry consistent trend amidst the experts who were interviewed was on the emphasis of education in building the curiosity to learn. This curiosity, they pointed out, will reshape itself to not just kindle entrepreneurship but also push the workers to re-skill and up-skill themselves which is a sine-qua-non for surviving in the ever-changing sector of information technology. IT sector is in itself the sector of innovation. It is the sector where the latest technologies are evolved for the consumption of other sectors. Thus, for professionals to survive in this sector, it is necessary for them to reskill themselves.

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While the importance of up-skilling cannot be emphasized enough, it is pertinent to point out that many of these skills can be obtained via e-learning platforms run by various academic institutions and companies.[14] Also the practical aspects can be grasped either in run-time or during internship programs which various corporations run.[15] IBM takes teaching initiatives, without division on the lines of the popularity of the college, wherein the students are taught the practical aspects of the work (including the latest technologies) they will actually be doing in their work life and the program when coupled with internships have been really responsive.

In the IT Sector, there is a new technology every year. Given the limitations of a traditional college such as a bureaucratic establishment, sluggish update of curriculum, and irregular re-skilling of the faculties, it is incumbent on the students to be equally responsible for their skilling. A student/worker has access to thousands of gigabytes of internet data at his disposal to take up e-learning to understand emerging technologies and prepare himself for Industrial Revolution 4.0. It is preferred that an employee re-skill himself every six months. The industry leaders stressed that as long as there is curiosity and creativity the Industrial Revolution 4.0 will have no negative implications on jobs.

The industry leaders stressed that as long as there is curiosity and creativity the Industrial Revolution 4.0 will have no negative implications on job

1. Hiring and jobs

a. Hiring

The newer models of Skill-Biased Technical Change have led to the notion that automation is routine-biased, that is, it impacts jobs with primarily routine tasks across a range of skill levels.[16] This has traditionally served as an explanation for the job polarisation evidenced in high-income countries since non-routine tasks tend to cluster in the lower and upper ends of the job hierarchy while also accounting for interactions with other factors such as demographic shifts, labour law legislation, migration patterns etc.[17] One of the stakeholders stated, in the Indian labour context, that at the aggregate level, the non-routine cognitive (further subdivided as analytical and interactive) task intensity of jobs is increasing in India with a decline in manual task intensities (both routine and non-routine).[18] This is similar to what has been observed in the context of developed economy as well. However, a point of departure from global trends is that widespread de-routinisation of routine cognitive tasks is not evidenced in India. On the contrary, the routine cognitive task intensity of jobs has been constant. This is accredited largely to the nature of jobs in the agriculture and services sector.[19] Another stakeholder mentioned that, since Industry 4.0 is impacting more granular tasks of software production, there is a huge demand shift in the context of the hiring process. The industry is no longer concerned about the worker's knowledge of Java.Net. Rather, they have already

The newer models of Skill-Biased Technical Change have led to the notion that automation is routine-biased, that is, it impacts jobs with primarily routine tasks across a range of skill levels.

migrated to the Cloud and are now venturing into Robotics and want Cloud-Computing experts and NLP (Natural Learning Program) professionals among others.

Therefore, even though the industry is not venturing into or incorporating all emerging technologies right now, there is a demand for professionals with a good foundational knowledge of the Industrial Revolution 4.0 technology. The primary research conducted during this research demonstrates that demand for Industry 4.0 professionals are increasing and there is a scarcity in the market as of now. Compared to last year, the industry is venturing more into AI, Cloud, Robotics, NLP etc. Additionally, a stakeholder emphasised that hiring a new employee is costlier than reskilling and up-skilling. Also hiring entails losing the relationship built with the employee over time. Thus, instead of laying off professionals, the industry believes in up-skilling them.

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b. Jobs

Another stakeholder from an IT sector recruitment company pointed out that there has been a cumulative increase in jobs in the IT/IT-es sector. He added that the increase was predictable as the number of skilled job requirements is clearly on the rise. He emphasized that Industry 4.0 has not penetrated the IT/IT-es to a great extent. IT sector programming is still manual, unlike the automotive sector where the technology is leveraged for the heavy lifting and precision work. It must be reiterated that the AI for the automotive sector is developed by the experts in the IT sector itself. The emergence of Industry 4.0 technology has given rise to some new jobs too, like, content moderators on social media, where they need to track who is sponsoring these ads, and also fish out fake news and socially prohibited content.

IT sector programming is still manual, unlike the automotive sector where the technology is leveraged for the heavy lifting and precision work.

Similarly, a growth has been witnessed in the hiring of professionals who can label or transcribe raw data which can be used for training machine learning algorithms. These are the least sophisticated jobs. The ecosystem for development of such machine learning algorithms has evolved.

To illustrate, a company builds algorithms to improve certain functions. In order to build these algorithms, they need thousands of samples which will teach the machine how to function. This is where the labeling of data comes in. After a few learning exercises the machine can replicate the desired information. Once the machine is trained on this function, the company only needs data-scientists to oversee functionalities and suggest improvements. Data scientists engineer data and are the core employees who manage the data through distribution systems. The jobs which were earlier manned and were relatively easier have now faded. However, parallelly, jobs like that of data feeders and data scientists have increased.

2. Acquiring Industry 4.0 technologies

There are very few companies and as a result fewer success stories in India of companies investing in Industry 4.0 technologies. The IT/IT-es industry at large is not in a phase that it can bet on Industrial Revolution 4.0. technologies and indulge in Research and Development by dedicating resources for the same, pointed the stakeholders. Major players like Amazon Super, Google, Alibaba, Apple, IBM and others are investing beyond their time. Our field research records that the market is going for a merger and acquisition model. Instead of investing in research, companies are either acquiring startups which have already invested in the research or going for a tie-up

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3. Skilling infrastructure

A decade ago, the fraction of humanity with internet access hovered around 20 per cent. Studies suggest that a 10 per cent increase in internet penetration is correlated with a 1.35 per cent increase in GDP for developing countries.[20] Fixed broadband subscriptions have gone up from 82,409 users in 2002 to more

than 18,733,454 users today, according to World Bank data.[21] Mobile subscriptions, too, have gone up from 13 million in 2002 to more than one billion today. Internet users have gone up from 1.54 per cent to 29.56 per cent of India's population. Mobile penetration is extremely high with the majority having smartphones. Everyone has thousands of gigabytes of exposure. Directed or undirected, exposure is useful. Aspirations of students in the village and urban areas are the same.

a. Industry & Government Lead Skilling Programs

The primary research for the paper entailing interviews of experts involved in the skilling ecosystem informs that the practical knowledge which should be taught in Indian colleges in the context of Industry 4.0 is minimal. The stakeholders mentioned that there are a dozen IITs in our college but majority of our youth studies in other government and private engineering colleges where many-a-times a faculty for a regular course is non-existent - leave aside Industry 4.0.

b. Best practices

Partnership model: There are some colleges who rely on public-private-partnership model or outsourcing the curriculum designing and teaching to established market players. For example, IIT Tirupati has partnered with a vendor with expertise in Robotics. The robotics classes are scheduled for the last semester, increasing the chances for recruitment.

There are certain skills which ought to be imparted as part of the syllabus from the foundational year of the college itself. The stakeholders, which involved professors and industry leaders, stated that the demand for such skills in the industry has pushed them to go for such partnerships. Big Data, Cloud Computing and NLP are part of the skills among others taught during these partnership program, but only in few universities. The courses are still not recognised by the Government in the curriculum but were added to give a competitive edge to the students.

The stakeholders, which involved professors and industry leaders, stated that the demand for specialised skills in the industry has pushed them to go for such partnerships

Incubation centers: The stakeholder from an HR Consultancy explained that many IT companies connect with universities for development of incubation centres. The Microsoft incubation center is a classic example. Similarly quite a few incubation centers have been established in colleges across India.[22] The students are given a year to learn a particular skill-set required by the corporate, at the end of which, they are hired by the company.

Industry lead skilling: IBM mandates a minimum of 44 hours of mandatory re-skilling and up-skilling per year. The employees are encouraged to skill themselves beyond the minimum threshold too. IBM stops not just at providing the opportunity of skilling but measures the impact annually. The measurement is not just based on the hours dedicated by an employee on skilling but gauges the practical application of the new skills in the work of the employee. The stakeholder pointed out that most IT Companies provide for skilling opportunities through various models. Some companies provide skilling bonuses.

4. Gender

Female participation in the IT sector workforce is further impaired owing to technological barriers. There exists a digital divide where women face the brunt. In India, out of 481 million internet users, only 143 million (30 per cent) are women.[23] A study at the John F. Kennedy School of Government at Harvard University asserted that there exists a 33-percentage-point gender gap in mobile phone ownership in India which is "exacerbating inequality and inhibiting women's earnings, networking opportunities and access to information".[24]

This scenario in India is further worsened due to huge literacy and education gap which obviates women from learning social, interpersonal, soft and entrepreneurial skills. Adding to this is the backlash from the patriarchal setup, especially the high caste men who see technological enablement of women as a threat to established familial and societal structure. The

The gender gap in use of technology is worsened due to huge literacy and education gap which obviates women from learning social, interpersonal, soft and entrepreneurial skills.

women who somehow cross these barriers have to now face a hostile online environment.

Amnesty International in its project "Troll Patrol" decoded 500,000 tweets where women were trolled on parameters like religious and ethnic slurs, sexual and death threats, and stereotyping among others.[25] Such online abuse against women not only has adverse effects on their political participation and public life but also takes a toll on their mental health and forces women into self-censoring, limiting what they post, anonymising their accounts, or leaving the platform altogether. Additionally, it negatively impacts their perceptions of offline safety. Women who are from religious and ethnic minorities, transwomen, queer women, and Dalit women are especially affected.[26] Accordingly, this leads to inhibited access to economic opportunities, critical information, and social networks.

5. Impact on productivity in the IT sector

For any function of any organisation whether it is IT or any other sector, technology is interrupting the traditional transactional element of work. If earlier, people were manually crunching data, that job is now taken over by the machines.

For instance, say a company wants to interview 5000-10000 people. Earlier, they would create a Bank of Recruiters who would be given a script. The recruiters would use that script to call people. They would select people if their responses matched the script. And this is sequential, one call after the other. The machine can call 1000 people simultaneously and based on the response, it can pre-filter and bring down the number from 1000 to around 100. This way, if the questionnaire is of 10 minutes then between 11th to 15th minute a filter of 100 candidates is ready. This reduces time drastically and increases productivity. Video-Based Interviews opens another front of expertise wherein a machine can look at the facial expressions of the candidate, that is look for non-verbal clues. These patterns are judged by Algorithms and/or A.I."

6. Incidental impact on allied sectors

The IT industry works for the client. Once the technology is developed, new jobs will emerge in the automotive, telecom, textile sector and the likes. Technology in these sectors is getting redundant and is being replaced with emerging technology. During the visit to an Original Equipment Manufacturer working in the automotive sector in Gurgaon the interviewee explained how the factory incorporated the new technology in a phased manner. With the technological adoption, the workforce requirement reduced. The existing workforce was up-skilled and relocated to a nearby factory as the manufacturer had expanded operations owing to increasing demand.

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Another important facet of this is the rise of IT jobs in allied sectors. The Mercedes-Benz Research and Development Lab established in Bengaluru has developed an enhanced model with gesture controls.[27] Accordingly, the IT research work for the automobile sector for Industry 4.0 enabled cars is a new arena for employees who need to up-skill themselves.

Similarly, during the field visit to Northern India Textile Research Association, a Centre of Excellence for Protective Textiles established by the Ministry of Textiles, Government of India, the adoption of emerging technologies like IoT, robotics, sensors among others was witnessed. Smart textiles can be used in communicating information of the wearer, such as biological parameters including blood pressure, heart rate, temperature and location. The international smart textile market volume is anticipated to achieve US$ 5.55 billion by 2025 recording a CAGR of 30.4 per cent. International requirement of smart textile is chiefly driven by escalating dissemination of smart phones and other high-tech devices. Miniaturisation of electronic goods is anticipated to further fuel market expansion.

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There are many other companies who neither manufacture in India nor export to it but have their R&D Laboratories in India and use the Industrial

V. Conclusion and suggestions

The literature review and stakeholder interviews lead to three broad conclusions. First, the emerging technologies are still finding their way into the IT/IT-es sector of India. The automation reach along with the limited penetration of Industry 4.0 technologies has led to dilution of some routine job roles, intensification of existing job-roles, and creation of new job roles in the IT/IT-es sector and also allied sectors like medicine, textiles and automobile sector among others. Second, while the emerging technologies penetrate further, it is pertinent to streamline skilling, re-skilling and up-skilling mechanisms in the sectoral ecosystem wherein the burden is shared by all, i.e., the corporations, the State and the worker. Third, in order to tap the potential of Industrial Revolution 4.0 to boost India's digital economy the State has to develop forward-looking policies providing ground for evolution. The efforts of the State ought to be complimented by the Corporations in the ecosystem through skilling initiatives for the existing workforce and educational and internship opportunities for the upcoming workforce. With sincere efforts from the State and the corporations, it is upon the individual to make the best of the existing opportunities to educate and up-skill oneself. The major suggestions are:

1. Diversify export target countries

The Indian IT sector's heavy reliance on the United States, and the United Kingdom has adversely impacted the potential to make inroads in other major markets such as Japan. Moreover, this reliance has also stymied India moving up the value chain and not confining the areas of the IT sector specialisation to services and the BPO sector.[28] Such a heavy reliance on an export-oriented model, that too to a select few countries in not a pragmatic business model and was evidenced by the impact on the sector during the recession[29] and is being evidenced due to growing protectionism in the aforementioned countries. Consequently, there needs to be a shift within the industry to explore alternative venues of sustainable growth by both diversifying to other international jurisdictions while tapping into the domestic IT market in India itself.[30]

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2. Enabling lifelong learning capabilities

In a labour market that can be expected to undergo rapid changes, it becomes expedient for the government to develop dynamic high-quality lifelong learning programs. Such programs would enable reskilling and upskilling in the wake of an evolving technological environment and would also enable transitions that the workforce might face (such as moving from manufacturing to services or informal to formal etc.).[31] This would require a focus on employability in addition to the ongoing focus around sole employment. This has been highlighted in interviews with trade unions engaged in the IT sector.

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Upskilling of the workforce becomes more challenging given the design of the Indian education system along with a cultural proclivity towards undertaking formal education not later than 20-25 years of age.[32] Moreover, as the OECD report points out, "given that low-skilled workers are likely to bear the brunt of adjustment costs, efforts should be targeted on them, as well as on small and medium-sized enterprises which tend to face greater barriers to investments in training."[33]

3. Incentivising industry involvement in skilling

Access to upgraded technological infrastructure is the key to up-skilling, stated one of the stakeholders. E-learning or training programs led by high-skilled professionals, usually from abroad, is the usual mode of up-skilling of employees in the IT sector. A corporation can provide infrastructural and learning opportunities. It is incumbent upon the professional to kindle the curiosity and creativity within.

While the companies that were looked into during the research incorporate skilling programs, a need for incentivising demand-driven skilling programs within the larger ambit of government skilling programs has been felt.[34] While this was the idea behind underpinning the establishment of Sector Skill Councils, the Report of the Committee for Rationalization & Optimization of the Functioning of the Sector Skill Councils highlights several gaps plaguing the SSC framework.[35] It is also acknowledged that policies relating to higher education in the formative years after independence laid the foundation for the IT boom in India and that limited market failures now exist in the space of higher education. Accordingly, greater state intervention is required in primary education than in higher education.[36]

While companies incorporate skilling programs, a need for incentivising demand-driven skilling programs within the larger ambit of government skilling programs has been felt.

Platforms that allow the industry to work in tandem with the government could be one approach. This would entail utilising the industry's capital prowess and technological know-how to aid in the development of skills that are anticipated to be required in the future of work within the IT sector, and subsuming the industry's strengths into government envisioned skilling programs.[37] While one way to incentivise participation could be through purely financial perks: inclusion of participation in government skilling programs being added to permissible CSR activities and even tax breaks. Other incentive models such as firm-level incentives for quality upgradation and training[38] need to be looked at as well to determine the extent of private and public contributions towards these measures.[39]

Another financing model that is receiving consideration is a 'Reimbursable Industry Contribution' which would be a common pool of industry contributions to be utilised towards the training of manpower.[40] based of the training costs incurred over skilling, firms could then seek reimbursements from the fund. This could potentially solve the moral hazard preventing companies from undertaking rigorous skilling initiatives while also ensuring that there is financial skin in the game for firms.[41]

4. Strengthening social protection

The emergence of non-standard forms of employment is anticipated to only increase in the future of work. Problematically, these emerging employment relationships can be seen to exist alongside existing forms of employment that enjoy less to no labour law protection. Such as the variety of non-standard arrangements that exist in the informal economy (own account workers, contributing family workers, employees with informal jobs).[42] Building from the assumption that social security is a fundamental part of the implicit social contract of modern societies, it then becomes crucial to widen the net of social protection mechanisms by incorporating the realities of the future of work. What would be required is a fundamental shift in how social protection systems are currently premised on an existing unique employer-employee relationship. Decoupling entitlements from the traditional centrality of employment and instead focussing on the individual would ensure portability of entitlements across jobs while also not acting as an impediment in terms of labour mobility can be anticipated to acquire heightened importance.[43] It also then becomes crucial to envision ways in which the employer-employee relationships are seen. The ILO's Recommendation No. 198 developed in 2006 at the General Conference can be a very useful starting point. It emphasises on understanding working arrangements basis the nature of the work that is being carried out as opposed to how the arrangement is described contractually - indeed this is how disguised employment[44] manifests.[45]

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While implementing such a policy measure, it is naturally important to anticipate ways in which to sustainably finance a stronger social protection system. There could be two ways to do so: contributions and taxes. Entirely decoupling entitlements from jobs is not desirable as contributory forms of financing can sustainably work only with regular sources of income, and one way to solve that could be to make social security accounts multi-

employer, as in the United States.[46] In terms of taxation, in the interests of social and distributive justice, one policy tool could be to tax the usage and adoption technologies to ensure a more equitable sharing of productivity gains with the society at large.[47]

5. Building an R&D ecosystem

Multiple stakeholders echoed that that India is lagging behind in automation reach. Such technological disruptions happen in various universities around the world. Our government could develop a culture of investment in R&D centres, like in some countries around the world.

Oxford Insights and the International Development Research Centre reported that AI technologies are forecast to add US$15 trillion to the global economy by 2030. With Singapore, UK, Germany and USA taking the lead, the 2019 Government AI Readiness Index ranks India at 17.[48] While the Global North leads the ranking, the Global South is lagging behind in penetration of Industrial Revolution 4.0 technologies. There are 23 Indian Institutes of Technology (I.I.T.) and 31 National Institutes of Technology (N.I.T.) which are the backbone of technological advancement in India.

Ministry of Electronics and Information Technology has also established dedicated 'Electronics and ICT Academy' at the Indian Institute of Information Technology, Design, and Manufacturing, Jabalpur, NIT Patna, IIT Guwahati, IIT Kanpur, Malaviya National Institute of Technology Jaipur and IIT Roorkee. These Academies offer specialised courses in Big Data Analytics, Wireless Sensor Networks,, Embedded Systems, Technologies for Smart City, Cloud Computing and Cyber Security, Industry focused IT and Management Certification Courses, Innovative Delivery Mechanisms, Nano-Electronic Devices & Circuits; Soft-Computing, Data Mining, Video Surveillance and Analytics, Robotic All-Terrain Vehicle, GIS for Spatial Data Security, Handheld explosive detectors, etc.

Additionally, National Centre of Excellence in Technology for Internal Security (NCETIS) has been set up at IIT Bombay with an outlay of Rs 83.89 crore for five years and National Centre for Flexible Electronics (NCFlexE) has been set up at IIT Kanpur with an outlay of Rs 132.99 Cr for five years.

Despite the establishment of such grand institutions, India is unable to lead the discussion on technological disruptions. There is a need to develop a cultural shift in the Indian education system by instilling innovation and cross-sectional education at the center. IIT Delhi's 'PhD Incubator Program' to allow PhD students to kickstart a startup instead of Thesis is a move in the positive direction.[49] This program not only boosts technological disruptions in academic institutions and brings together the industry and the academia, but also generates employment opportunities.

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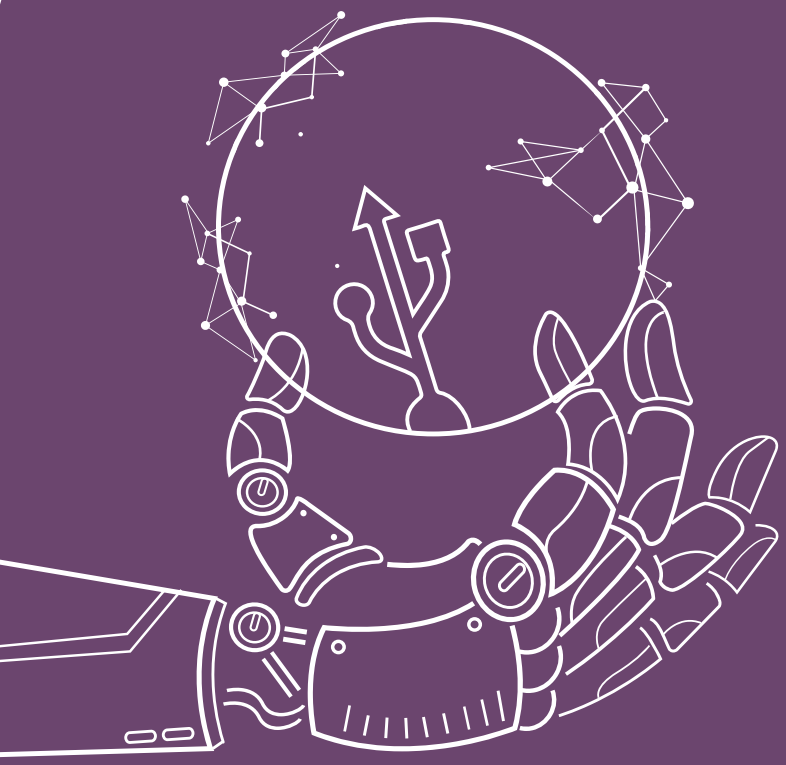

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